



City Research Online

City, University of London Institutional Repository

Citation: Spedale, S. (2000). The emergence of the network supply-chain: a study of co-operation and performance in supply-chain relationships in the UK fibre-optics industry. (Unpublished Doctoral thesis, City University London)

This is the accepted version of the paper.

This version of the publication may differ from the final published version.

Permanent repository link: <https://openaccess.city.ac.uk/id/eprint/8167/>

Link to published version:

Copyright: City Research Online aims to make research outputs of City, University of London available to a wider audience. Copyright and Moral Rights remain with the author(s) and/or copyright holders. URLs from City Research Online may be freely distributed and linked to.

Reuse: Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge. Provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

THE EMERGENCE OF THE NETWORK SUPPLY-CHAIN
A study of co-operation and performance in supply-chain
relationships in the UK fibre-optics industry

A Doctoral Thesis Presented
By

Simona Spedale

Submitted to
City University Business School
Department of Human Resource Management and Organisational Behaviour

In fulfilment of the requirement for the award of the degree of
Doctor of Philosophy

October, 2000

TABLE OF CONTENTS

	page	1
CHAPTER 1 – THE NATURE OF THE RESEARCH		
	page	1
Introduction	page	2
1.1 Research objectives	page	4
1.2 Research contribution to the existing body of knowledge	page	6
1.3 Structure of the thesis		
CHAPTER 2 – A REVIEW OF THE EMPIRICAL EVIDENCE	page	8
2.1 The nature of changes in supply-chain management	page	9
2.1.1 The role of the lead firm	page	13
2.1.2 The network supply-chain: key issues in the emergence of a new organisational form	page	15
2.2 The relationship between organisational networks, co-operative inter-organisational relationships, and organisational performance	page	17
2.3 Gaps in the literature and new directions for research	page	23
CHAPTER 3 – THE THEORETICAL FRAMEWORK: A DEFINITION OF ‘ORGANISATIONAL NETWORKS’	page	25
3.1 The network organisation: an overview	page	25
3.1.1 The contribution of Organisation Studies	page	26
3.1.2 The contribution of Organisational Economics	page	33
3.1.3 The contribution of Strategy	page	44
3.2 An overview of the different contributions	page	49
CHAPTER 4 – THE RESEARCH CONTEXT	page	52
4.1 Opto-electronics: a technological discontinuity	page	53
4.1.1 Optical communication systems: technical aspects	page	55
4.1.2 The evolution of opto-electronics technology	page	57
4.2 The economics of optical communications	page	60
4.3 The market for optical communication systems	page	61
4.4 The supply side	page	62
4.5 Summary: a few strategic implications	page	66
CHAPTER 5 – THE RESEARCH FRAMEWORK	page	68
5.1 The research questions	page	68
5.2 The network supply-chain: a working definition	page	69
5.3 Network supply relationships: operationalisation	page	71
5.4 Organisational performance: definition and operationalisation	page	75
CHAPTER 6 – RESEARCH STRATEGY AND METHODOLOGY	page	79
6.1 Research strategy	page	79
6.2 The selection of a suitable context for the study	page	82
6.3 Research methodology	page	84
6.4 Data collection and the unit of analysis	page	86
6.5 The questionnaire	page	87
6.6 The sample	page	100

CHAPTER 7 – SURVEY FINDINGS: THE EVIDENCE ON ORGANISATIONAL PROCESSES	page 102
7.1 Response rate and general characteristics of respondents	page 103
7.2 The organisational structure of purchasing	page 109
7.3 General evidence on change in supply-chain management: an analysis of traditional indicators	page 113
7.4 The evidence on the six organisational areas	page 119
7.5 The emergence of the network supply-chain: the case of the UK optical communications systems industry	page 134
CHAPTER 8 – CO-OPERATIVE SUPPLY RELATIONSHIPS AND ORGANISATIONAL PERFORMANCE: THE FINDINGS	page 138
8.1 Overall trends in organisational performance of the sample firms	page 138
8.1.1 Efficiency	page 139
8.1.2 Innovation	page 142
8.1.3 General financial performance	page 146
8.1.4 Summary	page 147
8.2 The correlation analysis	page 149
8.2.1 The correlation coefficients	page 155
8.3 Network supply relationships and organisational performance in the UK optical communications systems industry	page 168
CHAPTER 9 – THE FOLLOW-UP INTERVIEWS	page 171
9.1 Case sample and interview structure	page 171
9.2 The mini-case studies	page 174
9.2.1 The case of manufacturers	page 174
9.2.2 The manufacturers: a comparison	page 178
9.2.3 The case of installers	page 179
9.2.4 The installers: a comparison	page 187
9.3 Integrating survey and interviews: a discussion of the case studies	page 188
9.3.1 Differences between manufacturers and installers	page 188
9.3.2 Differences among installers	page 190
9.3.4 The role of the contract	page 192
CHAPTER 10 – CONCLUSIONS	page 193
10.1 Industry characteristics and the sample	page 194
10.2 Research findings: the relationship between governance forms in the supply-chain, technology , and organisational performance	page 196
10.3 Exploring the relationship between governance, performance and technology: The exploitative and explorative models of network supply relationships	page 202
10.4 A few research implications	page 210
LIST OF REFERENCES	page 214
APPENDIX A – SURVEY QUESTIONNAIRE	page 233
APPENDIX B – The components of a fibre-optics communications system	page 243
APPENDIX C – CONFERENCE PAPERS AND PUBLICATIONS	page 248

LIST OF FIGURES

Figure 2.1 Antagonistic versus Co-operative Model (adapted from Matthyssen and van den Bulte, 1994)	page 11
Figure 2.2 A comparison of supply management models (adapted from Dyer, Sung Cho, and Chu, 1998)	page 12
Figure 2.3 Information Codification/Power Relations Matrix (adapted from Scher, 1997)	page 22
Figure 3.1 The governance of contractual relations (adapted from Williamson, 1985)	page 36
Figure 4.1 Miyazaki’s model applied to opto-electronics	page 53
Figure 4.2 An optical communications system (adapted from the European Fibre Optics Directory and Report)	page 56
Figure 4.3 The structure of the optical communications systems industry	page 63
Figure 6.1 Research Strategy Matrix: a Comparison of Alternatives	page 80
Figure 7.1 Size: scatter-plot of respondents according to annual revenue and employees	page 104
Figure 7.2 Distribution of respondents by size and primary activity	page 106
Figure 7.3 Ownership: distribution of respondents by size	page 107
Figure 7.4 Number of employees in purchasing: distribution of firms	page 110
Figure 7.5 Macro-classes of denomination of the unit in charge of purchasing: distribution of respondents	page 111
Figure 7.6 Line of reporting: distribution of respondents	page 112
Figure 7.7 Major rationale for change in supply-chain management strategy	page 115
Figure 7.8 Trend in the number of suppliers	page 116
Figure 7.9 Trend in the number of suppliers: small versus large firms	page 116
Figure 7.10 Recent trend in importance of the key supply strategies	page 118
Figure 7.11 Collaboration in research and concept design: Small vs. Large	page 121
Figure 7.12 Collaboration in design and engineering: Small vs. Large	page 121
Figure 7.13 Collaboration in installation and distribution: Small vs. Large	page 122
Figure 7.14 Collaboration in research and concept design: Manufacturers vs. Installers	page 123
Figure 7.15 Collaboration in design and engineering: Manufacturers vs. Installers	page 123
Figure 7.16 Collaboration in installation and distribution: Manufacturers vs. Installers	page 124
Figure 7.17 Intensity of use of selection criteria	page 125
Figure 7.18 Transparency practices: degree of utilisation	page 128
Figure 7.19 Degree of specification of the contract: manufacturers vs. Installers	page 131
Figure 7.20 Conflict resolution mechanisms: All respondents, Manufacturers and Installers	page 132
Figure 7.21 Relationships assessment mechanisms	page 133
Figure 8.1 Price, Overall product-cost and Order-to-delivery time	page 141
Figure 8.2 Productivity improvement	page 142
Figure 8.3 Time-to-market for new innovation	page 144
Figure 8.4 General financial performance	page 147
Figure 10.1 A positioning matrix	page 206

LIST OF TABLES

Table 3.1 The definition of the Network form: the contribution of Organisation Studies	page 32
Table 3.2 Distinguishing characteristics of forms of transactions (adapted from Ring and van de Ven, 1992)	page 38
Table 3.3 The definition of the Network form: the contribution of Transaction Cost Economics	page 43
Table 3.4 N-form and M-form: a comparison (adapted form Hedlund, 1994)	page 46
Table 3.5 The definition of the Network for: the contribution of Strategy	page 48
Table 4.1 Matrix of opto-electronics related markets and technologies (from Miyazaki, 1995)	page 54
Table 4.2 The evolution of optical communications technology	page 58
Table 4.3 European applications sales of fibre-optics communications components (1992-1997)	page 62
Table 4.4 Estimated market shares of fibre-optics communications components for the major suppliers to the European market (Frost and Sullivan, 1992)	page 66
Table 5.1 Three alternative ways of managing supply relations	page 71
Table 5.2 A comparison between alternative economic institutions for regulating supply relations: key organisational areas	page 74
Table 5.3 Performance indicators	page 78
Table 7.1 Analysis of the overall response rate	page 103
Table 7.2 Manufacturers vs. installers by size: a comparison	page 107
Table 7.3 Spatial distribution of respondents according to size	page 109
Table 7.4 Spatial distribution of respondents according to primary activity	page 109
Table 7.5 Degree of strategic importance of the main six items purchased by the firm	page 114
Table 7.6 Availability in the market for the 196 items listed by the respondents	page 114
Table 7.7 Average length of supply relationships: frequency	page 119
Table 7.8 Selection criteria: trend in importance (percentage of respondents)	page 126
Table 7.9 Performance evaluation criteria: trend in importance (percentage of respondents)	page 130
Table 8.1 Percentage of sales for different categories of new products (percentage of respondents)	page 145
Table 8.2 Correlation analysis: independent and dependent variables	page 149
Table 8.3 Composite variables: an overview	page 151
Table 8.4 Teamwork across organisational boundaries and performance: whole sample	page 155
Table 8.5 Teamwork across boundaries and performance: primary activity and size	page 156
Table 8.6 Span of competencies in selection criteria and performance: whole sample	page 158
Table 8.7 Span of competencies in selection criteria and performance: primary activity and size	page 159
Table 8.8 Commitment to suppliers and performance: whole sample	page 160
Table 8.9 Commitment to suppliers and performance: primary activity and size	page 161
Table 8.10 Supplier's performance evaluation and performance: whole sample	page 162
Table 8.11 Supplier's performance evaluation and performance: primary activity and size	page 163
Table 8.12 Role of the contract and performance: whole sample	page 164
Table 8.13 Role of the contract and performance: primary activity and size	page 165
Table 8.14 Conflict resolution and performance: whole sample	page 166
Table 8.15 Conflict resolution and performance: primary activity and size	page 167
Table 8.16 Correlation analysis: key findings	page 169
Table 9.1 Key characteristics of the firms included in the sample	page 173
Table 9.2 Company A: selection criteria for 'partnering suppliers'	page 176
Table 10.1 Independent and dependent variables is the correlation analysis	page 197
Table 10.2 Correlation analysis: key findings	page 199
Table 10.3 Behavioural patters of co-operation in supply relationships among four types of firms	page 205
Table 10.4 Two models of co-operation in supply relationships	page 207

ACKNOWLEDGEMENTS

This thesis would not have been possible without the help and support of many people. In particular, I would like to thank:

Professor Chris Hendry, my supervisor. Chris has always shown me enormous support and understanding, and has never stopped encouraging me in my efforts - even when my own self-confidence was put to severe test. He has been a challenging supervisor, but always constructive and helpful in his criticism. I have learnt a lot from him, and am very grateful.

Professors Franco Amigoni and Sergio Beretta for their support and encouragement during my years at Bocconi University, Milan and, most of all, when evaluating the opportunity to pursue Ph.D. studies abroad. My thanks also go to Bocconi University for contributing part of the funding for the first two years of the Ph.D.

All the people - both members of staff and Ph.D. students – from the Departments of Human Resource Management and Organisation Theory and Marketing and International Strategy, who have contributed their help and advice during seminars, workshops, and more informal meetings in the past five years. Special thanks go to Jim Brown, whose expertise in the area of my research has been very helpful and whose comments have always been illuminating. I also have a debt of gratitude to all the people who have contributed to the research – managers and practitioners I interviewed - for their time, for their interest in my studies, and for sharing their knowledge with me.

My fellow Ph.D. students at CUBS. Thank you all for sharing with me the good and bad times, in the Research Room as well as outside. A Ph.D., especially in an unfamiliar environment, can be a very lonely and disheartening experience, but I have been extremely lucky and have made good friends along the way. So, very simply, thank you Peter, Alex, George A., John, Mohammed, Amir, Moala, Oliviero, Mara, George K. and the rest of the ‘gang’. A very special thanks goes to Peter McNamara. From the very first day at CUBS, Peter has been there for me as a source of inspiration and new ideas, as a benchmark to measure my progress against, as an invaluable adviser and counsellor, and, above all, as a friend. I really appreciate that, and hope someday to be able to return the favour.

I cannot find words good enough to express my gratitude and love for my family, who have always supported me and stood by me. My husband Dave had the unenviable task of putting up with me at my worst, and did so with incredible patience. I only hope both Dave and my family know how important they all are to me, and how close to my heart.

DECLARATION TO THE LIBRARIAN

I grant power to the University Librarian to allow this thesis to be copied in whole or in part without further reference to me. This permission covers only single copies made for study purposes, subject to normal conditions of acknowledgement.

ABSTRACT

This study focuses on the emergence of a new governance form, the network supply-chain, in the UK optical communications systems industry. In doing so, it pursues two objectives.

The first is to investigate the extent of the shift from market-oriented to co-operation-oriented mechanisms in governing supply relationships. The focus is on the contingencies of this change and, in particular, on the impact of technology on the development of co-operative forms of governance.

The second objective of the research is to test the linkage between governance forms in the supply-chain and organisational performance, particularly efficiency and innovation. Again, the impact of technology on this relationship is put to test.

The study relies on a combination of secondary, survey and interview data. The key finding is that the degree of maturity of the technology has an impact on both the type of co-operative form governing supply relationships and its relationship with organisational performance.

For performance, co-operative governance forms in the supply-chain have a positive impact on efficiency (both global and partial) and innovation when the core technology of the firm is mature. When a radically new technology is still emerging, the network supply-chain has a limited positive impact on efficiency (partial only) and a negative one on innovation. Moreover, in emergent industries, the network supply-chain can hamper and delay technological development.

For the type of co-operative form, we identify two models of co-operative supply relationships, respectively named the exploitative and the explorative model. These are ideal-types that take into account the connection between technology, governance mechanisms, and organisational performance, and can be found in more or less pure form in real contexts. The exploitative model is consistent with environments where the technology is well established; ‘exploitation’ is the main strategic driver; and efficiency and incremental innovation the predominant objectives.

The explorative model is consistent with environments where a specific technology has not yet established itself as the dominant one; ‘exploration’ is still a strategic priority; and the search for opportunities to diffuse the emergent technology is the fundamental objective. Both the exploitative and the explorative models need a ‘trigger’ to develop in contexts previously dominated by market-oriented mechanisms. In other words, the change in governance forms in the supply-chain only occurs in response to an external event or condition.

CHAPTER 1 - THE NATURE OF THE RESEARCH

Introduction

In the wake of the “organisational revolution” (Miles and Snow, 1992) of the 1980s, increased attention is being given to subcontracting systems. Supply-chains are not a recent phenomenon, and for many decades they have constituted the traditional way of dividing and allocating activities among independent firms in various industries. The renewed interest in this particular organisational arrangement shared by academics and practitioners, however, is due to two elements. First of all, supply relationships are increasingly used as an efficient way of organising economic activities. Their diffusion has spread beyond the traditional scope of the sub-contracting system. New supply-chains have emerged from major restructuring and re-organisation processes involving large integrated firms. Large firms have, in a significant number of cases, fragmented their value chains and, while concentrating on few core activities, have out-sourced or sub-contracted the others.

Secondly, a substantial qualitative change in the way both new and old supply-chains are managed is taking place. Supply-chain management is progressively reshaping itself from the “stable and largely ignored process in the background of the leading firm” characteristic of the past (Brown and Hendry, 1998) into a critical and strategically relevant activity. Traditional supply relationships, based on a sharp appreciation of the different roles played by the parties involved, are changing in favour of relationships based on shared recognition of mutual interdependence.

From a researcher’s point of view, two aspects deserve special attention. The first is the way **buyer-supplier relationships are governed**. There is growing evidence of a shift from market-oriented to co-operation-oriented forms to govern supply relationships, so that buyer and supplier think of themselves as partners. Most of the evidence so far available is, however, based on the study of a limited number of industries. To broaden the analysis by collecting fresh data across different sectors is of fundamental importance if the change is to be regarded as structural and pervasive.

The second aspect is the impact of co-operation in the supply-chain on organisational performance. It is commonly thought that co-operation is the fundamental key to competitiveness because it creates the right organisational context for both increased efficiency and enhanced creativity and innovation capability. Market-based relationships tend to be seen as negative because they are one-sided. They may promote immediate efficiency gains, but may also hamper the development of creativity and innovation in the long term. Whether this is true and, if this is the case, under what conditions and contingencies is a fundamentally important issue.

1.1 Research objectives

This study focuses on the emergence of a new governance form, the network supply-chain, in the UK optical communications systems industry¹. The research concentrates on the shift from market-oriented to co-operation-oriented forms governing supply relations in this industry with two objectives. First, to investigate the extent of this change and its contingencies, and in particular the impact of technology. Optical communications systems is an industry characterised by the co-existence of – and on-going race between - two technologies, ‘established’ copper and ‘emergent’ fibre-optics, and therefore it offers an ideal context to test the role of technology in the development of co-operative forms of governance.

The second objective of the research is to test the linkage between governance forms in the supply-chain and organisational performance. Is it possible to correlate the adoption of co-operation as the fundamental principle to govern supply relationships with improvements in efficiency and innovation? Does technology have a significant impact on the relationship between governance forms and performance?

¹ For the purposes of the present study market, hierarchy (i.e. vertical integration) and co-operation (or networking) are considered three alternative institutional settings for co-ordinating economic exchanges (Jarillo, 1993). Three co-ordination mechanisms can also be identified - that is price, authority and trust. However, there is no direct and complete correlation between a specific economic institution and a specific co-ordination mechanism. Each institution uses all three mechanisms to some degree (Bidault and Jarillo, 1995).

The conclusions of the study are presented in detail in Chapter 10. The primary outcome of the research is the identification of two models of co-operative supply relationships, respectively named the exploitative and the explorative model, that take into account the connection between technology, governance mechanisms, and organisational performance. The exploitative model is consistent with environments where the technology is well established, ‘exploitation’ is the main strategic driver and efficiency and incremental innovation the predominant objectives. The explorative model is consistent with environments where a specific technology has not yet established itself as the dominant one, ‘exploration’ is still a strategic priority and the search for opportunities to diffuse the emergent technology is the fundamental objective.

From a methodological point of view, the research constitutes an attempt at developing an original and practical way to operationalise the key concept of co-operation or ‘networking’². Co-operation is not operationalised through the immediate application of a theoretical definition derived from the literature. Indeed, the proposed definition of co-operative network integrates different theoretical contributions (see Chapters 3 and 4). Instead, a process approach is used for operationalising the concept of networking and our measurement effort concentrates on the relevant characteristics of the key inter-organisational processes that underpin every supply relationship.

By focusing on the two objectives highlighted above, the research field is accordingly restricted. Some important issues are excluded from the boundaries of the study and left unexplored that are potentially interesting areas of research. A few examples are presented here, but others emerge in the course of the study. First of all, the present study is not concerned with exploring the fundamental reasons for adopting co-operation as a basis for inter-organisational relationships in the supply-chain. This is an important area that is left in the background. The main rationale for this choice is that this is the very issue most studies in this area up to the present time have been concerned with, and it seems now necessary to move the research scope further on. Most studies take for granted that the shift towards more co-operative forms of

² For the purposes of the present study co-operation and ‘networking’ are used indiscriminately to indicate the third economic institution available besides market and hierarchy.

organising supply relations is a pervasive phenomenon, but stronger empirical evidence is required to substantiate this assumption.

Equally, the study does not address the issue of whether the changes represent the outcome of emergent strategies or constitute realised strategy, or to what extent an intended strategy is put into practice. Another fundamental issue that is not addressed is the influence of personal relationships on co-operative behaviour between organisations - that is the interaction and interplay of two levels of analysis, the individual level and the organisational level. This study concentrates on the organisational one.

1.2 Research contribution to the existing body of knowledge

The research contributions to the existing body of knowledge are both theoretical and practical. First of all, the research concentrates on an under-researched context such as the UK optical communications systems industry and, consequently, offers new empirical evidence for the study of co-operation in supply relationships. This new evidence supports the view that the diffusion of co-operative supply relationships is not confined to traditional industries with established technologies, such as automotive, but affects high-tech industries and industries where the technology is still at a developmental stage.

Secondly, the research identifies an environmental variable – the degree of maturity of the technology – that affects both the form and the outcome of co-operation in supply relationships. The two models of exploitative and explorative co-operation summarise the relationship between governance form, organisational performance and technology and offer a starting point for a deeper understanding of the complexity of inter-organisational relationships and behaviours. This is valuable for both researchers and practitioners. It is valuable for researchers because they can approach the study of co-operation starting from a more refined conceptualisation of the phenomenon. It suits practitioners because they find themselves better equipped to make sense of the jungle of directions all generically pointing to co-operation as the key to improved performance.

The study adds, in fact, to the short list of contributions that take a more critical view of co-operation as a recipe for competitive success. It improves our understanding of the conditions and contingencies under which the adoption of co-operative arrangements is truly beneficial and helps clarifying the relationship between different types of co-operation and performance improvements. The practical implications are immediately obvious at two critical levels. The first is the level of the individual organisation, whose managers can engage in co-operative strategies that are more in line with their expected results. The second is the level of industry and policy making. This knowledge could contribute to direct more effectively the efforts of institutions and agencies whose main concern is to promote the competitiveness of nationally key industries.

Finally, the study puts an original methodological approach to the study of co-operation to test. There is no general consensus on what ‘networking’ is, or on the specific characteristics of co-operative organisational structures. Different disciplines offer different definitions, and provide different sets of criteria to measure co-operation. From a research point of view, the problem is that most of these criteria prove extremely difficult to translate into operational measures that can be used in concrete research projects.

The study suggests a way out of this problem. The solution proposed is to concentrate on organisational processes as a tool to measure co-operation. Instead of directly applying the theoretical definition of co-operation to find the metrics, this study looks at the expected effects of co-operation on a number of key organisational processes and areas. The characteristics of these processes are more readily observable and can provide a surrogate measure of the degree and nature of co-operation underpinning the relationship. The theoretical issue of the definition of ‘networking’ and co-operative organisational structures is addressed in the literature review carried out in Chapter 3. It always lies in the background. However, in order to get out of the ‘jungle’ of too many, not-so-operationalisable definitions, a process approach is suggested and a manageable way of measuring co-operation is proposed.

1.3 Structure of the thesis

Chapter 2 and 3 are devoted to the analysis of the existing literature and the development of the theoretical framework. A number of theories and concepts are derived that help clarify the boundaries of the present research and sustain the methodological choices. In particular, Chapter 2 concentrates on the changes currently occurring in supply-chain management. In so doing, it draws attention to the need for more empirical evidence on the extent of the shift towards co-operation and away from arm's length relationships, and whether this is pervasive and affects all industries. Chapter 2 also addresses the relationship between co-operation in the supply-chain and organisational performance. The case for a better understanding of the complex and ambiguous relationship between co-operation and performance is reinforced. Chapter 3 is devoted to the theoretical issues in defining the network organisation and identifying its founding characteristics. Different theoretical perspectives are introduced and analysed, and the integration of different theoretical contributions is suggested as a fruitful way to derive a suitable working definition.

Chapter 4 concentrates on the analysis of the research context, the UK optical communications systems industry. Particular attention is devoted to the understanding of the specific characteristics of opto-electronics technology. A general knowledge of the technology, of its overall development, and of its impact on the competitive game provides the necessary background for understanding individual firms' behaviours and strategies.

Chapter 5 is devoted to the operationalisation of the key variables used in the study. A number of key definitions and concepts are introduced. In particular, a definition of co-operative networks in the supply-chain is derived from a review of the literature in Chapters 2 and 3. However, as already suggested, the practical operationalisation of the key variables and concepts of the study relies on a process approach. A number of key organisational processes and areas are identified whose characteristics can be used as

indirect measures of the existence and type of a network-based relationship between buyer and supplier.

Chapter 6 outlines the **research strategy and detailed methodology**. The research strategy and design are described by presenting the iterative process that led to their final shape. Special attention is also given to the development of the survey instrument, so that the connections with the research concepts and variables are clearly identified.

Chapter 7 reports the **survey findings** and concentrates on the presentation of descriptive survey data. **Chapter 8** follows immediately with the results of the correlation analysis on the relevant survey data. The main objective of this analysis is to correlate specific characteristics of the organisational processes and areas (independent variables) selected to operationalise co-operation in supply relationships with efficiency and innovation, the selected dimensions of organisational performance (dependent variables).

Chapter 9 reports the findings of the **follow-up interviews** with a number of managers of firms involved in manufacturing and installation of optical communication systems. The interviews concentrate on a number of issues raised by, but not fully accounted for in, the survey. The findings are presented in six mini-case studies that reveal valuable information for a deeper understanding of the development of supply relationships in the UK optical communications systems industry. Chapter 9 concludes with a general discussion based on the integration of survey and interview data.

Chapter 10 summarises the **conclusions** of the study and presents the key findings on the relationship between governance forms in the supply-chain, organisational performance and technology. It also presents the two models of explorative and exploitative co-operation in the supply-chain and highlights the conditions under which they develop. Finally a few implications of the study for academic research and for practitioners are presented.

CHAPTER 2 - A REVIEW OF THE EMPIRICAL EVIDENCE

Chapters 2 and 3 develop the theoretical framework for the research issues in Chapter 1. The literature review is primarily driven by the need to narrow and clearly define the boundaries of the empirical study. Also, the identification of significant gaps in the literature legitimises the research and highlights its original contribution to the existing body of knowledge.

Chapter 2 concentrates on the **changes currently occurring in supply-chain management**. The need to gather more empirical evidence to corroborate the idea of a diffusive adoption of co-operation as the fundamental principle to regulate supply relationships is given special attention. Chapter 2 also addresses the issue of the **relationship between co-operation in the supply-chain and organisational performance**. The case for a better understanding of the complex and so far poorly understood relationship between co-operation and performance is reinforced. The idea that co-operation, with no further qualifications, contemporaneously fosters all dimensions of performance in all cases and circumstances is therefore questioned as not effectively representative of the real phenomenon. This paves the way for the introduction in Chapter 10 of a new variable – the degree of maturity of the technology – that has a significant impact in shaping the form and outcomes of co-operative supply relationships.

Chapter 3 is devoted to the theory of the network organisation and to identifying its founding characteristics. Different theoretical perspectives are introduced and analysed. The lack of a comprehensive theory encompassing all aspects of the life of network-based organisational structures is highlighted. The integration of contributions from different disciplinary fields is suggested as the most promising and practicable way to move empirical research forward.

The structure of Chapter 2 is, in consequence, as follows. First, we consider the issue of the nature and actual extent of the changes occurring in supply-chain management. Second, we analyse the relationship between organisational ‘networks’ (and co-

operative inter-organisational relationships) and organisational performance, with particular attention to supply-chains. Finally, relevant gaps in the literature are identified and the boundaries of the research more clearly defined.

2.1 The nature of changes in supply-chain management

A growing body of literature suggests that advanced economies are experiencing a **substantial economic restructuring**, with an increased role for small, independent firms engaging in co-operative partnerships with customers and suppliers. In the process, there is growing recognition that inter-firm relations have a significant impact on economic performance. Concepts such as flexible specialisation (Hirst and Zeitling, 1989; Piore and Sabel, 1984), just-in-time systems of production (Shoenberger, 1982; Voss, 1987), and the lean production system (Womack, Jones, and Roos, 1990) are all part of this debate about the changing nature of inter-firm relations and the emergence of co-operative buyer-supplier relationships.

A number of causes are suggested in the literature to justify the shift from **relationships based on power and bargaining positions to partnerships based on trust and co-operation**. Examples include the impact of the so-called ‘new competition’ (Best, 1990; Speckman, Kamauff, and Salmond, 1994); the increasing importance of quality-based and time-based competition (Blackburn, 1991; Jones, 1985; Stalk and Hout, 1990); and the growing uncertainty of product markets (Sabel, 1992). These factors contribute to the crisis of the traditional mass-production system. Alternative emerging systems, like the “lean production” system (Womack, Jones, and Roos, 1990), tend to reduce the relative importance of once fundamental elements such as high volumes, standardisation, economies of scale and the experience curve in the pursuit of cost-minimisation and efficiency. Efficiency and cost-minimisation are always fundamental objectives, but their achievement is more and more the result of a complex and inter-functional process of continuous improvement rather than of a thorough application of mass-production principles. Cost reduction, timeliness (in terms of both time-to market and punctuality), and quality are no longer alternative objectives. They can be pursued together by means of an accurate fine-tuning and scheduling of

activities throughout the overall production process (Schonberger, 1982; Ferdows et al., 1986; Imai, 1985; Ferdows and De Meyer, 1989).

The boundaries of organisational units that constitute the ‘production set’ both within and outside the firm tend to blur. Moreover, following the increased dynamism of the environment and the rising level of competition, the ability to generate a continuous flow of innovations and to reduce the period between invention and market introduction has become paramount (Bolwijn and Kumpe, 1990).

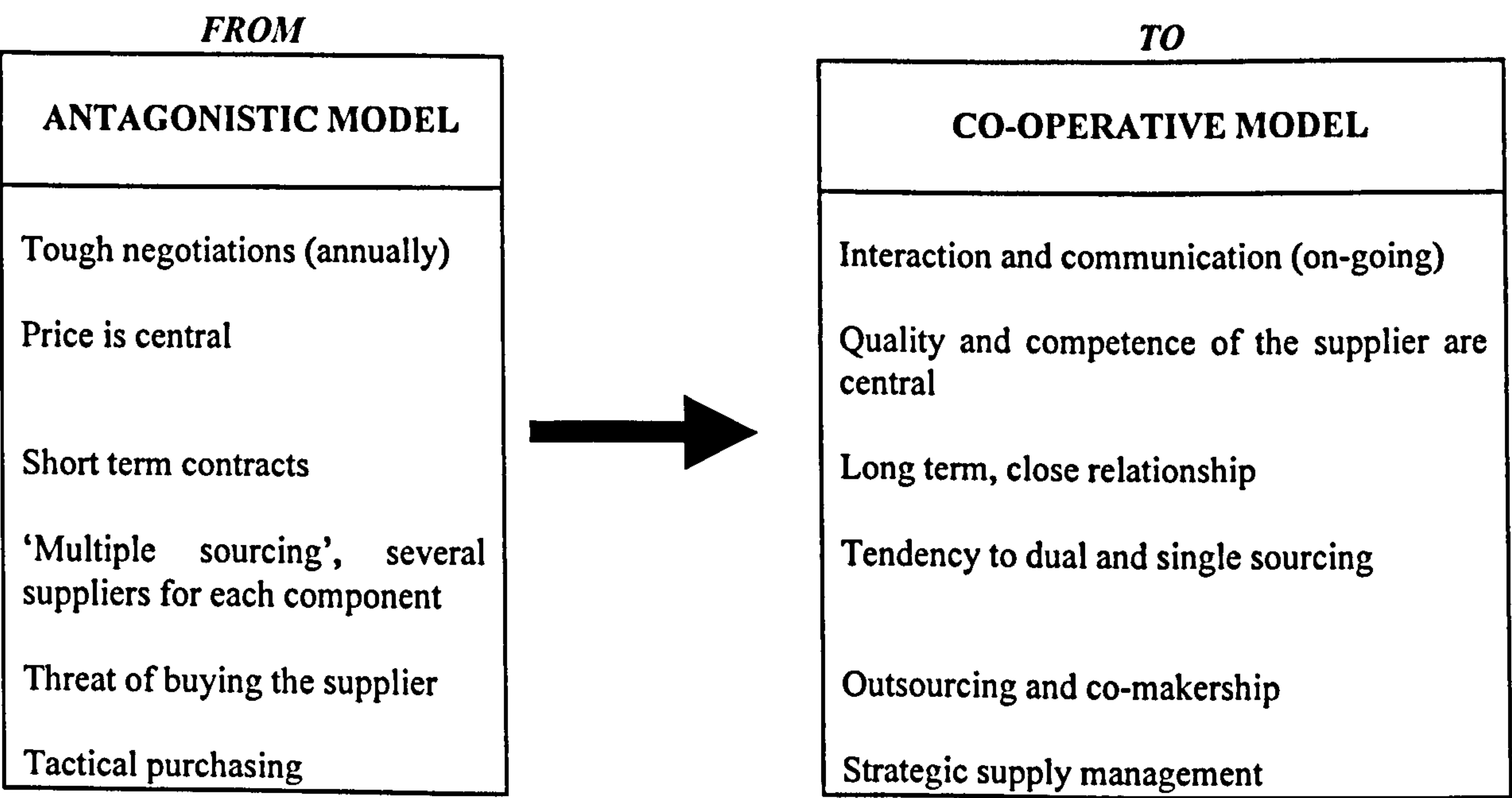
In the literature **two different approaches** can be found when discussing the changing nature of supply relationships. In one, authors list the **types of changes** occurring in inter-firm supply relationships (Lamming, 1989; Lyons, Krachenberg and Henke, 1990; Lorenzoni, 1992; Normann and Ramirez, 1993). The most common changes identified are:

- Firms pay increasing attention to the **individual characteristics of suppliers**, both in the selection stage and during the management of the relationship.
- There is a marked tendency towards a **reduction in the number of suppliers**, even though the overall number of suppliers can still be remarkably high. The number of suppliers and sub-contractors tends to stabilise, with few newcomers and few exits.
- The division of labour is always functional, but **objectives other than sheer cost efficiency and cost reduction are gaining importance** and are now openly recognised as valuable. As a consequence, the balance of power between the lead firm in the supply-chain and its suppliers and sub-contractors tends to shift towards the latter, whose contribution (in terms of flexibility, innovation, knowledge of the markets, etc.) is actively sought and considered of strategic importance.
- The **boundaries of different organisations operating in the supply-chain tend to be blurred** by the frequency and intensity of the relationships involved and by the emerging awareness that the supply-chain operates as a unitary system in direct competition with other similarly structured systems in the

same industry.

The second approach is to develop general models that systematise existing empirical evidence, mainly in the automotive industry. These models vary quite significantly in depth and scope. Some simply summarise complex changes by contrasting and labelling ‘old’ and ‘new’ ways. For example, Matthyssens and Van den Bulte (1994) compare the ‘antagonistic’ and ‘co-operative’ models in buying attitudes (see Figure 2.1) and behaviour and identify a few causes for the shift. Excessive attention for short-term cost savings at the expense of innovation, quality, and reliability, and increasing and unmanageable complexity play a major role.

Figure 2.1 Antagonistic versus Co-operative Model (adapted from Matthyssen and Van den Bulte, 1994)



Other authors introduce an historical perspective into the debate and describe the evolution of supply-relationships in a specific industry over time. This is the case of Lamming’s (1993) four-phase model of the automotive industry in the UK, Europe and North America. The “traditional model” of supply relationships - based on bargaining power and antagonism – is supplanted in the mid-1970s by a “stress model”. Buyers exploit their bargaining power and impose a number of practices on their suppliers (such as open books and quality control) mainly in pursuit of immediate increases in efficiency. The third phase stretches from the mid-1980s to the 1990s and is

characterised by the adoption of a “resolved model”. There is growing recognition of the importance of collaboration and the number of practices involving suppliers in a closer relationship with their buyers increases, even if these practices are still perceived as an imposition and resented. In the 1990s a fourth phase emerges with a powerful “partnership model”. Relationships between buyers and suppliers become more entangled and give origin to complex networks, with strong focus on inter-dependence and mutual assistance alongside a strong economic basis.

Dyer, Sung Cho, and Chu (1998) have developed a more prescriptive model based on the idea of strategic supplier segmentation. By comparing supply practices in the U.S., Japan, and Korea, these authors identify three models of supply-chain management – respectively named the ‘arm’s-length’, the ‘durable arm’s-length’, and the ‘partnership’ models (see Figure 2.3). Three characteristics discriminate between the three: (a) the intensity of investment in dedicated or relation-specific assets; (b) the degree of information-sharing and mutual assistance; and (c) the degree of trust and the length of the relationship.

Figure 2.2 A comparison of supply management models (adapted from Dyer, Sung Cho, and Chu, 1998)

	ARM'S-LENGTH MODEL	DURABLE ARM'S- LENGTH MODEL	PARTNERSHIP MODEL
Relation-Specific Assets	Low	Low	High
Information-sharing And assistance	Low	Medium	High
Trust/Length of Relationship	Low/Short	Medium/Long	High/Long

Dyer et al. (1998: 68) suggest that there is not a ‘one-size-fits-all’ strategy for procurement, but that “suppliers should be analysed strategically and then segmented into two primary groups: one group of suppliers that provide necessary but non-strategic

inputs; and another group that provide strategic inputs.” For inputs that are necessary but not strategic, “firms should employ *durable arm’s-length (quasi-market) relationships*” while they should employ “strategic partnerships (*quasi-hierarchies*)” with strategic inputs (Dyer et al. 1998: 69-70).

In more general terms, the need to shift towards a more co-operative and less opportunistic relationship between buyer and suppliers is widely recognised in the literature. The ideal model for the successful buyer-supplier relationship seems to be the Japanese vertical *keiretsu* (Lincoln and Gerlach, 1992), where exclusive (or semi-exclusive) supplier-purchaser relationships focus on maximising the efficiency and the effectiveness of the entire value chain (Dyer and Ouchi, 1993). The shift towards co-operation in supply relations has been most thoroughly documented in car manufacturing following the diffusion of the Japanese approach to lean production (Lamming, 1989; Oliver and Wilkinson, 1988; Heide and John, 1990; McMillan, 1990; Cusumano and Takeishi, 1991; Helper, 1991b; Turnbull, Oliver, and Wilkinson, 1992; Dyer and Ouchi, 1993; Richardson, 1993; Oliver, Delbridge, and Lowe, 1996; Dyer, 1996; Langfield-Smith and Greenwood, 1998; Dyer, Sung Cho, and Chu, 1998). Others have also identified electronics (Morris and Imrie, 1993).

2.1.1 The role of the lead firm

Notwithstanding the rising importance of sub-contractors and the wide acknowledgement of their contribution to the success of the supply-chain as a unitary system in competition with similarly structured entities in the same industry, the lead firm remains a fundamental actor. This may seem paradoxical. On the one side, it cannot be denied that the shift from a competitive towards a co-operative relationship between the lead firm and its (now stable and relatively few) suppliers reduces the gap in the balance of power in favour of the latter. A high degree of reciprocal interdependence is generally recognised as intrinsic in supply-chain relations based on co-operation (Turnbull, Oliver, and Wilkinson, 1992; Dyer and Ouchi, 1993; Richardson, 1993), whereas the traditional supply-chain is characterised by a marked dependence of the suppliers on the nearly absolute power of the leader.

On the other hand, the role played by the lead firm continues to be confirmed as vital for the success and the competitiveness of the supply-chain. In his seminal analysis of “strategic networks”, Jarillo maintains that “essential to this concept of strategic network is that of the ‘hub firm’”. The ‘hub firm’ is the “firm that, in fact, sets up the network, and takes a pro-active attitude in the care of it” (1988: 32). More recently, Baden-Fuller and Lorenzoni point out that “it is becoming increasingly apparent that those networks that are not guided strategically by a “centre” are unable to meet the demanding challenges of today’s markets” (1995: 146-7).

Baden-Fuller and Lorenzoni (1995) also identify four main features in the critical role of the strategic centre or lead firm as creator of value:

- *Strategic Outsourcing.* The strategic centre outsources and requires partners to be more than doers, and expects them to be problem solvers and initiators.
- *Capability.* The strategic centre develops the core skills and competencies of partners to make them more effective and competitive, and forces members of the network to share their expertise with others in the network and with the central firm.
- *Technology.* The strategic centre borrows ideas from others that are developed and exploited as a means of creating and mastering new technologies.
- *Competition.* The strategic centre explains to partners that the principle dimension of competition is between value chains and networks, that the network is only as strong as its weakest link, and encourages rivalry between firms inside the network in a positive manner.

In the transition from a traditional supply-chain to a co-operative supply-chain, the role of the buyer seems, therefore, far from limited by the growing importance of the suppliers. On the contrary, it tends to be as much enriched and valued as that of its own counterparts, and the purchasing process becomes a critical value-adding activity (Spekman, Kamauff, and Salmond, 1994).

The importance of the lead firm is pre-eminent also when objectives other than immediate competitive advantage are taken into account. In their analysis of the supply-chain as a vehicle for organisational learning, Hendry and Brown (1998: 14) point out that in those supply-chains where the buyer-supplier relationship is of the co-operative type, “greater learning, specifically directed towards getting more performance out of the supply-chain” seems to be a primary objective, “rather than in the case of the industrial district where there is a lack of strategic intent.” In the industrial district, the lack of a clearly identified leader can lead to the inability to institutionalise the learning generated, and, as a consequence, to a sub-optimal utilisation of its potential. The role of the centre in the supply-chain is, therefore, crucial in orchestrating the knowledge and the capabilities existing within the overall system, so that the system itself can take advantage and benefit from them (Baden-Fuller and Lorenzoni, 1995).

2.1.2 The network supply-chain: key issues in the emergence of a new organisational form

The available empirical evidence seems to suggest that, at least in a few industries, the traditional supply-chain is undergoing an evolutionary process. Traditional supply-chains are transforming themselves and this process is likely to lead to the emergence of a network-based organisational entity, or **network supply-chain** (Ferlie and Pettigrew, 1996).

This claim, however, has a number of problematic aspects. First of all, a sound assessment of the actual extent of this transformation across different industries is still missing. Before claiming that a new organisational form has emerged as the dominant form for the future, it is necessary to expand the empirical research beyond the limited boundaries of the few industries that have so far constituted the field of study. The risk of generalising a phenomenon that is in reality industry-specific must be recognised and avoided by directing the attention to sectors with different characteristics. Secondly, alongside the problem of **variation between sectors** lies the problem of possible **variation between countries** and national cultures.

The UK constitutes a very good example of the difficulties in these two areas. As suggested by Korczynsky (1998), most of the literature on the benefits of high-trust relationships comes from outside the UK with the notable exception of the study by Sako on the automotive industry (Sako, 1992). Within the UK there are, moreover, discordant voices. Some authors claim that there is a shift in inter-firms relations towards co-operation, to the benefit particularly of small and medium sized firms (Baxter et al., 1989; Murray, 1985). Others, however, highlight some critical areas. In his review of the literature on co-operative supply relations in the UK, Korczynsky (1998) mentions the following aspects. First of all, most of the early research focuses on the success stories, ignoring the difficulties and indulging in “cheerleading” (Harrison, 1994: 34). The overemphasis on success can be related, according to Korczynsky (1998: 789) to “the lack of focus upon power relations.” Moreover, in the international literature the UK is always presented as an example of traditional arm’s length relations (Casson, 1991; Dore, 1983; Hirst and Zeitling, 1989), and this raises the suspicion that shifts in the UK may be different from shifts occurring in other countries.

In their review of the literature on buyer-supplier relations in the UK, Morris and Imrie (1993: 59) conclude that: “there is some empirical evidence which reinforces the perception that British industry is involved in a reappraisal and reorganisation of buyer-supplier relations. However the evidence indicates that the transformations are concentrated in particular industrial sectors.” Korczynski (1998: 790) reinforces these conclusions by claiming that “in the UK large firms continue to be dominant, that they use this dominance to pass on costs to smaller firms, and that while there is limited evidence of increased information-sharing, inter-firms relations continue to be beset by low trust” (p.790). In research on the UK engineering construction industry, for example, Korczynski (1998) argues that management contractors have predominantly adopted a low-trust route to improved performance, and identifies a number of potential constraints to the adoption of high-trust relations generally.

Finally, the dynamics of the transformation as well as the contingencies that can affect its final outcome have not yet been identified and analysed. The role played by the lead firm in the supply-chain, as well as the nature of the overall strategies pursued by the

firms involved in the transformation, are examples of grey areas where further research is needed.

To summarise, it seems possible to identify **four major gaps** in the existing literature on the changes occurring in supply-chain management and the emergence of the network supply-chain. The first gap is concerned with the degree of diffusion in the shift from market-oriented to co-operation-oriented governance mechanisms in **different sectors**. In other words, is the change widespread or is it limited to a restricted number of industries? And, if this is the case, why is that? The second gap is about the degree of diffusion of co-operation as the fundamental principle to govern supply relationships in **different countries and national contexts**. In other words, is the change world wide, or is it localised? And what is the relative position of the various countries, and of the UK in particular? The third gap is about **variation among firms of different sizes at different levels of the supply-chain**. In other words, is the change occurring for small as well as for large firms, at the bottom end of the supply-chain as well as at the top? The fourth gap is to do with the **dynamics and contingencies** of the transformation. How are both inter-organisational processes and individual firms' behaviours affected by the transformation?

2.2 The relationship between organisational networks, co-operative inter-organisational relationships, and organisational performance

Evaluating the outcome of network-based organisational entities is complex from both a theoretical and a practical point of view. Ho Park (1996: 796) maintains that “the measurement of network performance depends on the context and the level of analysis in each study and it is not possible to have a universal measure.”

From a theoretical point of view it is possible to distinguish between the two concepts of **network effectiveness** and **organisational performance** (Provan and Milward, 1995). Network effectiveness relates to “outcomes of the network as a whole” (Provan and Milward, 1995: 2), such as stability, and is particularly appropriate in the public and

not-for-profit sectors³. Organisational performance relates to the outcome of individual organisational entities and encompasses a number of dimensions⁴.

Most studies on the impact of increasing co-operation in the supply-chain deal with the organisational level and concentrate on organisational performance. The relationship between the adoption of a co-operative organisational structure and organisational performance is a very debated area. Two main positions can be found in the literature. The first, also chronologically, is very optimistic about the existence of a **positive and strong relationship between co-operation and improved organisational performance**. The second, developed in more recent times, is **more sceptical and critical**.

The literature in favour of a positive correlation between networking and improved organisational performance points to a great number of **advantages** deriving from co-operation. The most recurring ones are creativity, innovation and technological diffusion (von Hippel, 1985 and 1986; Clark, 1989; Womack, Jones and Roos, 1990; Clark and Fujimoto, 1991; Turnbull, Oliver, and Wilkinson, 1992; Dyer and Ouchi, 1993); higher quality (Nishiguchi, 1994); time-to-market and responsiveness to environmental change (Ohmae, 1982; Imai, Nonaka and Takeuchi, 1985; Johansson and Nonaka, 1987); and increased flexibility (Jarillo, 1993).

For some, **co-operation is in itself a source of competitive advantage** (Jarillo, 1993). Differential performance between firms (and systems) operating in the same industry can be attributed to the adoption of a more-or-less network-oriented organisational structure. The rationale lies in the network-based organisational structure being inherently characterised by the “right” combination of elements to match the changed nature of competition (Miles and Snow, 1992). This blend facilitates the creation of

³ Provan and Milward (1995) maintain that issues of network outcomes and effectiveness are mostly ignored. This is partially due to the intrinsic difficulties of identifying the appropriate measures and measurement procedures. There is however another possible explanation in that network effectiveness is especially salient in the public and not-for-profit sectors where a public interest motive is involved and the “rationale for organisations co-operating to accomplish system goals rather than organisational ends is often stronger than in the private sector” (Provan and Milward, 1995: 3).

competitive advantages in an increasingly complex and dynamic environment. According to Jarillo, the strategic network is “winning over in more and more industries because it is able to capture the main advantages of two organisations - that is the efficiency of the functional organisation and the flexibility of the divisional one - considered mutually exclusive” (1993: 11-12). All the firms within the network are supposed to benefit from this enhanced ability of the network itself to provide opportunities and to reinforce individual efforts.

When flexibility is fundamental, the most commonly acknowledged advantages provided by the network-based organisational form lie in the area of **technology and innovation**. Hagedoorn (1993), in his analysis of inter-organisational modes of co-operation and sectoral differences, has contributed a broader understanding of strategic technology partnering⁵. The motives – and the competitive advantages sought through the adoption of a network-based organisational structure - change according to the nature of the industry. Different motives are associated with differences in the degree of technological intensity of the industry, with the degree of maturity of the sector, with the importance played by technological complementarity, and with the nature and level of competition.

Moreover, different network-based solutions are enacted in order to achieve different types of advantage. Hagedoorn identifies two major network-based forms - *complex strategic technology alliances*, “motivated by both market and technology-mediated objectives”, and *contractual strategic technological alliances*, “primarily aimed at more focused and narrow technological achievements” (1993: 375).

⁴ For reviews of the problems posed by measuring effectiveness at the organisational level see Goodman and Pennings, 1997, and Cameron and Whetten, 1983).

⁵ In general terms, and adopting a “somewhat linear interpretation of the innovation process from developing science and performing R&D down to market entry and the joint introduction of new products”, the alternative concrete motives for strategic interfirm technology co-operation, both vertical and horizontal, are the following (Hagedoorn, 1993): (a) *motives related to basic and applied research, and some general characteristics of technological development*; (b) *motives related to concrete innovation processes*; and (c) *motives related to market access and search for opportunities*.

The belief in the superiority of the network-based organisation in pursuing both cost efficiency and innovation is not, however, unchallenged. There is, in fact, **growing concern over potential shortcomings** deriving from the adoption of co-operative arrangements, and co-operative supply relationships are not always seen as a magic remedy.

Miles and Snow (1992) raise the problem of potential failures of network structures at the theoretical level. According to their classification, the supply-chain constitutes a **stable network**, that is an “organisational form which has its roots in the structure and operating logic of the functional organisation” (1992: 63), and is based “on a set of component firms, each tied closely to a core firm by contractual arrangements, but each maintaining its competitive fitness by serving firms outside the network” (1992: 63). For the effectiveness of the overall network, it is extremely important that sub-contractors keep in touch with the market, and avoid the risks of both “over-specialisation” and “over-dedication”. Low quality, rising costs (and prices), and decaying technological expertise and flexibility are the inevitable negative effects of suppliers’ decreasing participation in the external market. According to Miles and Snow, the lead firm in the supply-chain plays a fundamental role in maintaining the effectiveness of the overall system, by both carefully using a balanced set of subsidies and incentives and avoiding excessively authoritative and defensive behaviours.

On a similar theoretical level, Uzzi (1997) maintains that there are a number of clear advantages in embedded forms of exchange and network structures. In his words “embeddedness is a logic of exchange that promotes economies of time, integrative agreements, Pareto improvements in allocative efficiency, and complex adaptation” (Uzzi, 1997: 35). However these positive effects are not unlimited. A threshold exists after which “embeddedness can derail economic performance by making firms vulnerable to exogenous shocks or insulating them from information that exists beyond their network” (Uzzi, 1997: 35). According to Burt (1992) isomorphism within the network decreases diversity. A concentrated level of exchange with a few partners reduces non-redundant information and access to new opportunities.

At a more practical level, the mixed results achieved by Western firms trying to introduce “Japanese-like” practices⁶ also call for a re-assessment of the actual benefits deriving from the adoption of co-operation as a fundamental co-ordinating principle. In the UK, the unsatisfactory performance of the car-industry (Turnbull, Oliver, and Wilkinson, 1992; Richardson, 1993; Oliver, Delbridge, and Lowe, 1996) has originated a debate on the relative advantages and disadvantages of co-operative approaches in supply-chain management.

Two main alternative explanations are offered to explain poor performance levels by UK firms shifting towards co-operative practices. On the one side, the advocates of the adoption of Japanese practices by Western firms (Dyer and Ouchi, 1993; Richardson, 1993) claim that the introduction of Japanese-like methods in the UK has been carried out superficially. In particular, UK firms seem to have adopted only the “colourful, people-oriented aspects” of these techniques, without paying due attention “to the harder, process-control oriented aspects” (Oliver, Delbridge, and Lowe, 1996). According to Voss (1987), UK firms are ready to introduce the “easy-to-implement” elements of the Japanese model rather than the most useful ones, those that really explain Japanese success and superiority.

On the other side, there are a number of researchers who impute the differential performances of Japanese and UK firms to more general factors, and in particular to the structure of the industry. The high degree of fragmentation of the industry, the lack of trust and co-operative spirit between long-standing antagonists, and the presence of multiple standards must be given special attention when explaining differential performance (Turnbull, Oliver, and Wilkinson, 1992).

Whatever the real cause, there is a growing awareness and understanding of the Japanese system and its true complexity, which is far higher than commonly thought. The Japanese system is, in fact, characterised by a fine-tuned mixture of “hard” and

⁶ The relationship established between a Japanese firm and its sub-contractors tends to be qualified as “partnership” (Dyer and Ouchi, 1993). An alternative definition is given by Sako, who describes it in terms of “obligational contractual relation” (Sako, 1992).

“soft” elements, reciprocally interdependent and reinforcing, and its final outcome depends also on the characteristics of the general competitive environment. Scher (1997) addresses the issue of potential network failures by focusing on the performance of Japanese inter-organisational networks in the light of the current economic crisis. Scher maintains that the “concept of trust in Japanese organisational relationships and the practices commonly associated with it are at root merely a metaphor of convenience used by social scientists for a highly elaborated schema of relationships” based on “relational access”⁷ (Scher, 1997: 3).

Based on previous contributions⁸, Scher develops a model for codifying inter-organisational relationships along two dimensions (see Figure 2.3). The first is the degree of information codification – codified versus un-codified. The second is the nature of power relations – hierarchical versus horizontal.

Figure 2.3 Information Codification /Power Relations Matrix (adapted from Scher, 1997)

Codified information	BUREAUCRACIES	MARKETS
Un-codified information	FIFES (Patrimonial Bureaucracy) KEIRETSU – (Vertical) Asymmetrical Power relationships Subsidiary-like affiliations	CLANS (Kinship Network) KIGYO SHUDAN – (Horizontal) Collegial relationships Non-Competitive Synergistic Alliances
	Hierarchical power relations	Horizontal power relations

The debate on the impact of networking on organisational performance is far from close

⁷ “Relational access” is defined as a “highly nuanced continuum of relationships – informal, invisible, and inescapable – by which the gradation of interfirm relations from insider to outsider are determined” (Scher, 1997: 4).

⁸ Scher cites the following as direct sources for his model: Boisot and Child (1988); Durkheim (1933); Hall et al. (1977); Hofstede (1991); Ouchi (1980); Weber (1921); Williamson (1975).

to a definitive solution. However, it is more and more widely acknowledged that **the adoption of a given organisational structure does not, by itself, determine a specific outcome**. Other variables are at play, and it is to the identification of these contingencies that future research efforts must be directed.

2.3 Gaps in the literature and new directions for research

From the analysis of this literature, two key issues arise that require further investigation. The first is the **emergence of the network supply-chain and the actual extent of the transformation**. There is growing evidence to suggest that a new organisational form, the so-called network supply-chain, is emerging, which involves a major shift from market-oriented to co-operation-oriented mechanisms to govern supply relationships. However, it is not at all clear what is the actual extent of the transformation. It is important to extend the investigation to industries other than the few so far intensely researched, primarily car-making, construction, engineering and electronics. This could also contribute to the clarification of issues regarding the contingencies of this transformation, and help to identify industry-specific characteristics. In other words, is the move towards co-operation a genuinely pervasive one? Does the transformation process occur in the same way and under the same circumstances in every industry, or are there significant contingencies that affect its development and, consequently, its final outcome?

The same questions can be raised when comparing the transformation process in different countries and national contexts. The UK seems to represent an interesting area for further research due to the contradictory and mixed nature of the evidence so far available. And again, a similar approach could be used to analyse relations between companies at the bottom end of the supply-chain, given that most of the studies focus on the relationships existing between the top firms and their first or second tier suppliers. In other words, is the transformation affecting all firms in the supply-chain, without distinction in terms of size and level - that is position - in the overall chain?

A second key issue is the **actual impact of co-operative inter-organisational**

arrangements on organisational performance. Again, the issue is one of contingencies. Does the adoption of co-operation as the primary basis for managing supply relations bring positive outcomes in terms of increased performance? Are there trade-offs to be managed and resolved between different dimensions of performance? And again, are there different routes to co-operation that might lead to different outcomes? And if this is the case, what are they, how do they emerge, and in what direction do they affect a firm's performance? Is there any geographical or industry variation in this area?

It is the main objective of the present research to contribute to the clarification of some of the aspects just mentioned. In particular, the research addresses the issues of both geographical and industry variation in the adoption of co-operative arrangements in supply-chain management by **gathering evidence in a fresh field - that is, the optical communications systems industry – in a problematic country – that is, the UK.** As to the impact of co-operation on organisational performance, the research gathers evidence on the **correlation existing between specific inter-organisational processes and practices and organisational performance.** Some of the contingencies affecting this relation should also become clearer.

Chapter 3 now considers the important theoretical issue of the definition of the network organisation. This is a fundamental step towards the clear definition of the boundaries of the empirical work and the development of an appropriate research methodology.

CHAPTER 3 - THE THEORETICAL FRAMEWORK: A DEFINITION OF ‘ORGANISATIONAL NETWORKS’

The purpose of this Chapter is to address the fundamental theoretical issue of defining the network organisation as the starting point for the operationalisation of the network supply-chain in Chapter 5. The network supply-chain is, in fact, one particular type of hybrid organisational arrangement.

Many theoretical perspectives address the issue of the network organisational form, each from their own particular point of view and with their particular analytical tools. In this Chapter we present only three – Organisation Studies, Organisational Economics and Strategy – because they focus on governance issues and are, therefore, most directly relevant for the study of the emergence of the network supply-chain. Our selection excludes a whole set of research on the structural and dynamic properties of organisational networks that is very important but, to a certain extent, lies outside the boundaries of our interest.

The structure of the Chapter is as follows. First, each perspective is briefly presented and analysed. Secondly, we evaluate their different contributions. The main gaps are highlighted, and the need for crossing the boundaries of the various disciplinary fields to develop a workable definition of the network organisation is advocated. Finally, the key elements characterising each disciplinary field are summarised.

3.1 The network organisation: an overview

Burt stated in 1982 that “...networks are a terminological jungle in which any newcomer may plant a tree” (Burt, 1982). Since then, many scholars from different disciplines have addressed the study of co-operative organisational structures and relationships. Their common objective is to explain the emergence of co-operative organisational forms, and in so doing, identify their founding characteristics. The result of the past two decades of research is that, notwithstanding undeniable steps forward in the common understanding of this organisational phenomenon, the terminological jungle is still there, as healthy as ever. A variety of definitions are used, and each discipline has developed a specific language for this area of

study. No unifying theory is available, and the combination of elements from the various contributions seems at the moment the most fruitful direction of enquiry.

Contributions from the fields of Organisation Studies, Organisational Economics, and Strategy are reviewed and analysed. As anticipated before, these fields are selected because they emphasise governance-related aspects and are, therefore, close to our approach. It is perhaps useful to remind the reader that for us the term **network organisation** refers to a **specific form of governance - that is a way of “co-ordinating economic activity” - that is distinct from and in competition with markets and hierarchies** (Powell, 1990). This distinguishes our particular view of the network from the idea of the network as a “construct of the investigator” (Aldrich and Whetten, 1981). Aldrich and Whetten (1981: 400) maintain that “networks are essentially constructs created by researchers to aid the process of conducting organisational research.” Consequently, all the contributions that use network analysis - an analytical tool and research methodology for investigating the patterns of relations among social entities and their implications (Kenis and Knoke, 1998) – to highlight structural and dynamic characteristics of organisational networks lie outside the boundaries of the research. Reference in passing to a few key studies based on the idea of the network as a construct is only made to illustrate the general development of a broad disciplinary field.

3.1.1 The contribution of Organisation Studies

The contribution of Organisation Studies to the analysis of ‘organisational networks’ is potentially rich but under-exploited. Tichy’s criticism that there is “very little systematic theorising” (Tichy, 1981: 227), with theories highlighting different aspects, still holds true⁹. Still, organisational networks are “increasingly identified as important empirical phenomena”

⁹ Kenis and Knoke (1998) quote the following passage from Mayntz’s 1991 keynote speech to the European Group for Organisational Studies (EGOS):

(Kenis and Knoke, 1998: 5). A number of seminal references to emergent structures in organisations can be traced in Barnard (1938); Homans (1950); Katz and Kahn (1978); March and Simon (1958); Thompson (1967).

Within the contingency approach, Thompson’s study is a paradigmatic example (Lomi, 1992). In maintaining that “the design, structure, or behaviour of organisations will reflect variations in task environment”, Thompson (1967: 161) explicitly recognises the importance of the environment. In particular, he emphasises the relationships existing between a specific organisation, acting as the focal organisation, and its sources of inputs and outputs, which together constitute its organisation set. The organisation set and the way the focal organisation’s relationships with it are structured are fundamental in determining the different configurations that the organisation can assume. The idea of “networking” is implicit.

A more direct contribution to the study of networking and co-operative organisational forms comes from the area of inter-organisational relationships¹⁰. Inter-organisational relationships are defined as the “relatively enduring transactions, flows, and linkages that occur among or between an organisation and one or more organisations in its environment” (Oliver, 1990: 241). The inter-organisational relationships literature explicitly recognises that “organisations typically operate in a relational context of environmental interconnectedness and that an organisation’s survival and performance often depends critically upon its linkages to other organisations” (Oliver, 1990: 241).

However, an in-depth review of this literature (Gray, 1990; Oliver, 1990) shows its lack of uniformity and its substantial fragmentation. An integrated theory on the nature and formation of inter-organisational relationships is missing. In Oliver’s words,

“ It is here (in policy research), and not in organisation research proper, that inter-organisational networks – under the name of policy networks – had their most successful scientific career. Nor is this surprising. Organisation research focuses attention on the meso level; its basic unit of analysis and point of reference for theoretical generalisation is the single organisation (or category of organisations). In spite of the interest in inter-organisational relations, the inter-organisational network therefore never became a favourite unit of analysis in the sociology of organisations. Understandably so, since networks composed of organisations pose entirely different questions from those asked in organisation research: their theoretical relevance lies on the macro level of society, not on the meso level” (Kenis and Knoke, 1998, p.3).

¹⁰ Organisational theorists devoted to the study of interorganisational relationships are, among the others, Aldrich and Whetten, 1981; Evan, 1966; Laumann, Galaskiewicz, and Marsden, 1978; Galaskiewicz, 1985; Pennings, 1981; Perrow, 1979; Schermerhorn, 1975; Van de Ven, 1976; Whetten, 1981.

“We no longer know what we know about the formation of inter-organisational relationships. (...) Many types have been studied in a variety of settings, and little attempt has been made either to integrate the literature into generalisable predictors of relationship formation or to distinguish between what causes such relationships or the conditions under which such relationships occur” (Oliver, 1990: 241).

Following the growing recognition of the **embedded nature of behaviour** (Granovetter, 1985), the importance of the social environment of an organisation has emerged as a fundamental issue in the organisational literature¹¹. Embeddedness explains how dyadic exchanges and the overall structure of relations influence economic actions and outcomes (Granovetter, 1992). Granovetter (1985, 1992) distinguishes between relational embeddedness - which refers to the quality and depth of a single dyadic tie, and structural embeddedness - which refers to the overall structure and architecture of the relations. The concept of embeddedness has been incorporated in a number of theories. In **resource dependence theory**, for example, the interconnectedness of the organisational environment, resource munificence, and resource concentration are three fundamental factors affecting the inter-organisational behaviour of an organisation (Pfeffer and Salancik, 1978).

¹¹ The recognition of the importance of the social environments of an organisation has given origin to a specific type of organisation theories, that is theories based on the so-called “social behaviour model” (Pfeffer, 1997). According to Pfeffer (1997) there are five general heading under which all existing organisation theories can be classified, the other four being the economic model of organisational behaviour, the retrospectively rational model of behaviour, the moral model of behaviour, and the interpretive, cognitive model of behaviour. For an analysis of the various theories based on the “social behaviour model” see Kenis and Knoke (1998).

Resource dependence theory also reaffirms the importance of power¹² in terms of network centrality and influence as a fundamental variable in the study of inter-organisational networks (Aldrich, 1976; Aldrich and Pfeffer, 1976; Pfeffer and Salancick, 1978; Boje and Whetten, 1981).

Power is derived from control over strategic interdependencies, and can be “accrued in an exchange network by gaining control over various types of valued resources” (Boje and Whetten, 1981: 378). Burt (1977b) identifies three aspects of power: control of resources as the basis of power; processes converting the basis of power into manifestations of power; and the network of influence relations as manifestations of power.

¹² The relevance of power issues in inter-organisational networks emerges in two different areas of debate. The first is in connection with the study of the relationship between the concepts of network centrality, influence and power. From an exchange perspective, two dimensions of inter-organisational networks are fundamental. The first is the “horizontal differentiation of transactions into more or less stable subsystems” (Boje and Whetten, 1981: 378). The second is the vertical differentiation of organisations, with the emergence of power differentials and other patterns of vertical dominance (Aldrich, 1972; Benson, 1975; Cook, 1977). More recently, the power-dependency perspective (Emerson, 1962; Cook, 1977) and the resource dependency perspective (Aldrich, 1976; Aldrich and Pfeffer, 1976; Pfeffer and Salancick, 1978; Boje and Whetten, 1981) have reaffirmed the importance of power in the study of inter-organisational networks. The relationship between power, network centrality and influence has been investigated at both the intra-organisational level (Hinings et al., 1974) and the inter-organisational one (Laumann and Pappi, 1976; Galaskiewicz, 1979; Whetten and Aldrich, 1979; Boje and Whetten, 1981). The second area of debate where power is used in connection with inter-organisational networks is in the dispute over the relative importance of efficiency and power to explain the existence and form of organisations. Two factions confront themselves. On the one side mainstream organisational economics reinforces the centrality of efficiency as fundamental criterion for organisational design. Williamson and Ouchi maintain that “Inasmuch as power is very vague and has resisted successive efforts to make it operational, whereas efficiency is more clearly specified and the plausibility of an efficiency analysis is buttressed by ecological survival tests, we urge that efficiency analysis be made the centre piece of the study of organisational design” (1981: 364). On the other side, radical organisation theorists proclaim that “organisations are all about power” (Littler, 1990: 72). For a comprehensive review of this debate, and an attempt at building a bridge between the two radical perspectives, see Ingham (1996) and Rowlinson and Procter (1997).

Uzzi (1997) relies on the concept of **relational embeddedness** (Granovetter, 1992) to identify different forms of exchange. In particular, he distinguishes between arm’s length and embedded ties, and identifies some of the distinctive features of embedded relationships. Embedded relationships “have three main components that regulate the expectations and behaviours of exchange partners: trust, fine-grained information transfer, and joint problem-solving arrangements” (Uzzi, 1997: 42). Trust is expressed as the “belief that an exchange partner would not act in self-interest at another’s expense” (Uzzi, 1997: 43) and is based on heuristic processing, not calculative ones. Information exchanges are more tacit and holistic than in market transactions. Joint problem-solving arrangements constitute a “mechanism that enables actors to co-ordinate functions and work out problems ‘on the fly’. These arrangements typically consist of routines of negotiation and mutual adjustment that flexibly resolve problems” (Uzzi, 1997: 47).

The concept of **structural embeddedness** lies at the core of Jones, Hesterly, and Borgatti’s general theory of network governance (1997). They maintain that “network governance involves a select, persistent, and structured set of autonomous firms engaged in creating products or services based on implicit and open-ended contracts to adapt to environmental contingencies and to co-ordinate and safeguard exchanges” (Jones, Hesterly and Borgatti, 1997: 914). Their approach integrates Transaction Cost Economics (see following section) and social network theory, and identifies structural embeddedness as a key factor in explaining the emergence and diffusion of network-based governance structures.

In recent times, a network theory of organisations combined with the adoption of a structural analysis approach has been advocated as a tool for studying emerging organisational forms (Alter and Hage, 1993; Kenis and Schneider, 1991; Knoke and Guilarte, 1994; Powell, 1990). **Structural analysis** is a relatively new approach in social analysis (Emibrayer, 1997). It focuses on the study of patterns of “relationships among basic units within social structures, and seeks to discover what effects these connections have on units that are or are not

connected to them” (Kenis and Knoke, 1998)¹³. Kenis and Knoke attempt to build a network theory of inter-organisational relations where macro-level phenomena are linked to micro-level ones. They maintain that (1998: 2) “the structural properties of inter-organisational networks affect the inter-organisational behaviours of individual organisations”, and that “whether an organisation creates or dissolves various types of connections to other organisations is conditional on the forms of the broader networks within which it is embedded.” They identify five broad types of macro-level network depending on their substantive content: (a) information transmissions; (b) resource exchanges; (c) power relations; (d) boundary penetration; and, (e) sentimental attachments. The theory, however, focuses on inter-organisational communication as the primary macro-level network that shapes the micro-level strategies and actions available to individual organisations¹⁴.

Table 3.1 summarises the contribution of Organisation Studies to the development of network theory.

¹³Wellman (1997) identifies five characteristics of the structural analysis approach: (a) behaviour is interpreted in terms of structural constraints on activity, rather than in terms of inner forces within units...; (b) the analysis focuses on the relations between units, instead of trying to sort units into categories defined by the inner attributes (or essences) of these units; (c) a central consideration is how the patterned relationships among multiple alters jointly affect network members’ behaviour. Hence, it is not assumed that network members engage only in multiple duets with separate alters; (d) structure is treated as a network of networks that may or may not be partitioned into discrete groups...; (e) analytic methods deal directly with the patterned, relational nature of social structure in order to supplement – and sometimes supplant – mainstream statistical methods that demand independent units of analysis.

¹⁴ “(..) our theory privileges inter-organisational communication as the primary relation. Information transmission takes many forms, ranging from such relatively low-cost interactions as verbal and written messages to more intense commitments of time and resources (...). Information is antecedent to the formation and persistence of all other types of interactions. Communicating preferences, intentions, values, normative expectations, and other varieties of data is a necessary prelude to establishing resource exchanges, power, penetrative, and sentimental ties. Communication provides a foundation on which organisational agents build trust among partners, and thus is a requisite for organisations to proceed toward more complex and riskier collective actions” (Kenis and Knoke, 1998: 22).

Table 3.1 The definition of the Network form: the contribution of Organisation Studies

DISCIPLINARY FIELD	KEY CONTRIBUTORS	KEY CONCEPTS FOR THE DEFINITION OF THE NETWORK FORM
ORGANISATION STUDIES	<p>Thompson (1967)</p> <p>Aldrich and Whetten (1981) Evan (1966) Laumann, Galaskiewicz and Marsden (1978) Galaskiewicz (1985) Pennings (1978) Perrrow (1979) Van de Ven (1976) Whetten (1981)</p> <p>Granovetter (1985)</p> <p>Aldrich and Pfeffer (1976) Pfeffer and Salancik (1978) Boje and Whetten (1981)</p> <p>Uzzi (1997)</p> <p>Jones, Hesterly and Borgatti (1997)</p> <p>Kenis and Knoke (1998)</p>	<p>Contingency theory: importance of relationship between the focal organisation and its organisation set</p> <p>Studies of Inter-organisational relationships: importance of relational context of environmental interconnectedness</p> <p>Embedded nature of behaviour. Difference between relational and structural embeddedness</p> <p>Resource dependence theory. Importance of interconnectedness of the focal organisation’s environment. Power is a critical factor</p> <p>Distinction between arm’s length and embedded ties. Trust, fine-grained information and joint problem-solving as key components of embedded ties</p> <p>Integration of TCEs and social network theory. Structural embeddedness is key for the diffusion of network governance</p> <p>Network theory of organisation based on a structural analysis approach and the use of network analysis</p>

3.1.2 The contribution of Organisational Economics

Transaction Cost Economics derives from the convergence of two disciplinary fields, **economics** and **organisation theory**. The convergence is promoted by Williamson’s attempt to operationalise Coase’s institutional comparative approach to economic organisation (Coase, 1937; Williamson, 1975). Though not rejecting the general-equilibrium assumption of traditional standard economics, Coase (1937) provides an innovative explanation of the existence of the firm and argues for the individual transaction as the elementary unit of analysis. This, in turn, is derived from Commons’ proposition (1934: 4-8) that “the transfer of goods or services across a technologically separable interface” should be the elementary unit of analysis. The firm is not a production set, but an “island of conscious power” in a decentralised market. In order to explain why firms exist, Coase introduces the concept of “the cost of using the price mechanism” (Coase, 1937: 33), that is “transaction costs”. Both markets and firms are institutions aimed at facilitating exchange, and their primary function is one of co-ordination. The entrepreneur “is the person or persons who, in a competitive system, take the place of the price mechanism in the direction of resources” (Coase, 1937: 33) when the costs of “organising a transaction” become lower than the costs of “carrying it out through the market”.

Williamson (1985: 4) recognises that “unless the factors responsible for transaction cost differences could be identified, the reason for organising some transactions one way and other transactions another would necessarily remain obscure”. His explanation lies in that *“transactions, which differ in their attributes, are assigned to governance structures, which differ in their organisational costs and competencies, so as to effect a discriminating, mainly transaction cost economising, match”*.

Transaction costs are both ex-ante and ex-post. Ex-ante transaction costs are “incurred in drafting and negotiating agreements, and vary with the design of the good/service to be produced”. Ex-post ones include the “setup and running costs of the governance structure to which monitoring is assigned and to which disputes are referred and settled, the mal-adaptation costs that are incurred for failure to restore positions on the shifting

contract curve; the haggling costs that attend adjustments and the bonding costs of effecting secure commitments” (1985: 20-22).

The attributes according to which individual transactions differ are respectively identified in the condition of asset specificity, uncertainty, and frequency. Asset specificity, however, plays a fundamental role, and is regarded as the “big locomotive” (1985: 56) of the theory. The degree of asset specificity depends on whether or not a given transaction is “supported by investments in durable, transaction-specific assets”, that determine “lock-in” effects (1985: 53)¹⁵. Asset specificity, in conjunction with bounded rationality/opportunism¹⁶ and the presence of uncertainty, determines what Williamson defines as “the fundamental transformation”: a “large numbers bidding condition at the outset is effectively transformed into one of bilateral supply thereafter” (1985: 61). Recurring transactions also matter, because frequency can reduce the cost of a specialised governance structure in the presence of high asset specificity.

¹⁵ According to the most recent developments (Williamson, 199b: 281), there are six different kinds of asset specificity: “(1) site specificity, as where successive stations are located in a cheek-by-jowl relation to each other so as to economise on inventory and transportation expenses; (2) physical asset specificity, such as specialised dies that are required to produce a component; (3) human asset specificity, that arises in learning by doing; (4) brand name capital; (5) dedicated assets, which are discrete investments in general purpose plant that are made at the behest of a particular customer; and (6) temporal specificity, which is akin to technological nonseparability and can be thought of as a type of site specificity in which timely responsiveness by on-site human assets is vital”.

¹⁶ Transaction Cost Economics is based on two behavioral assumptions that distinguish it from standard economics. The first is bounded rationality, and is derived from Simon’s statement that human behaviour is “intendedly rational, but limitedly so” (Simon, 1947: xxiv). The second is opportunism, that allows for self-interest with guile. Economic agents are permitted to disclose information in a selective and distorted manner (Williamson, 1990). Given bounded rationality, “all complex contracts are unavoidably incomplete”, while given opportunism, “contracts-as-promise unsupported by credible commitments is hopelessly naive” (Williamson, 1990: 12). Apart from bounded rationality and opportunism, Williamson’s theory underlies a third behavioral assumption, which is very rarely mentioned but which plays an important role: risk neutrality. According to Williamson, “unlike the other two assumptions, this one is patently counterfactual”. He gives three alternative reasons for using such an assumption: (a) emphasis is on transactions occurring between firms, not individuals; (b) it can be managed; and (c) “this assumption helps to disclose core efficiency features that go unnoticed or are misconstrued when risk aversion assumption are employed”, which is the most compelling of the three (Williamson, 1985: 388-390).

Although the conditions of uncertainty to which the transactions are subject and the trading context (customs, mores, habits, legal institutions) in which the transactions are located influence both the ex-ante and the ex-post costs of contracting, those features are mainly taken as given. Three governance modes (i.e., three organisational forms - all of which are contractually based) are available to co-ordinate economic transactions (1985: 72-78). They are, respectively:

- a. **Market governance**, suitable for non-specific transactions of both occasional and recurrent contracting;
- b. **Trilateral governance**, suitable for occasional transactions of the mixed and highly specific kind; and
- c. **Relational contracting**, suitable for recurring transactions with high and mixed asset specificity. Within the general domain of relational contracting, it is possible to distinguish between *bilateral governance*, which occurs when the autonomy of the parties is maintained, and *unified structures*, which occurs when the transaction is removed from the market and organised within the firm subject to an authority relation (vertical integration).

These alternative modes of governance of contractual relations are illustrated in Figure 3.1.

Figure 3.1 The governance of contractual relations (adapted from Williamson, 1985)

	Investment Characteristics		
	Non-specific	Mixed	Idiosyncratic
Occasional transactions	Market governance (Classical contracting)	Trilateral governance (Neo-classical contracting)	
Recurrent transactions		Bilateral governance (Relational contracting)	Unified governance

Governance structures differ in ‘competencies’, that is to say that each of them is characterised by a specific set of incentives and control mechanisms in order to keep transaction costs as low as possible. In particular, standard contracting - the market - has higher-powered incentives than the unified structure - bureaucracy - while hierarchy is more efficient in adaptability respects. This implies that the market is generally better at preventing opportunism ex-ante by means of incentives, while hierarchy tends to rely on ex-post, administrative controls and on “fiat”.

Williamson’s attention is primarily focused on the two extreme poles of market and hierarchy (Stinchcombe, 1990; Williamson, 1991b) leaving a “significant void in our understanding of alternatives” (Ring and Van de Ven, 1992: 484). As a matter of fact, hybrid forms are not even contemplated in the first version of the Transaction Cost Economics approach (Williamson, 1975), and, in any case, they are not regarded as stable. Little effort is consequently devoted to their analysis, and to the study of their

inherent properties in terms of their respective incentives and controls¹⁷. In order to fill these gaps, researchers have tried to integrate Williamson’s approach and describe in more detail the characteristics of the intermediate governance form.

The concept of **recurrent and relational contracting** (Dore, 1983; Ring and Van de Ven, 1992) is one form of this. According to Ring and Van de Ven (1992), co-operative agreements governed through either recurrent or relational contracts represent a type of inter-organisational relations which is very little explored in the traditional stream of

¹⁷ A number of criticisms accompanied the first formulation of the Transaction Cost Economics (TCEs) approach (Williamson, 1975) as well as the following developments and refinements due to both Williamson (1985) and his supporters (Klein et al., 1978; Grossman and Hart, 1986). The most recurring remarks are:

1. TCEs tends to concentrate on the polar forms (Jarillo, 1988 and 1993; Powell, 1987; Ring and Van de Ven, 1992; Stinchcombe, 1990). The intermediate form, which probably constitutes the most interesting one - at least when recent diffusion is considered - is generally addressed in residual terms and is poorly explored for its own sake.
2. The view of the transaction as the elementary unit of analysis is limiting because it does not capture the overall complexity of the relationship (Dore, 1983; Doz and Prahalad, 1991; Lorenzoni, 1992 ; Thorelli, 1986; Johanson and Mattsson, 1987).
3. TCEs heavily relies on the behavioral assumption of opportunism, while ignoring the potential role played by trust in reducing the impact of transaction costs (Bidault and Jarillo, 1995; Bradach and Eccles, 1989; Dore, 1983; Granovetter, 1985; Håkansson, 1989; Jarillo, 1988; Johanson and Mattsson, 1987; Lincoln, 1990; Ouchi, 1979, 1980; Powell, 1990; Perrow, 1986; Ring and Van de Ven, 1992; Thorelli, 1986). Williamson himself (1985: 406) recognises the potential importance of both trust and the institutional setting where transactions take place. It is important to notice that trust is generally perceived as ambivalent, in the sense that it can be regarded as much a pre-requisite for a transaction as a product of it (Buckley and Casson, 1988; Gulati, 1995; Ring and Van de Ven, 1992). It can also be embedded in the overall social system, triggering a general preference and attitude towards “trustworthy behaviour in relationships” as opposed to more diffident and cautious ones (Granovetter, 1985; Ouchi, 1980; Wilkins and Ouchi, 1982).
4. TCEs is based on efficiency, but other elements can explain the organisation’s survival in the environment (Nelson and Winter, 1982; Johanson and Mattsson, 1987). Moreover, it is static and does not reject the general equilibrium assumption. Organisational processes are completely neglected (Foss, 1993). The mode of analysis is the comparative institutional: entrepreneurship is a factor of production whose function is to reduce the costs of combining other factors into some given final output.
5. The concept of transaction costs is vague and even ill defined, and there is little empirical evidence that economising is a good explanation of, or even a major motive for, vertical integration (Goshal and Moran, 1996; Johanson and Mattsson, 1987; Kogut, 1985; Pettigrew, 1979).
6. The ability of the model to predict how actual transactions will be carried on in reality is limited (Bidault and Jarillo, 1995). Most of the evidence gathered in favour is based on the interpretation of one (or few) specific situation (Simon, 1991), and is not focused on the confirmation of its hypotheses. In particular, the assumption of opportunism is given too much importance, while neglecting the potential role played by trust in lowering the level of transaction costs and reducing the need for ex-post control mechanisms. As Bradach and Eccles (1989) also point out, there are three ways of co-ordinating economic activity, that is, price, authority and trust. In this respect particularly important is the concept of “clan” developed by Ouchi (1979, 1980).

Transaction Cost Economics. They identify a set of distinguishing characteristics associated with the various forms of transactions (see Table 3.2).

Table 3.2 Distinguishing characteristics of forms of transactions (adapted from Ring and Van de Ven, 1992)

Distinguishing Characteristics	Forms			
	Discrete market transactions	Hierarchical managerial transactions	Recurrent contracting transactions	Relational contracting transactions
Nature of exchange	One-time transfer of property rights	On-going production and rationing of wealth	Episodic production and transfer of property rights	Sustained production and transfer of property rights
Terms of exchange	Clear, complete and monetized, sharp in by agreement, sharp out by pay and performance	Authority structure superior hires subordinate obeys or quits the employment relationship	Certain, complete contingent on prior performance; plans for experimentation on safeguards	Uncertain, open and incomplete; plans for bilateral learning safeguards and conflict resolution
Transaction-specific investment	Non-specific	Idiosyncratic	Mixed	Mixed and idiosyncratic
Temporal duration of the transaction	Simultaneous exchange	Indefinite	Short to moderate term	Moderate to long term
Status of the parties	Limited, nonunique relation between legally equal and free parties	Structural functional command-obedience role relationship between legally unequal parties	Unlimited, unique relation between legally free and equal parties	Extensive, unique social-embedded relation between legally equal and free parties
Mechanism for dispute resolution	External market norms and societal legal system	Internal conflict resolution by fiat and authority	Norms of equity and of reciprocity and societal legal system	Endogenous designed by the parties and based on trust
Relevant contract law and governance structure	Classical contract market governance	Employment contract unified governance	Neo-classical contract market governance	Relational contract bilateral governance

Their analysis of the main features of co-operative agreements modifies some of the assumptions underlying Williamson’s perspective. In particular:

7. Williamson’s “simplistic” assumptions can have potentially damaging consequences when the theory is used in a strongly normative way (Goshal and Moran, 1996; Pfeffer, 1994). In particular, the possibility to attenuate opportunism through control is questioned and the need for taking into consideration the different “institutional logics” of both market and hierarchy is maintained (Goshal and Moran, 1996: 31-32).

1. They introduce the concept of risk. Risk is associated with uncertainty, and the “degree of risk inherent in any transaction generally will rise in direct proportion to decreases in time, information and control” (1992: 488);
2. They substitute the behavioural assumption of opportunism with that of trustworthiness, defined as “open, other-regarding behaviour” (1992: 487); and,
3. Thanks to the use of trust, that operates both as an ex-ante condition and as a result of repeated transactions between the same parties, they pose a limit to the importance given by Williamson to ex-post contract implications and, therefore, to ex-post control mechanisms.

An interesting implication of the model developed by Ring and Van de Ven is that, when observed in dynamic terms, the emergence of relational contracts - that is the emergence of hybrid organisational forms - is the outcome of a time-consuming process where trust-building play an essential role. This reinforces the idea expressed by various authors (Thorelli, 1986; Powell, 1987) that a **long-term perspective** is essential to the existence of the hybrid. Thorelli (1986: 41) views trust “as confidence in the continuation of a mutually satisfying relationship and in the awareness of other parties of what this requires of their performance as network members”. Trust is based on “reputation, “past performance”, and social bonds established in day-to-day interactions”. All these elements require time to be effectively built. Powell (1987: 82) qualifies a long-term perspective as a “cornerstone of network forms”.

According to Granovetter (1985), the trust building process is triggered by **time** and **experience**. Repeated interaction with the same partner is the best source of information because:

“(a) It is cheap; (b) one trusts one’s own information best; (c) individuals with whom one has a continuing relation have an economic motivation to be trustworthy, so as not to discourage future transactions; and (d) departing from future economic motives, continuing economic relations often become overlaid with social content that carries strong expectations of trust and abstention from opportunism” (Granovetter, 1985: 481-510).

Ouchi’s (1980) notion of **clan** also explores in more detail Williamson’s intermediate governance form. Ouchi (1980) identifies the sources of transaction costs in two conditions, namely **goal incongruence** and **performance ambiguity**. In his view:

“different combinations of these causes distinguish three basic mechanisms of mediation or control: markets, which are efficient when performance ambiguity is low and goal incongruence is high; bureaucracies, which are efficient when both performance ambiguity and goal incongruence are moderately high; and clans, which are efficient when goal incongruence is low and performance ambiguity is high” (Ouchi, 1980: 129).

Socialisation constitutes the basis of the clan, the intermediate governance structure associated with hybrid organisational forms. Both bureaucracy and clan are characterised by a certain degree of goal congruence, though this commonality of purpose is moderate in the former and high in the latter. The concept of goal congruence underlying the clan form is akin to Durkheim’s concept of “organic solidarity” (Durkheim, 1933), where the union of objectives between individuals derives from their necessary inter-dependence. The clan form is based on the assumption that individual “interests are better served by a complete immersion of each individual in the interests of the whole” (Ouchi, 1980: 136; Kanter, 1972: 41). The role of reciprocity and authority, respectively characteristic of the market and the bureaucracy, is diminished.

Larson (1992) concentrates on entrepreneurial settings and develops a process model of the formation of **network dyads**, defined as sets of stable relationships. The formation of network dyads is seen as an alternative to organic growth for the firm. Larson emphasises the importance of **social controls** arising from norms of **trust** and **reciprocity** as opposed to formal contract and written arrangements in governing network dyads. He also recognises the inherent vulnerabilities of these structures, which are not necessarily permanent. Changes in competitive conditions may lead to a premature termination of network relations but there are also in-built risks. Particularly dangerous are heavy reliance on a partner and the fact that in-house capacities are not

cultivated.

The problem of gaining a better understanding of the intrinsic features of hybrid governance structures constitutes the core of Demsetz’s remarks on the recent developments of Transaction Cost Economics. Demsetz (1993) directly addresses the question “**when is a nexus of contracts *more firm-like*?**” (1993: 170), where “more-firm like” can be interpreted as “hybrid-like”. He maintains that the “defining content of the nexus of contracts remains rather vague in the literature on the theory of the firm. We may as well recognise that we have no clear notion of firm-like contractual arrangements” (1993: 170). He subsequently identifies three aspects of the nexus of contracts that influence “firm-like” co-ordination or hybrid governance structure - namely, **specialisation, continuity of association, and reliance on direction**. These characteristics are “productive in many circumstances”, some related to transaction and monitoring cost considerations, some dependent on other conditions.

According to Demsetz, (1993: 74) “transaction costs will influence the decision (as to which governance form to adopt) but it is not the only important consideration. The decision also turns on the productivity benefits derivable from different arrangements. Particularly important in determining these benefits are **knowledge-based considerations**. Continuing association of the same persons makes it easier for firm-specific and person-specific information to be accumulated.

The importance of **information flows and knowledge** considerations in the explanation of hybrid forms is maintained also by other researchers in the strategy field and in the field of industrial organisation (Powell, 1987). Hybrids, when compared to vertically integrated structures, constitute a faster means of acquiring sources of know-how located outside the legal boundaries of the organisation (Powell, 1987; Teece and Pisano, 1989), and are also less costly, less irreversible, and more feasible (Porter and Fuller, 1986). Moreover, they seem more able to deal with tacit knowledge (Powell, 1987), that is knowledge that is difficult to codify and difficult to transmit. Network-like organisational forms are particularly apt when there is a need for “efficient, reliable information” (Powell, 1987: 82). According to Kaneko and Imai (1987), information

passed through the network is “thicker” than information obtained in the market, and “freer” than information communicated within a hierarchy.

Table 3.3 summarises the contribution of Transaction Cost Economics to the development of network theory.

Table 3.3 The definition of the Network form: the contribution of Transaction Cost Economics

DISCIPLINARY FIELD	KEY CONTRIBUTORS	KEY CONCEPTS FOR THE DEFINITION OF THE NETWORK FORM
TRANSACTION COST ECONOMICS	Commons (1934) Coase (1937) Williamson (1975, 1985) Dore (1993) Ring and Van de Ven (1992) Thorelli (1986) Powell (1987) Ouchi (1979) Larson (1992) Demsetz (1993) Powell (1987) Kaneko e Imai (1987) Uzzi (1997)	Transaction as unit of analysis Transaction costs Market versus hierarchy. Opportunism, bounded rationality, uncertainty and asset specificity determine the “fundamental transformation”. Three governance modes, all contractually based, are in competition: market governance, trilateral governance and relational contracting (with the two options of bilateral governance and unified structure) Recurrent and relational contracting. Risk, trustworthiness and repetitiveness are key assumptions Trust based on reputation, past performance and social bonds from day-to-day interactions Long-term perspective is a cornerstone Markets, bureaucracy and clan as basic mechanisms of mediation and control. Goal congruence, and performance ambiguity are the key determinants. Socialisation is the basis of the clan Network dyads as stable, sustained relationships governed by social controls based on norm of trust and reciprocity. Inherent vulnerabilities The firm as nexus of contracts. Firm-like coordination is based on specialisation, continuity of association and reliance on direction. Importance of knowledge based considerations Information flows and knowledge considerations are critical. Information in networks is thicker and freer than within a hierarchy

3.1.3 The contribution of Strategy

The existence of the hybrid as a permanent actor in the economic environment - one whose importance is constantly growing in terms of both relevance and diffusion (Powell, 1987) - is strongly advocated by researchers in the fields of business policy and strategic management. Terms such as “hybrids” or “networks” are widely used in the strategic management literature as a metaphor to label non-standard organisational forms. Joint ventures, strategic alliances, co-operative agreements, strategic networks, partnerships, coalitions, consortia, constellations, franchises (Contractor and Lorange, 1988; Eccles and Crane, 1988; Friedlander and Gurney, 1981; James, 1985; Jarillo, 1988; Lincoln, 1990; Lorenzoni, 1982; Ouchi and Kremen-Bolton, 1988; Perlmutter and Heenan, 1986; Porter and Fuller, 1986; Powell, 1990) are all examples of the variety of forms, and labels, developed in this area.

A key issue in the strategy field is to describe how organisations interact with their external environment in general, and with other organisations in particular, in order to achieve long-term competitive advantages. According to this perspective, hybrids can represent a viable organisational solution when pressures due to rapid changes in technology, increasing competition, growing uncertainty and complexity, and the like become particularly high (Powell, 1987; Ring and Van de Ven, 1992).

Despite rising interest, however, the topic of organisational hybrids in strategy still “lacks a generally accepted conceptual framework, with enough theoretical depth to help understand the plentiful anecdotal evidence” (Jarillo, 1988: 31). The reasons for this lack of depth may lie in the concept of network being difficult to conceptualise because it “was coined outside the strategy field (...) and it does not fit well within the basic paradigm of competitive strategy” (Jarillo, 1988: 31).

A major contribution in the direction of a more comprehensive theory of network-oriented organisational forms has recently emerged thanks to the development of the resource-based and the knowledge-based views of the firm. Within the theoretical perspective of the **resource-based view** of the firm, Ring (1996) proposes a framework for predicting the use of collaborative inter-organisational relationships. He maintains that (1996: 9):

“Managers of firms will consider reliance on network organisation as a source of resources, depending upon their views of five factors. These five are:

- 1. Their strategic intent (Hamel and Prahalad, 1989);*
- 2. Their prior relationships with the firms with whom they are contemplating collaboration;*
- 3. The resources they are seeking;*
- 4. The use to which these resources will be put; and*
- 5. The governing principles they will employ in their dealings.”*

The strategic intent of managers is to create extraordinary economic rents through co-operatively sustained advantages, based on resources that cannot easily be duplicated or imitated and that are not consequently available on the market. The only way to access these resources is therefore through collaboration with the firms that control them. A key determinant of the willingness to collaborate is the experience matured during past relationships between the firms involved in the exchange, which if positive leads to reliance on trust as opposed to preference for safeguards.

Alternatively, Hedlund (1994) develops a model of **knowledge management** based on the interplay of articulated and tacit knowledge. Differences in patterns of knowledge management between Western and Japanese firms are related to specific organisational characteristics. Hedlund distinguishes between two basic organisational structures, the M-form and the N-form, on the basis of six major features (see Table 3.4):

Table 3.4 N-form and M-form: a comparison (adapted from Hedlund, 1994)

	N-form	M-form
Technological interdependence	Combination	Division
People interdependence	Temporary constellation, Given pool of people	Permanent structures, Changing pool of people
Critical organisational level	Middle	Top
Communication network	Lateral	Vertical
Top management role	Catalyst, architect, protector	Monitor, allocator
Competitive scope	Focus, economies of depth, Combinable parts	Diversification, economies of scale and scope, semi-independent parts
Basic organisational form	Heterarchy	Hierarchy

Hedlund also identifies the weaknesses of the N-form, and comes to the conclusion that “ a case could be made for the comparative effectiveness of M-form for exploitation, and of N-form for exploration (March, 1991; Hedlund and Rolander, 1987, 1990)” (Hedlund, 1994: 86). Although Hedlund’s ideas apply directly to organisations as individual entities, some of the characteristics of the N-form can also be extended to network-oriented types of organisational arrangements. Starting from a knowledge-based perspective, Grant and Baden-Fuller (1995) emphasise the need to shift the attention from the costs of economic organisation to the benefits, especially in terms of knowledge creation. In their view, network-based organisational arrangements are more suitable to act as knowledge integrators than the market or the hierarchy.

A different perspective is adopted by Mohr and Spekman (1994) who try to identify the **characteristics of partnership success**, instead of concentrating on the antecedents of partnership formation and the features of co-operative inter-organisational relationships. There are two indicators of partnership success. The first is objective (the sales volume flowing between dyadic partners); the second is subjective (satisfaction of one party with the other). A partnership’s success depends on the degree of intensity of three behavioural characteristics. These include attributes of the partnerships, such as commitment and trust; communication behaviour, such as participation and information sharing between the partners; and conflict resolution techniques, such as joint problem solving and the use of persuasion and consensus. The higher the intensity of these characteristics, the more successful the partnership.

Within the broad field of strategy, a quite unique perspective on the emergence of network-based organisational forms is offered by two parallel streams of research, originated from the work of Marshall (1920) and respectively labelled **Networks in Economic Geography** and **Industrial Networks** (Araujo and Easton, 1996). In the field of Economic Geography, attention concentrates on the demise of the Fordist mode of production and the emergence of networks of geographically concentrated small firms as an alternative to the traditional, vertically integrated firm (Piore and Sabel, 1984). The “new industrial district” (Capecchi, 1989) is inherently flexible, and its flexibility lies primarily in the network of relationships existing between firms and in their ability to change configuration very rapidly (Araujo and Easton, 1996). The geographical concentration of the firms represents a key factor and physical proximity is regarded as a fundamental dimension.

The field of Industrial Networks is connected to this in that it focuses on the empirical study of dyadic relationships in industrial markets. Its peculiarity is that it is mainly developed by Swedish scholars (Håkansson, 1982; Turnbull and Valla, 1985; Johanson and Mattsson, 1994) and therefore reflects the distinctive conditions of the Swedish economic environment. The perspective is quite unique also from a theoretical point of view. Unlike the majority of contributions on hybrid organisational arrangements, its focus is not on transactions but on the development and institutionalisation of economic exchange relationships between industrial companies. Its core characteristic is the extension of dyadic studies to a systemic level of analysis through the use of the concept of **connectedness** (Easton, 1992; Anderson et al. 1994; Håkansson and Snehota, 1995). As Araujo and Easton (1996) point out, “complex and multi-level patterns of exchange (surround) each transaction episode in a buyer-supplier relationship” (Araujo and Easton: 22). Each transaction is also embedded in a relational atmosphere, that is a set of local rules and norms that are characterised by variables such as conflict vs. co-operation and power vs. dependence (Håkansson, 1982).

Table 3.5 summarises the contribution of Strategy to the development of network theory.

Table 3.5 The definition of the Network form: the contribution of Strategy

DISCIPLINARY FIELD	KEY CONTRIBUTORS	KEY CONCEPTS FOR THE DEFINITION OF THE NETWORK FORM
STRATEGY	<p>Contractor and Lorange (1988) Eccles and Crane (1988) Friedlander and Gurney (1981) James (1985) Jarillo (1988) Lincoln (1990) Lorenzoni (1982) Ouchi and Kremen-Bolton (1988) Perlmutter and Heenan (1986) Porter and Fuller (1986) Powell (1990)</p> <p>Ring (1996)</p> <p>Hedlund (1994)</p> <p>Grant and Baden-Fuller (1995)</p> <p>Marshall (1920) Piore and Sabel (1984) Capecchi (1989)</p> <p>Håkansson (1982) Turnbull and Valla (1985) Easton (1992) Johanson and Mattsson (1994) Håkansson and Snehota (1995)</p>	<p>The terminological jungle: hybrids, joint ventures, strategic alliances, co-operative agreements, strategic networks, partnerships, coalitions, consortia, constellations, franchises. Hybrids as a viable option in highly uncertain and complex environments</p> <p>Resource-based view of network formation. Importance of strategic intent, the nature of the resources and their use, prior relations and experience, and governing principles</p> <p>N-form vs. M-form: weaknesses and strengths (exploitation vs. exploration)</p> <p>Shift the attention from the costs of economic organisation to the benefits. Network organisation as knowledge integrator</p> <p>Networks in Economic Geography and the New Industrial District. Importance of physical proximity and concentration of small firms. Flexibility lies in the network</p> <p>The Swedish School of Industrial networks. Extension of dyadic studies to a systemic level. Importance of connectedness</p>

3.2 An overview of the different contributions

The literature overview shows that the emergence and definition of network-based organisational arrangements is indeed a very complex issue. Many disciplinary fields contribute to the debate, but none of them seems so far capable of offering a unified and comprehensive theory of the antecedents and formation of the network organisation. In other words, none seems able to predict the emergence of the network organisation in a reliable way. The three disciplines presented above prove no different in this respect.

Organisation Studies identifies a few elements that appear crucial for the formation of network-based organisational structures, such as the importance of power relations and the inherently embedded nature of behaviour. Both elements tend to emphasise the importance of time as a key variable at play in the creation and development of intermediate organisational forms. The most developed approaches within this disciplinary field, however, limit themselves to the identification of different typologies of inter-organisational relations without addressing the issue of predictors of network formation. The particular contribution of Organisation Studies is to raise questions about the organisational set that should constitute the focus for an empirical study - is it sufficient to focus on dyadic relationships, or do we need to view the wider structure of relationships (Granovetter, 1985)?

Strategy mainly uses the label ‘network organisation’ to identify non-standard organisational forms. The network organisation always remains a loosely defined object, whose main feature is its ability to cope with a changing external environment and, as a consequence, provide a basis for competitive success. This approach is inherent to the field of Strategy, which traditionally focuses on the characteristics of the environment to identify a firm’s most adequate response given its ultimate objective of securing a sustainable competitive advantage. In so doing, the emphasis is generally on what firms do - that is their behaviours and their strategies - and only secondarily on their structure - that is, how they organise themselves. In other words, the structure of the firm is a means to an end, and is rarely given attention in its own right. The same applies to the network organisation. Attention focuses on its suitability for the challenges posed by an

increasingly complex environment, but what constitutes the network organisation - that is, its actual configuration - remains undefined and blurred. The resource-based view breaks with this tradition in that it assumes the firm as the starting point of strategy making instead of the external environment and emphasises processes of knowledge management. However, attention concentrates on what the organisation is ‘good at’ and not on what it is ‘like’.

Of the three disciplines reviewed, Organisational Economics is the only one to address directly the issue of network formation in the sense that it concentrates on the identification of predictors for the three governance structures - market, hierarchy and intermediate forms. The approach is fundamentally static, and the three alternative structures are compared on the basis of their relative efficiency at a given point in time. This lack of dynamism is a key limiting factor for the development of this approach, mainly because it confines it to an under-socialised world of opportunistic actors, guided only by economic rationality. The importance of social relations in organisational phenomena is under-rated, and this opens the door for endless criticism. In this respect, the substitution by Ring and Van de Ven (1992) of the assumption of ‘trustworthiness’ for ‘opportunism’ and the emphasis on risk and uncertainty (which leads to a focus on time) offers a better way forward.

On the whole, it seems that no individual perspective is able, within its own traditional boundaries, to offer a sufficiently articulated and comprehensive response to the formation of the network organisation and the identification of its founding characteristics. At the present time, the most promising contributions for the development of our knowledge of the network organisation come from a number of classifications of inter-organisational relations based on a combination of different theoretical perspectives. The difficulty in precisely classifying these contributions as belonging to a specific disciplinary field is symptomatic of the general direction recently taken by researchers - namely, the **convergence and cross-fertilisation of different perspectives**. In particular, the most fruitful approach for both theoretical and practical development seems the convergence of the revised Transaction Cost Economics perspective with Social Network theories (Uzzi, 1997; Jones, Hesterley and Borgatti,

1997) and the concern with behavioural characteristics and information flow processes in the work of Ring and Van de Ven (1992), Mohr and Spekman (1994), and Uzzi (1997). This is the avenue followed in the present research.

In Chapter 4, a general definition of the network supply-chain is derived from the integration of the contributions reviewed here. On the basis of that definition, as well as of some of the considerations illustrated above, three key inter-organisational processes are identified that play a major role in shaping co-operative buyer-supplier relationships. These processes represent the lens through which co-operation is observed and provide the pillars for the operationalisation of the key variables of the study.

CHAPTER 4 – THE RESEARCH CONTEXT

This Chapter provides an overview of the optical communications systems industry, a sub-sector of opto-electronics. For the purpose of the research, it is important to build a good understanding of both the characteristics of the technology and its development. These two elements affect quite dramatically the strategies and behaviours of firms, including the development of supply relationships.

Opto-electronics meets all the requirements of suitability for the study. First of all, **optical communications systems are complex systems** (Nelson and Rosenberg, 1993), which makes it very difficult for a single firm to cover the entire range of competencies and skills required to satisfy customers' needs. Co-ordination between different organisations is a key element. Fibre-optics communications systems are, typically, **assembled products** (Utterback, 1994) and supply relationships play a critical role.

Secondly, optical communications systems can be classified as a “**demand-pull**” (Griffin, 1993) type of industry. It is therefore an interesting field to observe the way changes at the top end of the industry supply-chain reproduce themselves at lower levels and affect firms' behaviours lower down, in the area of purchasing and supply-chain management in particular. Moreover, fibre-optics communications systems are an example of how firms assimilate, and react to, a radical emerging technology. The industry provides an ‘**extreme**’ environment, which represents an ideal field for challenging and testing ideas generated in more traditional technological settings.

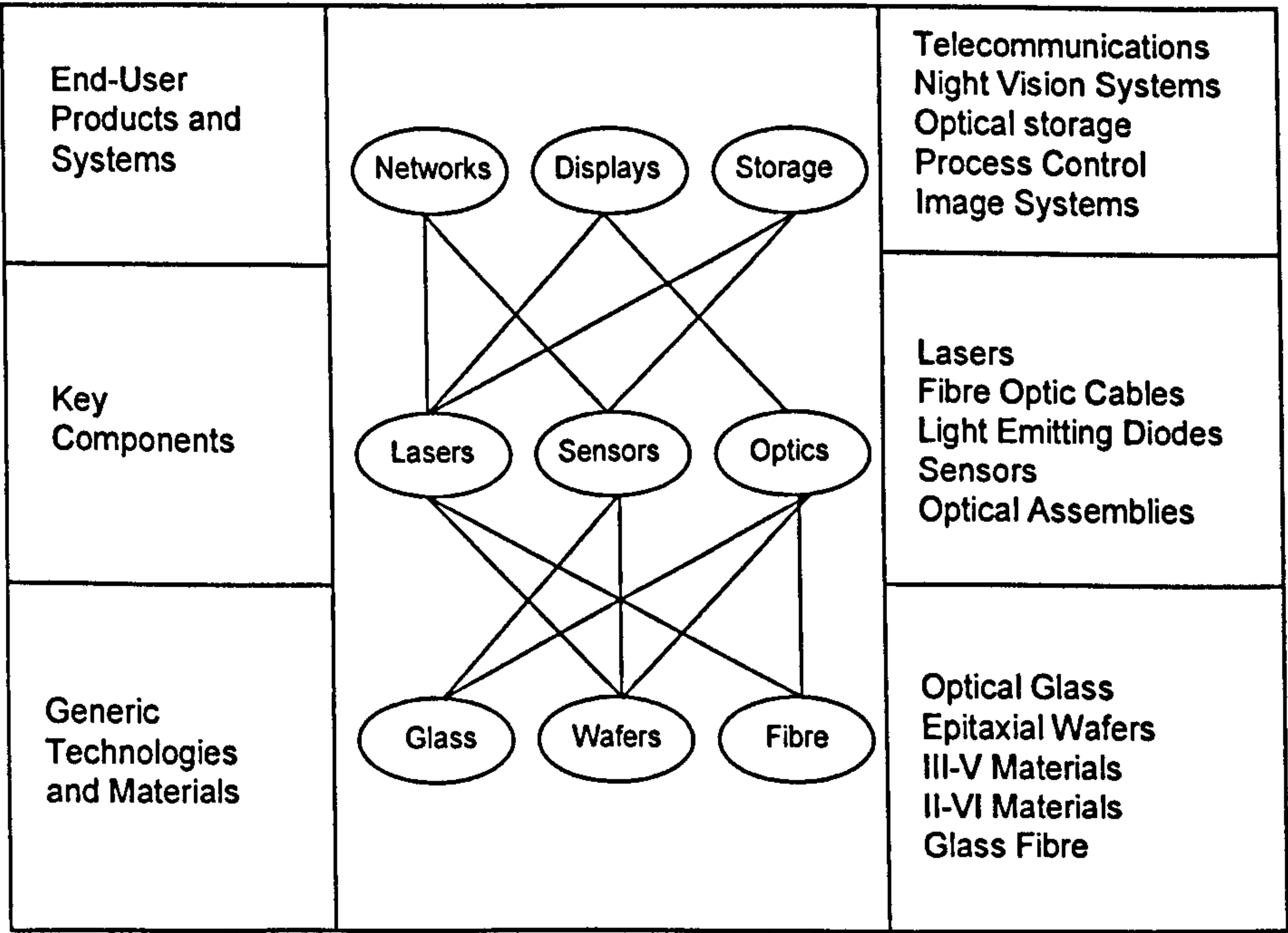
This Chapter consists of a general overview of the opto-electronics industry, with its inter-related markets and technologies. A few technical aspects of fibre-optics communications are illustrated, and the general evolution of opto-electronics technology is described through major innovations and key firms. Second, the basic economics of optical communications as a product are considered, with the relative advantages and disadvantages of fibre-optic technology compared to traditional copper-based communications. The structure of the market is then presented, and particular attention is devoted to the analysis of the supply side. Finally, the key elements characterising the

strategic environment of the industry are set out, since these provide a framework for the subsequent analysis and interpretation of the research data.

4.1 Opto-electronics: a technological discontinuity

Opto-electronics is a technology based on the distinctive properties of two elements of the atom, the photon and the electron²⁶. It can be classified as an example of technological discontinuity, and more precisely of “scientific fusion” because it “exemplifies the merging of optical and electronic properties at the atomic level” (Miyazaki, 1994: 50). The three-level model proposed by Miyazaki to analyse an industry technological base fits opto-electronics. The model is based on the interconnection of component generic technologies, key components, and systems, each representing a different level of technology (see Figure 4.1).

Figure 4.1 Miyazaki’s model applied to opto-electronics



²⁶ Photons are ideal for long-distance transmission of information due to their resistance to attenuation; electrons are ideal for information processing activities due to their high interaction properties.

The opto-electronics industry is also characterised by the presence of **technological interdependencies**. As Itami and Roehl (1987: 105) put it, “ the logic of technological interdependence means that the various elements operate on the same level. Unless all are brought up to the level of the strongest one, having a standout technology is of no use”. The implications for the competitive game are that “firms have to strive to maintain an effective linkage between systems, key components and component generic technologies. They have to choose whether to acquire the components through markets or by in-house production” (Miyazaki, 1994: 64).

In terms of end markets, opto-electronics is a strategically core technology for a number of different industries. An overview of its related markets and technologies is shown in Table 4.1. This indicates the importance and variety of the component technologies for different markets.

Table 4.1 Matrix of opto-electronics related markets and technologies (from Miyazaki, 1994)

		TECHNOLOGIES								
		Material	Transmission & Switching systems	Components for comms systems	Optical Information Processing	Optical Storage	Displays	Imaging	Sensors	Lasers
M A R K E T S	Communicationss	***	***	***	***	*	**	*		**
	Information Systems	**	**	**	***	***	***	**		*
	Consumer	**				***	***	**	*	
	Military	***	***	***	***	***	***	***	***	***
	Automotive	**	*	**		*	***		**	
	Aerospace	**	*	**		*	***		**	
	Medical	**		*	*	***	**	**	***	***
	Material Processing	**								***
	Process Control	**	**	**		*	**	**	**	*
	Safety	**	**	**		*	*	***	**	
	Energy	***								*

One of the biggest end-markets for opto-electronics is telecommunications. This is particularly true of the UK and Western countries, where telecommunications have always been the key driver for the technological development of the industry. In the UK optical telecommunications account for three-quarters of the overall opto-electronics market.

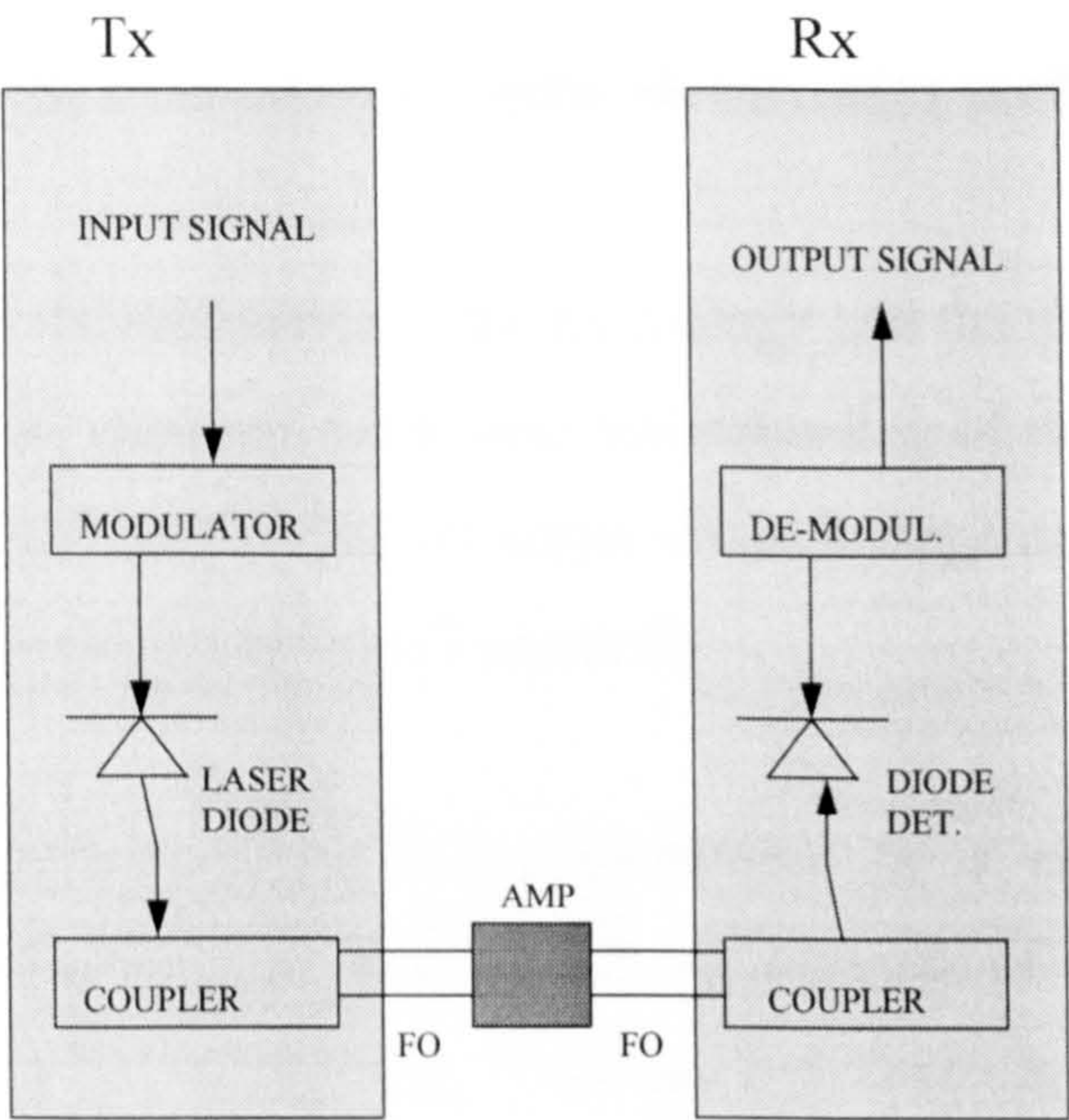
The study concentrates on a sub-sector of the overall opto-electronics industry, that is optical communications systems. Two aspects are important to understand the technological and competitive background of firms in this sub-sector. The first is the technical characteristics of optical communications systems. The second is the evolution of opto-electronics in relation to its application to telecommunications.

4.1.1 Optical communications systems: technical aspects

An optical communications²⁷ system is obtained by assembling a number of key components and by combining two key technologies, the electrical and the optical. Figure 4.2 is a schematic diagram of an optical communications system. Detailed information about the single components of a fibre-optics communications system can be found in Appendix B.

²⁷ In telecommunications the fundamental problem today is still how to ensure that the message received is the one that the sender intended. The first efforts used the concept of synchronisation, where both sender and receiver use the same frequency and electrical impulses are decoded immediately. These attempts were frustrated because electricity supplies in different places could not be guaranteed to be identical. The search for an asynchronous technique began. Initially the telephone connections were point to point, but subsequently telephone exchanges were built. The need for an automatic “switching” device - that is a device able to separate the signals, emerged. The first switches were designed for use with analogue transmissions, while today most of the transmissions are digital. The signals can be decoded and regenerated using electronic devices and switching can also be carried out electronically.

Figure 4.2. An optical communications system (adapted from the European Fibre Optics Directory and Report, 1992)



A light-transmitting component (Tx) and a light-receiving component (Rx) are connected to each other by a fibre-optics channel (FO). Between transmitter and receiver is the amplifier or regenerator (AMP), which amplifies the fibre-optics signal after it has reduced to a certain threshold level²⁸. The input signal can be audio, video, or data, or a combination of the three, and is impressed or modulated into the light emitting device (LED or laser). In the case of digital transmission the light is merely switched off and on, with the presence of light representing a “1” and the absence a “0”. In the case of analogue transmission, the information may be represented by either direct intensity modulation (i.e. the intensity of the light is proportional to the amplitude of the information signal), or frequency modulation (the frequency of the optical signal is proportional to the amplitude of the information signal).

The light is directed into a fibre-optics cable by means of an optical coupler. The attenuation of the fibre-optics signal limits the length of the fibre that can be used. On average, amplification is required after 30 km. Optical couplers are also used to connect the fibre to the amplifiers, and eventually to the receiver. In the receiver, the light is

²⁸ This phenomenon is generally known as attenuation.

captured by a photo-detector, and the electrical output is demodulated so that the original digital or analogue message can be read.

4.1.2 The evolution of opto-electronics technology

Both the characteristics of the technology and the industry's technological development are crucial elements for a clear understanding of firms' strategies and behaviours, and for interpreting the data on supply-chain management from the survey (Chapter 7) and the follow-up interviews (Chapter 9).

Opto-electronics is a field characterised by a **clear pattern of innovation**, from laboratory discovery in the 1960s, to a decade of uncertainty in the 1970s leading to successful commercialisation and rapid diffusion in the 1980s. The initial technological driver for opto-electronics was optical communications, but the spark for mass production was led by demand for CD players. This is, however, only partially true for Europe. It is definitely not true for the UK, where BT has played a fundamental role so that telecommunications has always been the strategic driver for the development of opto-electronics technology. Two objectives have driven the development of optical communications systems technology - **increasing transmission capacity** and **increasing transmission distance**. These have also influenced the development of the key components in fibre-optics communications systems, specifically, light emitting components, light transmitting components, and light receiving components. The technological interdependencies implied by this can be seen in the **four major phases in the development of optical communications**. This is summarised in Table 4.2.

Table 4.2 Evolution of optical communications technology

<p>The 1960s</p> <p>The emergence of optical communications as a potential reality</p>	<p>■ (1966) Kao and Hockman of the Standard Telephones and Cables laboratory (STC) show theoretically the possibility of using optical communications if optical fibre transmission loss is reduced below the threshold level of 10db\km.</p>
<p>The 1970s</p> <p>Optical communications becomes a reality</p>	<p>■ (1970) Panish and Hayashi of Bell Labs discover semiconductor lasers oscillating at room temperature.</p> <p>■ The first commercially viable laser (the Gallium Arsnide, which produces light at the 0.85 µm wavelength) is produced</p> <p>■ (1970) Corning demonstrates the possibility of low-loss optical fibres. Silica-based multi-mode optical fibres with a transmission loss of 20 db/km at 0.8 µm wavelength are developed.</p> <p>■ (1972) Corning (US) develops the Outside Vapour-Phase Oxidisation (OVPO) process for optical fibre manufacturing.</p> <p>■ (1974) Bell Labs (US) develop the Modified Chemical Vapour Deposition (MCVD) process for optical fibre manufacturing.</p> <p>■ (1975) NTT (Japan) develops the Vapour-phase Axial Deposition (VAD) process for optical fibre manufacturing.</p> <p>■ (1975-1976) Researchers at Southampton University (UK) and at NTT (Japan) report that light in the 1.3 µm wavelength band is more transparent in silica fibre than the previously used 0.8 µm. Successively, dispersion is found even lower at 1.55 µm. Optical communications switches from short to long wavelength.</p> <p>■ (1975) The Indium Gallium Arsenide laser, which produces light at the 1.3 µm wavelength, is developed.</p> <p>■ (1976) In the US the first trial of long-distance, public optical communications system takes place.</p> <p>■ (1977) Britain becomes the first country to carry public telephone traffic through optical fibres.</p>
<p>The 1980s</p> <p>Commercialisation and rapid diffusion</p>	<p>■ (1985) At&T (US) proposes the Asynchronous Transmission Mode (ATM).</p> <p>■ (1986) The Distributed Feedback laser diodes (DFBs), operating at the 1.55 µm wavelength, become available.</p>
<p>The 1990s</p> <p>New technological challenges</p>	<p>■ Optical amplifiers, digital switching and routing systems</p>

The **first phase** (1960s and first half of the 1970s) is characterised by two contrasting factors. The difficulty in producing low-loss fibres is paralleled by steady progress in the development of suitable opto-electronics sources of light. During the **second phase**

(mid-1970s to mid-1980s) this ‘technological bottleneck’ is removed by the development of successive generations of fibres. Progress in the development of other system components - particularly sources of light - is also achieved. The first two phases are predominantly characterised by technological development, while the **third phase** (mid-1980s to early 1990s) coincides with the commercialisation and the diffusion of optical communications systems in the market. Great emphasis is put on mass production and on lowering the manufacturing cost of key components. Fibres play a fundamental role. The **fourth phase** (the 1990s) is characterised by significant differences between the rate of growth of the overall industry on the one hand, and that of some of its sub-segments on the other.

At a general level, the optical communications systems industry is still expanding at the present time and there is still scope for radical innovations. However, the picture in relation to individual components shows quite remarkable differences. Optical fibre is now a mature product, characterised by falling prices and high volume production. Transmission capacity is no longer a key technological problem, and priority in innovation is now given to fibre connection and to the development of digital switching and routing systems. This means that while the overall sector is growing, the strategic environment for firms operating in different sub-segments can vary considerably. In particular, at the lower end of the industry supply-chain, fibre cable manufacturers face a very high level of price-based competition. Fibre cable manufacturers tend to be big players, and their strategies basically follow Porter’s “cost-leadership” model, with high manufacturing volumes and mass production techniques. A key strategic issue for these firms is, therefore, to increase their market share and expand their customer base. This has a strong impact on the development of supply relationships further up the supply-chain, where cable users have to deal with very aggressive suppliers. This situation is made even more complex by the resilience of traditional technology in cable manufacturing, based on copper. Copper cables are, for a number of applications, still a good alternative – and a cheaper one in most cases – to fibre cables. This means that fibre cable manufacturers compete against each other and also against copper cable manufacturers in getting access to the market. These aspects are all inter-related and

play a fundamental role in the way supply relationships are structured and managed. The implications are very clearly illustrated in the interviews in Chapter 9.

4.2. The economics of optical communications

From a technological point of view, the fundamental difference between optical and copper-based communications is that in optical fibre cables information is carried by light beams, while electrical current is the carrier in conventional copper cables. The key advantage of optical communications over conventional forms of communications lies in the **different carrying capacity of optical cables and metallic cables**. The capacity of an optical fibre cable is three orders of magnitude higher than copper coaxial cables and five orders of magnitude higher than copper pairs.

Other advantages derive from or are connected to this overpowering transmission capacity. First of all, optical cables provide larger bandwidth, so that they can transmit between 100 and 1000 times the amount of information carried by metallic cables. Tens of thousands of simultaneous channels can be transmitted and received. Second, optical fibres suffer lower transmission losses, therefore significantly decreasing the need for amplifiers, a relatively expensive component. Third, optical fibres weight far less (up to one hundredth) than metallic cables, and also take up far less space. Fourth, optical signals are immune from electromagnetic interference, as transmission is via a dielectric and not a conducting medium. This is particularly important for a few specific applications, especially in military and aerospace. Finally, optical cables are intrinsically safe, and this represents an advantage in areas where conducting cables or radio frequency signals could be hazardous.

There are, however, two major disadvantages. The first is that **connecting two optical fibres is much more difficult** than connecting two copper cables. The second is that **optical fibres suffer transmission losses when bent**, even minimally. This means that they have to be carefully protected from stress and temperature variation. As a result, copper cables still represent a viable alternative to fibre-optics cables in a variety of applications. They tend to be cheaper to install and easier to connect, and are therefore

preferred unless huge capacity and high speed of transmission are important features for the end user.

Recent developments in optical technology are reflected in parallel changes in the cost structure of the average optical communications system. The cost of light emitting components, such as lasers, has dropped significantly in the past decade. The same can be said of optical fibres, and prices keep falling quite dramatically. This means that transmission costs are becoming a smaller part of the total cost of a telecommunications service. Moreover, new technological developments, such as optical amplification, optical switching and routing signals according to their wavelength, all reduce dependence on conventional electronic switching technology. This makes the provision of high-reliability transmission and service delivery more and more economically viable, so that fibre-optics systems can be delivered directly to business premises and individual homes.

4.3 The market for optical communications systems

In the UK, telecommunications transmissions have so far constituted the main application for optical fibre communications systems, and they have also formed the principal target for pioneering R&D programmes. In recent times, there has been a sideways diffusion of fibre-optics communications systems to other applications, such as short-haul communications between on-site computers in both point-to-point links and LANs, in video, telemetry, and in sensing systems. Six different applications can be identified:

1. Public Switched Networks (PSTN, divided into Trunks and Local Systems). These are long haul trunks and junction systems, traditionally operated by the various national Post and Telecommunications administrations. With increasing deregulation in Europe, independent companies – such as Mercury in the UK - have started building commercial networks.
2. Local Loop or Subscriber connections. These entail the extension of the public long haul or junction systems to the individual subscriber, both residential and business.

- 3. Local Area Networks. These are networks where the maximum distance between terminals is 1 km.
- 4. Metropolitan Area Networks and Cable TV. These are networks where the maximum distance between terminals is 50 km.
- 5. Military & Aerospace. These relate to communications systems within aircraft, ships or tanks
- 6. Undersea Systems.

The market is growing for all types of applications, with Public Switched Networks and LANs leading the pack. Table 4.3 shows the European data for sales of fibre-optics components for the six applications between 1992 and 1997.

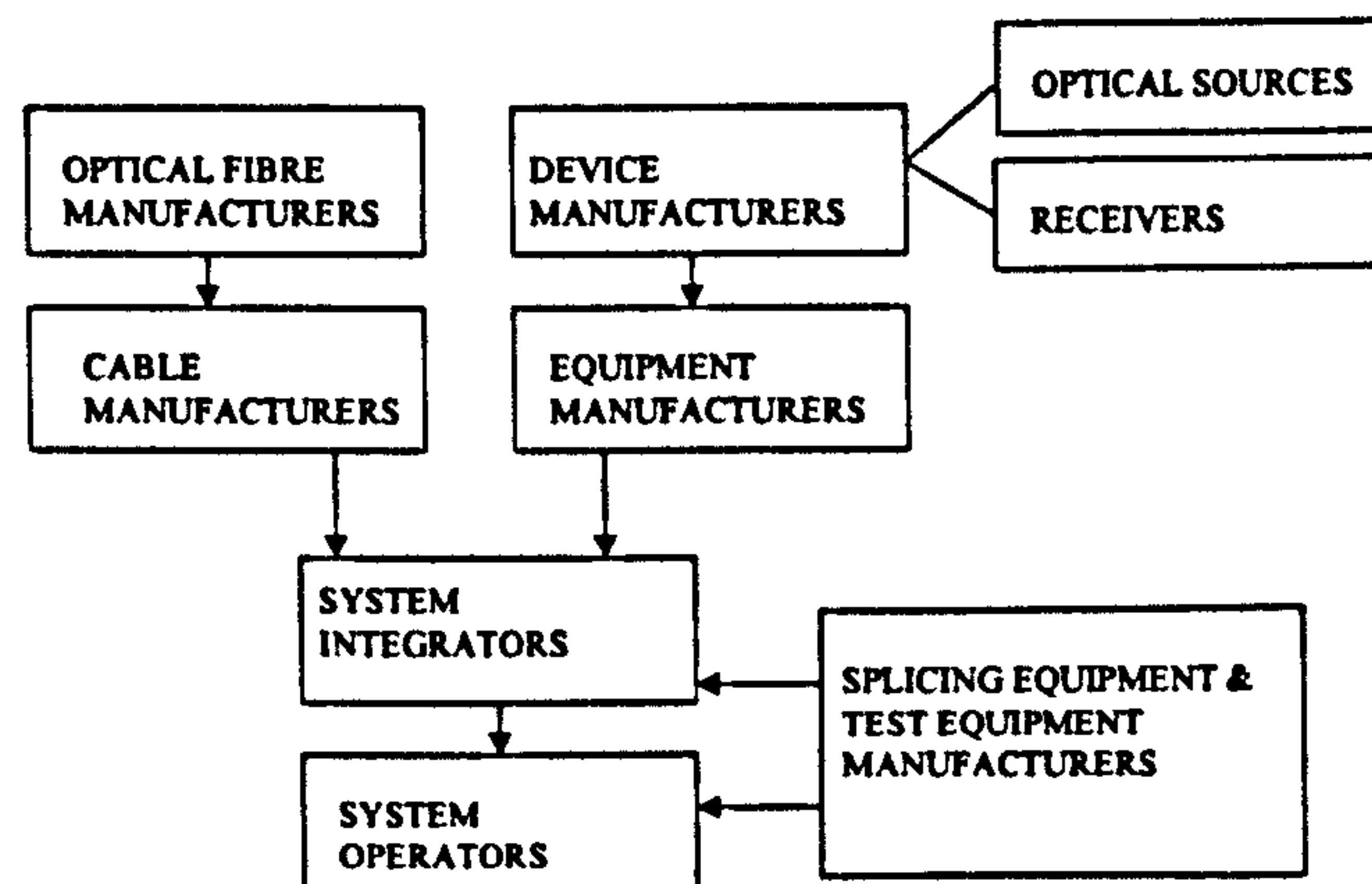
Table 4.3 European applications sales of fibre-optics communications components (1992 – 1997)
(\$ m)

	1992	1993	1995	1997
Public Switched Networks	484.7	539.1	698.9	877.6
Local Loop	7.3	41.7	52.5	68.1
Local Area Networks (LANs)	156.2	185.4	263.5	381.5
Metropolitan Area Networks (MANs) and CABLE TV	70.7	76.8	98.1	133.3
Military and Aerospace	48.4	49.4	52.0	55.4
Undersea Systems (only Europe)	97.4	110.8	144.0	187.9
TOTAL	864.7	1003.2	1309.0	1703.7

4.4 The supply side

Figure 4.3 shows the typical structure of the optical communications systems industry.

Figure 4.3 The structure of the optical communications systems industry



Cable production involves two basic technologies, silica-glass fibre manufacturing and cabling. Silica-glass fibre manufacturing is a high-tech process. There are three different manufacturing methods that are commercially successful: (a) the outside vapour deposition process (OCVD) developed at Corning Glass (US); (b) the vapour axial deposition process (VAD) developed at Sumitomo; and, (c) the modified chemical vapour deposition process (MCVD) developed at Pirelli. All of them involve the formation of a pre-form (or crystalline mass) by depositing silica and dopants using a chemical vapour process. The heated pre-form is then drawn into fibre. The method of depositing the silica differs, but the common driver for improvements in the manufacturing process is to fabricate larger pre-forms to provide scope for longer continuous fibre lengths.

Silica fibre manufacturing technology is regarded as a mature business. New materials are under investigation, but no revolutionary change is expected in the medium term. The agenda for immediate improvement is efficiency enhancement through larger pre-forms and improvements in the fibre drawing process. Competition is characterised at both the national and international level by falling prices and by the threat of over-capacity. New applications for optical fibres are actively sought by leading manufacturers.

Cabling optical fibre is not as high a technology as silica-glass manufacturing, but nonetheless it requires a considerable amount of specialist knowledge and expertise. Optical fibres are fragile and their performance is affected by applied stress. The driver for improvements in cabling research and development is to produce cables that are sufficiently strong to withstand environmental conditions but do not stress the fibre.

In fibre connection, it is necessary to distinguish between **splicing**, which involves joining two cables with one another, and **termination**, that is connecting cables to other components such as transmitters, receivers and amplifiers. Two main technologies compete in splicing. The first - more widely used in the US - is mechanical splicing, which involves the manufacturing of a mechanical device to hold the fibre ends in alignment. The second - more widely adopted in the UK - is fusion splicing, where localised heat is applied at the interface between two butted, pre-aligned fibres in order to soften and fuse them.

Connector manufacturers have easily adapted to the various changes in fibre dimension, though there are differences between multi-mode and single-mode fibres. The driver for future developments is the use of ceramics instead of metals, with better tolerances at reduced cost. Another traditional area of improvement is the continuous attempt to reduce the loss of light to a minimum. The cost of good quality connectors, especially when compared with that of other system components - typically fibre - remains high.

In **manufacturing optical sources** – mainly light-emitting diodes and lasers - thin layers of semiconductors are grown on top of each other. The early driver for the development of this technology was the identification of the semiconductor material that would emit light at sufficiently long wavelengths. Much of the fundamental research was carried out in the big research laboratories of large organisations, but subsequent commercialisation was fostered by the formation of spin-off companies. Today, the emphasis is on volumes and on packaging technology. Apart from specialist applications, the fundamental driver for future developments is improving existing technology and enhancing efficiency. A possible threat to established lasers

manufacturers comes from the developments achieved in the high-volume market of lasers for CD-players. CD lasers are a somewhat different technology from telecommunications lasers, but the experience acquired in CD lasers can be partially transferred. This is a matter of concern for Western manufacturers, since Japanese companies have a leading position in the supply of CD lasers and are devoting increasing attention to the telecommunications market.

In light receiving technology, the principles of photo-detection, which are at the base of the devices currently used, have never created a bottleneck comparable to the one that affected light emitting devices in the early stages of opto-electronics development. Avalanche photodiodes are more sensitive than PIN photodiodes, but are also more expensive and are affected by temperature. The driver for research and development is, consequently, the improvement of the sensitivity of PIN detectors.

Table 4.4 shows the estimated market shares of fibre-optics communications components for the major suppliers to the European market.

Table 4.4 Estimated market shares of fibre-optics communications components for the major suppliers to the European market (Frost and Sullivan, 1992)

	Manufacturers	Market share
Transmitter, receivers, trans-receivers and active modules (LEDs and lasers)	Siemens	7%
	BT&D	7%
	Honeywell	5%
	ABB Hafo	5%
Passive devices (couplers and wavelength division multiplexers)	Corning	20%
	Aster	5%
	SIFAM	5%
Connectors	Amphend	12%
	Radiall	10%
	AT&T	5%
	3M	5%
	AMP	5%
Splicers and splicing kits	Ericsson	10%
	Northern Telecom	10%
	Sumitomo	8%
	Furukawa	8%
Fibre-optics test equipment	Anritsu	15%
	Schlumberger	10%
	York	7%
	Hewlett Packard	5%
	Wandel & Goltermann	5%
Multi-mode fibre cable	Popo	7%
	Fort	7%
	NKT	7%
Single-mode fibre cable	Pirelli	20%
	BICC (OF)	12%
	STC	10%
	SIECOR	9%

4.5 Summary: a few strategic implications

The optical communications systems industry is, on the whole, a growing industry, with applications such as Public Switched Networks and Local Area Networks driving the growth process. The fundamental technology is relatively old, which explains the presence of relatively old and big companies in areas such as fibre-cable manufacturing, or connector manufacturing. However, new technological developments in not-mature areas of the industry, together with the relatively recent commercialisation of many applications, account for the great number of young, small and medium sized firms operating in the industry. Most of these tend to be highly specialised.

The market is growing but competition is tough, especially for some of the key components. Fibre cable is, in particular, a standardised and mature product. Big volumes and mass production characterise this sub-segment of the industry, where large companies fight to increase their market share. The level of competition is also heightened because of the resilience of traditional, copper-based technology. Copper cables are, for a great variety of applications, a viable and more practical alternative to fibre-optics cables. Also, it is not unusual to find both types of cable in the same system. For example, in a typical LANs application such as providing access to an industrial park, fibre cables could be used to connect different buildings, and copper cables could be used to extend the network to each individual terminal or desk within a building. It is interesting to note that there are quite significant differences in the strategy pursued by old and new companies in this particular area. Old copper cable manufacturers, such as BICC, have moved into fibre-optics cables and are now general providers of components for both installers and systems integrators (although BICC have since withdrawn from this in 1999). Firms that started as optical fibre and component manufacturers are much younger and tend to be specialist. They are not threatening directly the 'copper side' of the business, and their challenge to the general providers is based on the development of substitute products in the optical technological domain.

The interplay between copper-based and optical technologies is compounded by the presence of technological inter-dependencies (Itami and Roehl, 1987). As a result, firms operating at different stages of the industry supply-chain, or in different sub-segments, share the general industry context of growth but can also face very different levels of competition in their own specific area of business. This is an important element when considering the empirical evidence, and will constitute a central factor in interpreting the development of supply-chain relationships in the industry.

CHAPTER 5 - THE RESEARCH FRAMEWORK

The main purpose of this Chapter is to present the two broad research questions that drive the empirical investigation and to identify the variables used in the research and their operational measures.

5.1 The research questions

The research focuses on the diffusion of intermediate governance forms for regulating supply relationships in the UK optical communications systems industry. It concentrates on the shift from market-oriented to co-operation-oriented forms to govern supply relations in this industry with two objectives.

First, to investigate the extent of this change and its contingencies, and in particular the impact of technology. Optical communications systems is an industry characterised by the co-existence of – and on-going race between - two technologies, ‘established’ copper and ‘emergent’ fibre-optics, and therefore it offers an ideal context to test the role of technology in the development of co-operative forms of governance. The first broad research question can be formulated as follows:

What is the relevance of co-operative governance forms for regulating supply relationships in the UK optical communications systems industry? Does technology have an impact on the development of co-operative forms of governance in the supply-chain?

The second objective of the research is to test the linkage between governance forms in the supply-chain and organisational performance, and to verify whether or not technology is an intervening variable. The second broad research question can be formulated as follows:

Is it possible to correlate the adoption of co-operation as the fundamental principle to govern supply relationships with improvements in efficiency and

innovation? Does technology have a significant impact on the relationship between governance forms and performance?

The fundamental assumption underlying this second question is that co-operation should have a positive impact on organisational performance. The role of technology is, however, a grey area and its investigation give an exploratory edge to the research.

5.2 The network supply-chain: a working definition

The two research questions above drive the entire empirical investigation and constitute the starting point for identifying the variables for the study. We start with giving a working definition of the network supply-chain. This definition reflects the trend towards the convergence and cross-fertilisation of different disciplinary fields highlighted in Chapter 3. In particular, it is based on the integration of elements from Organisational Economics and Social Network Theory. The **network supply-chain** is defined as

A way of governing inter-organisational relations which is alternative to both the traditional supply-chain, based on the market governance structure, and the vertically integrated firm, based on hierarchy as its governing principle.

The idea of co-operation as an independent governance structure is derived from Organisational Economics, but the emphasis is on relations as opposed to individual exchanges. The influence of Social Network Theory appears in the characteristics of a network (co-operative) supply relationship. The first is that in a network supply relation the use of power is restrained. Firms operating in a supply-chain are formally autonomous and independent, but power is not necessarily evenly distributed among them, their relative endowment of critical resources and assets being the major source of power differentials. When co-operation is preferred to both antagonistic supply relations and vertical integration, the more powerful firm does not exploit its superiority in full in the short term. On the contrary, the use of power is restrained in the name of future and

uncertain benefits. Buyer and supplier openly recognise their mutual inter-dependence, which incorporate the notion of “commitment to sacrifice” (Gulati, Khanna, and Nohria, 1994).

A second characteristic of network supply relations is that buyer and supplier openly adopt a long-term view of their dealings. As Chapter 3 noted, a long-term perspective is increasingly recognised as intrinsic to co-operative organisational forms. Some authors refer to the repetitive and stable nature of the exchanges occurring between the actors involved in the relationships. Oliver defines inter-organisational relationships as “relatively enduring” (1990: 241); Williamson defines relational contracting as “suitable for recurring transactions” (1985: 72-78); Demsetz highlights the importance of “continuity of association” (1993: 74). Other authors emphasise the nature of the long-term advantages connected with the network organisation (Powell, 1987; Ring and Van de Ven, 1992). Finally, a great many reinforce the importance of a long-term perspective in an indirect way by introducing trust and past experience as fundamental characteristics of the network organisation (for examples see Uzzi, 1997; Dore, 1993; Thorelli, 1986; Ouchi, 1979; Ring, 1996). The adoption of a long-term perspective is also mentioned in several contributions on the types of changes occurring in supply-chain management and is incorporated in most of the models describing these changes (see Chapter 2).

A third characteristic of network supply relations is the common strategic intent shared by buyer and supplier. The need for co-operating organisations to share at least a ‘sense of direction’ is repeatedly mentioned in the literature. Ring (1996) explicitly introduces strategic intent as a fundamental determinant of network formation. A few authors from different disciplines share this view. For example, Demsetz (1993) maintains that “reliance of direction” is a fundamental aspect of the “firm-like” governance structure. Ouchi (1980) points out that a high degree of goal congruence and commonality of purpose is one of the key elements to differentiate the intermediate governance structure. More can be added by analysing the literature on supply-chain management. According to Wissema et al. (1989) and Matthyssens and van den Bulte (1994) the nature and the overall development of the relationship between buyer and supplier is

determined by the purchasing strategy of the former. Three archetypes of purchasing strategies can be identified: (a) the power strategy (supplier and buyer are opponents); (b) the tuning strategy (supplier and buyer distribute tasks between themselves); (c) the co-operation strategy (supplier and buyer have mutual goals and overlapping activities).

Table 5.1 summarises the three forms of governance in terms of the three characteristics, power, time and strategic intent.

Table 5.1 Three alternative ways of managing supply relations

	ECONOMIC INSTITUTION		
	MARKET-ORIENTED SUPPLY RELATION	NETWORK SUPPLY RELATION	VERTICALLY INTEGRATED ORGANISATION
USE OF POWER	Power is asymmetric and fully exercised through the application of a strict efficiency rule	Power is asymmetric but there is commitment to sacrifice	Power is asymmetric and exercised in the form of legal authority
TIME- PERSPECTIVE	Short-term	Medium to long-term	Long –term
STRATEGIC INTENT	Total independence leads to conflicts of interests	Recognition of mutual inter-dependence leads to commonality of interests	One-way dependence leads to commonality of direction

5.3 Network supply relationships: operationalisation

The literature offers few examples for operationalising the concept of network supply relationship, and most of these are based on the adoption of a single theoretical perspective. The most common is Transaction Cost Economics, and the key variable used to operationalise forms of network governance is the degree of asset specificity.

Exemplary applications of this approach can be found in Dyer (1996, 1997) and Dyer and Ouchi (1993). The hybrid governance structure is measured by the degree of inter-firm specialisation or the degree of asset specificity in three forms - physical asset specificity, site specificity and human asset specificity (Dyer, 1996, 1997; Dyer and Ouchi, 1993).

Our definition of network supply relationship is based on contributions from different disciplinary fields and this affects our approach to operationalisation issues. Our measurement effort is based on the assumption that **co-operation in a real organisational context can be more easily detected by looking at firms' actual behaviours in a few critical areas**. In other words, the focus for observation and measurement shifts from the characteristics of the co-operative relationship itself to the actual behaviours of the co-operating firms. The organisational areas subject to observation are identified on the basis of their relevance and poignancy from a governance perspective in the study of supply relationships. These are:

1. *Teamwork across organisational boundaries*. This relates to the existing division of labour between buyer and supplier. The more suppliers are involved and actively participate in the early stages of the overall production process, the more co-operative the nature of the mechanism governing the relationship.
2. *Supplier selection*. This relates to the span of criteria used to select suppliers: the wider the span, including criteria that go beyond past performance to encompass factors such as potential for innovation and technological capabilities, the more co-operative the relationship.
3. *Commitment to the supplier*. This relates to the level of commitment of the firm towards its suppliers, which is expected to be higher in co-operative relationships – where there is a shared sense of inter-dependence between the two firms - than in market-based ones. The use of 'transparency practices' such as open books, exchange of strategically sensitive data, exchange of key personnel, and idiosyncratic investments – that is, supplier-specific investments of both tangible

(for example, shared facilities) and intangible (for example, training) nature - constitutes a measure of the level of commitment of a firm to its suppliers.

4. *Supplier's performance evaluation.* This relates to the span of criteria used to evaluate suppliers' performance: the wider the span (beyond cost-reduction, timeliness and compliance to specifications to include also less objective and measurable dimensions of performance), the more co-operative the relationship.
5. *Role of the contract.* This relates to the value given to the contract, either written down in law or in oral form, as a means to specify the expectations of the negotiating parties¹⁸. Thanks to the protection and enforcement offered by the legal system, the contract is a form of safeguard¹⁹. The higher the degree of specification of the contract, the less co-operative the relationship.
6. *Conflict resolution.* This relates to the use of legal enforcement - as guaranteed by the contract versus trust-based mechanisms - in case of conflict between buyer and supplier. The more conflict resolution is based on trust, the more co-operative the relationship. The degree of 'voice' in conflict resolution is our measure of the firm's reliance on trust.

The three governance modes in Table 5.1 – that is, market-oriented supply relationships, network-oriented supply relationships and vertically integrated structures - can be differentiated in terms of these six critical areas. Table 5.2 compares the three.

¹⁸ For a review of the legal foundation of exchange in intermediate markets see Gundlach and Murphy (1993), and Lusch and Brown (1996). See also Dyer (1997). It is possible to distinguish two different types of legal contract, the classical contract and the neo-classical one. The classical legal contract is perfectly exhaustive, in that all the obligations of each party are explicitly written "within the four corners of the document" (Mcneil, 1978). The neo-classical contract is more complex in that it includes adequate safeguards such as contingency clauses, to allow for equitable adjustments between the parties as market conditions change (Mahoney, 1992).

¹⁹ This mechanism is also described as "self-enforcing agreements" (Telser, 1980) and as "private ordering" (Williamson, 1985).

Table 5.2 A comparison between alternative economic institutions for regulating supply relations: key organisational areas

	<i>ECONOMIC INSTITUTIONS</i>		
	MARKET SUPPLY RELATION	NETWORK SUPPLY RELATION	VERTICALLY INTEGRATED ORGANISATION
<i>ORGANISATIONAL AREAS</i>			
Teamwork across boundaries	Activities are allocated to specialised units Separate outputs from independent suppliers are assembled by the buyer	Resources are pooled (at least partially) by autonomous units Buyer and supplier jointly produce the output	Activities are integrated in a single unit Buyer and supplier no longer exist as autonomous parties
Supplier selection	Price is all that matters. Selection is only based on ‘hard’ dimensions of performance	Personal characteristics of the supplier matter. Selection is based on a combination of ‘hard’ and ‘soft’ dimensions of performance	Socialisation is more important than selection
Commitment to the supplier	Short-term Limited to the individual exchange episode	Medium-term Beyond the scope of the individual exchange episode	Long-term For the entire life of the organisation
Supplier’s performance evaluation	Based on the limited terms and conditions of the individual exchange It only includes measurable and objective dimensions of performance	Beyond the limited terms and conditions of the individual exchange to include less measurable and objective dimensions of performance	Long-term appraisal on ‘soft’ and ‘hard’ dimensions of performance
Role of the contract	Legal contract (classical or neo-classical) with formal safeguards	Informal contract with formal and informal safeguards	Contract is replaced by rules/procedures and direct supervision
Conflict resolution	‘Exit’ and law/ third party enforcement	‘Voice’ and mutual adjustment	Legal/rational authority

5.4 Organisational performance: definition and operationalisation

Measuring the overall performance of an organisation in a way that is both comprehensive and exhaustive is an almost impossible task, given the variety of dimensions comprised in this concept. Cameron and Whetten (1983) and Goodman and Pennings (1997) extensively review the problem of measuring organisational effectiveness.

A practical route is to concentrate the analysis on a limited number of dimensions of performance, according to the specific requirements of the research. This study concentrates on two dimensions of organisational performance – efficiency and innovation. These are at the heart of the debate on the relative advantages of co-operative and hybrid organisational structures²⁰.

There are many definitions of **efficiency**²¹. In a managerial context, however, **efficiency** is generally defined as the **ratio between the output obtained from a specific activity or process and the amount of resources used as input in the same process**. When efficiency is referred to as a dimension of the overall performance of the firm, two alternative concepts are available. The first is linked to the traditional model of production, that is the mass-production system. The firm is seen as a portfolio of different activities functionally organised, and the emphasis is on each of them individually – that is, vertically – considered. Efficiency in this context is the minimisation of costs within each functional area.

The second alternative is linked to the more recent model of the lean production system (Womack, Jones and Roos, 1990). A process-oriented approach is preferred to a

²⁰ See Chapter 2 for an overview of this issue specifically aimed at co-operation in supply-chains. At a more theoretical level, see Miles and Snow (1992), and Hedlund (1994).

functional-oriented one, and the inter-linkages between different organisational units become paramount. In this context, efficiency refers to the minimisation of costs throughout the overall firm. Different names have been devised for this type of efficiency, the most common ones being cycle-efficiency, throughput efficiency and inter-functional efficiency.

At a general level, **innovation capability** can be defined as the **ability to create something new and to exploit it in economic terms**. A key distinction is that between **incremental and radical innovation** (Mansfield, 1968; Moch and Morse, 1977; Freeman, 1982). Incremental innovation is about refining and improving existing products and processes, so that the established design is reinforced and its potential more fully exploited (Ettlie, Bridges and O’Keefe, 1984; Dewar and Dutton, 1986; Nelson and Winter, 1982; Tushman and Anderson, 1986). Radical innovation is about the introduction of a new concept that is significantly different from anything already existent, and the opening up of new markets and new potential applications (Cooper and Schendel, 1976; Dess and Beard, 1984; Dewar and Dutton, 1986; Ettlie, Bridges and O’Keefe, 1984; Tushman and Anderson, 1986).

The concepts of efficiency and innovation are not necessarily mutually exclusive. Noteboom (1996) develops the concept of **dynamic efficiency** as a bridge between the two. In his analysis of the different concepts of efficiency used in the literature, Noteboom distinguishes between four different typologies: allocative efficiency, productive efficiency, dynamic efficiency, and Pareto efficiency. Allocative efficiency is the optimal allocation of scarce resources associated with perfect competition. Productive efficiency can be assimilated to the concept of functional efficiency of the mass-production system. Cost-minimisation and the optimal use of economies of scale, scope and experience are key managerial issues. Dynamic efficiency refers to the

²¹ For a review of the different definitions of the concept of efficiency see Rowlinson and Procter (1997). The authors identify two major versions of efficiency, the subjectivist and the essentialist. The subjectivist version of efficiency is essentially Paretian. A “state of a given system is Pareto Optimal if and only if there is no feasible alternative of that system in which at least one person is better off and no one else is worse off” (Buchanan, 1985: 4). The essentialist definition of efficiency is expressed by the so-called “general Marxist postulate” as stated by Stinchcombe (1983: 8): “there is a long-run tendency for the relations of production to assume a form in which the activities of production are efficiently and effectively done”.

optimal production and diffusion of innovation, which is the long-term fundamental driver of a firm's survival in a competitive environment. Pareto efficiency refers to the efficiency achieved when, in a given allocation among n participants, no one's utility can be increased without decreasing utility for one or more others. It is a global measure of efficiency.

For the purposes of this research, a 'managerial' definition of both efficiency and innovation is used. **Efficiency** is defined as **cycle-efficiency**, that is the overall efficiency achieved by the firm as a unitary system of inter-linked parts. **Innovation** is defined as the **commercial exploitation of new technology, in the form of new or improved products**. The analysis includes two dimensions of efficiency, cost and time - that is, speed – with measures at both global and partial level. Global efficiency (A1 and A2 in Table 5.3) refers to the whole organisation, whereas partial efficiency (B1 to B4 in Table 5.3) is a measure of the firm's ability to make the best use of critical resources. Innovation is measured in terms of the output of the overall innovation process (D1 to D5 in Table 5.3) as well as in terms of the speed of the process itself (C1 in Table 5.3). Time-based measures of performance are included in the study because time is a fundamental competitive dimension in the optical communications systems industry.

Table 5.3 Performance indicators

Organisational performance	
Efficiency - Global - Partial	A1. Overall product cost (trend) A2. Order-to-delivery time (trend) B1. Labour productivity (trend) B2. Material productivity (trend) B3. Equipment utilisation (trend) B4. Cycle time (trend)
Innovation - Process - Output	C1. Time-to-market (trend) D1. New products developed in the last 12 months D2. New products developed in the last 5 years D3. % of sales of products developed in the last 5 years that are totally New D4. % of sales of products developed in the last 5 years that are up-grading over previous generations D5. % of sales of products developed in the last 5 years that are minor Improvement

CHAPTER 6 - RESEARCH STRATEGY AND METHODOLOGY

The overall research strategy and how this developed, based on the foregoing discussion in Chapter 5, constitute the core of this Chapter. The options available are compared, and the reasons for the final choice highlighted. The boundaries of the study are, as a consequence, more clearly identified and some of the intrinsic limitations of the project accounted for. The methodology used to investigate the research questions in Chapter 5 is detailed, and the methods of data collection outlined.

First, the research strategy is presented by describing the process that led to its final definition. Two key decisions are analysed - the choice of the unit of analysis and the extent of the empirical field covered. Second, the selection of a sector for study is outlined. Third, the development of an appropriate research methodology is described, with the shift from a case study approach to using a combination of survey and interviews. Fourth, methods of data collection are discussed, with special reference to the development of the survey instrument. The questionnaire is described in detail, and the connections between sets of questions and the key variables of the study are highlighted.

6.1 Research strategy

The development of the research strategy required the identification and evaluation of alternative approaches in two areas - the choice of the unit of analysis and the extent of the empirical field covered in data collection. These elements are important for the validity and reliability of the research findings, as well as their generalisability. The Research Strategy Matrix in Figure 6.1 presents **four alternative research strategies** based on different combinations of the two elements above mentioned.

Figure 6.1 Research Strategy Matrix: a Comparison of Alternatives

Unit of Analysis	Entire supply-chains	STRATEGY A	STRATEGY B
	Segments of supply-chains	STRATEGY C	STRATEGY D
		Single sector	Different sectors
Extent of empirical field			

For the **unit of analysis**, the two main options are **entire supply-chains** on the one hand, against **segments of supply-chains** on the other. The adoption of the entire supply-chain as the unit of analysis means that the different organisational levels at which supply relationships can be found - the different tiers of the supply-chain - must be identified and observed at the same time. This option is particularly attractive for various reasons. The first is originality. Studies adopting the whole supply-chain as the relevant dimension of analysis are quite rare. The second is the richness of data obtainable and the possibility of combining the perspectives of organisations in the supply-chain in a unitary picture. This strategy, however, is time-consuming and demanding in terms of resource requirements. The first obstacle is the identification of the relevant organisations in the supply-chain at different levels or tiers and getting the participation of the whole chain. To overcome this obstacle, a small sample of representative firms for each level in the supply-chain can be selected. The choice of selection criteria is, however, subjective and the final composition of the sample can also be biased by the firms' willingness to participate. Another difficulty lies in the trade-off between the depth of data obtainable by concentrating attention on some supply-chain, against the necessity to cover as much ground as possible to assess how pervasive are the changes occurring in supply-chain management.

Alternatively, the adoption of segments of a supply-chain - that is, dyadic relationships between buyer and supplier - as the unit of analysis means limiting the originality and richness of data. However, this does allow for a greater depth of information and the loss in richness can be partially counter-balanced by a deeper understanding of the context where supply relationships develop. Secondary data on the overall development of the industry structure can be used to build this framework.

For the extent of the empirical field, the options are to limit the comparison to units within the same industry or to extend this to units across sectors. Comparing industries offers greater opportunities for generalising findings. Different industries offer different contexts for research in terms of technological development. The technological trajectory (Dosi, 1984) of an industry combined with the nature and characteristics of innovation may add an extra dimension for interpreting and explaining potential differences and similarities amongst cases. The impact of technology, as a fundamental environmental variable affecting a firm's behaviour and performance, can be explicitly introduced. However, again, time and resource constraints mean a trade-off between depth of data and coverage of the field.

Limiting the research to a single industry offers certain advantages. At a practical level, it limits the amount of time and resources that needs to be devoted to analysing the research context and to identifying the boundaries of the empirical field. At a theoretical level, comparisons between different units of analysis are easier because of the similarities of the external environment. This may facilitate interpretation of the research findings by eliminating one major source of potential 'noise'.

A further option is to extend the comparison across countries. This option was, however, rejected early and the research concentrated on the UK. The reason for this can be traced back to the considerations presented in Chapter 2 on the special place the UK occupies in research on supply-chain relationships. The possibility to extend the study to different national contexts is suggested as a future avenue of research.

The relative advantages and disadvantages of the four research strategies led to Strategy C emerging as the most appropriate for this study. Segments of supply-chains - dyadic relationships between buyer and supplier - thus constitute here the unit of analysis. The comparison between cases, moreover, is limited to a single industry. In this way, it was possible to concentrate time and resources on getting detailed data on clearly identifiable cases instead of tackling the daunting task of defining the boundaries of supply-chains as a first step. It is argued that this leads to a better coverage of the empirical field.

Having decided to focus on a series of dyadic relationships, the next issue was to consider the level of analysis in the supply-chain. The key decision was whether to analyse relationships between firms at the interface with end-customers and their first-tier suppliers, or whether to focus on supply relationships between firms operating at the middle and lower end of the industry supply-chain. The choice was postponed until a better knowledge of the characteristics of the sector under study could be relied upon.

6.2 The selection of a suitable context for the study

Identifying a suitable sector meant identifying an industry best suited for the study of buyer-supplier relationships. Several typologies can be identified from the literature (Pavitt, 1990; Porter, 1990; Nelson and Rosenberg, 1993).

Some typologies are based on the **characteristics of the product** (or the service) offered. Nelson and Rosenberg (1993), for example, distinguish between *complex systems* (such as aircraft or telecommunications systems), *fine chemical products* (such as synthetic materials or pharmaceuticals), and *bulk commodities* (from steel to milk). At a more general level, a fundamental distinction can be drawn between *assembled* and *non-assembled* products (Utterback, 1994). A similar approach puts products in a continuum between the two extremes of *homogeneous products* and *assembled products*.

A second way of classifying industries is according to their **relative pace and rate of technological development**. A related dimension is the *strategic driver of innovation* (Griffin, 1993). In some cases the driver of innovation and technological development lies in the customers' needs (*demand-pull*). In other cases, it is the intrinsic pace of technological development that shapes the nature of competition (*technology-push*). In order to understand the pace and rate of technological development of a specific industry, it is necessary to analyse the characteristics of the development process that predominates in that industry. In particular it is important to assess whether this development is primarily characterised by a *continuous flow of incremental innovations* or, alternatively, by *major discontinuities* (Anderson and Tushman, 1990; Tushman and Anderson, 1986; Utterback, 1994).

The choice of industry finally concentrated on **manufacturing industries characterised by the production of assembled products, and more specifically of complex systems**. In this particular class of industries, supply-chains are the traditional way of structuring activity. They also have a high need for co-ordination between organisations in order to deliver the final output. This makes the issue of governance structure particularly poignant.

Among manufacturing sectors devoted to the production of complex systems, it is possible to identify industries characterised by different technological development and innovation processes. A number of possible candidates, such as the automotive industry and aerospace, were intentionally excluded because they have already been over-researched. The final choice fell on **opto-electronics**, and more specifically on the segment of the opto-electronic industry that concentrates on manufacturing and installation of optical communications systems (see Chapter 3).

Secondary data on the structure of the opto-electronics industry also helped solve the issue of the level of analysis. The research concentrates on **relationships occurring between firms at the interface with end-customers and first-tier suppliers**. It is, however, important to highlight that opto-electronics is part of a bigger system - the telecommunications industry - and operates at the bottom level of the complex chain

that leads to the provision of telecommunications services such as cable TV or mobile telephony. The boundaries of the telecommunications industry are hard to define, including different sub-systems and activities as varied as infrastructure installation (for example, the construction of a Local Access Network), infrastructure operation (for example, the provision of mobile telephony), distribution of services (for example, payphones), marketing and sales (for example, the sale of mobile phones), and customer service (for example, maintenance of computer networks). The optical communications systems industry concentrates on infrastructure-related activities, and in particular on manufacturing and installation of hardware components.

The development of opto-electronics has always been driven by telecommunications in general and the needs of its end-customers. It is an industry that could be classified as “demand-pull” (Griffin, 1993), and every environmental stimulus tends to be immediately reflected in the behaviour of firms operating at the top end of the industry supply-chain. Concentrating at this level of the supply-chain therefore allows us to see whether changes occurring at the customers’ end in telecommunications propagate themselves throughout the various sub-systems constituting this industry in a snowball fashion. As a side issue, this also provides an opportunity to consider the vertical diffusion of new managerial practices and strategies in purchasing and supply management.

6.3 Research methodology

In addition to drawing on secondary data, the key choice for data collection was between **in-depth case studies** and the **survey method**.

In-depth case studies can give a set of very rich data to understand the context for the shift in supply relationships. This method entails a deep involvement of the participating companies and, therefore, the scope of the research may be restricted by time and resource constraints. In practical terms, it means that only a few relationships can be observed, and the challenge becomes to pick up the really representative ones. On the other hand, survey methodology can offer a better coverage of the industry, and

therefore seems preferable to assess how pervasive the changes are. The richness of in-depth case studies may be partially lost, but it is easier to collect quantitative data in a systematic and standardised fashion. Moreover, if the study concentrates on a single industry, a survey can better satisfy the requirements for reliability.

The in-depth case study approach was initially preferred because it seemed more appropriate to the study of inter-organisational processes. Secondary data led to the identification of a few lead firms and contacts were established by means of letter, fax and telephone. At first the response was encouraging, but the process of getting access came to a halt when the managers contacted realised the full scale of the involvement required of them. Not only were they in charge of securing access to their own firm, but they were also asked to facilitate access to their suppliers. This proved too big an obstacle given time and resource constraints and the choice of methodology was reconsidered. Two more factors influenced the final decision to abandon the in-depth case studies approach in favour of the survey method. First, it became clear that the difficulty in getting access to firms constituted a material danger of missing the really meaningful relationships in favour of less significant - but easy to get to - ones. The second factor was the necessity to cover as much ground as possible in order to test the idea that the shift to co-operation in supply-chain management is pervasive. A careful design of the survey instrument could cater for the need to focus on inter-organisational processes.

The primary methodology eventually used was the **survey**, complemented by a series of **follow-up interviews**. These were planned so that issues identified as relevant through, but not fully explored or resolved in, the survey could be investigated. By combining survey and interview data, mainly quantitative information can be supplemented by qualitative data, and our understanding of the phenomena under observation can be improved in a practical and effective way. As well as corroborating the interpretation of the survey data, the interviews can also reveal unpredicted elements and consequently suggest new directions for future research and exploration. As a result, a mixture of quantitative and qualitative methods was used. Quantitative data were predominantly employed to assess factual elements, while qualitative data helped explain the relations

between the different variables in the analysis and describe and interpret dynamic phenomena.

To summarise, the overall approach to data collection is based on **triangulation**. Secondary data were collected through a variety of sources, among which specialist publications, material provided by the Fibre-optic Industry Association, industry studies by various research institutions, and companies' private documentation proved especially useful. This information helped define the boundaries of the empirical work, develop a suitable strategy and build a framework for the future interpretation of the data. A self-administered questionnaire was used to outline the trends in supply-chain management in the opto-electronics industry, and to assess the extent and the intensity of the changes. In other words, survey data sketched the overall picture at the industry level. Semi-structured interviews enriched our understanding of the development of buyer-supplier relationships in opto-electronics at the firm level by adding details with qualitative 'strokes'.

6.4 Data collection and the unit of analysis

The unit of analysis coincides with the unit of data collection, and is constituted by the individual firm. The perspective is the buyer's - that is, the buying firm - which means that **supply relationships are always assessed from the buyer's point of view, and that organisational performance is the buyer's performance.**

Several reasons justify this choice. First, the buyer's perspective seems especially relevant because the buyer normally has a view of the overall buyer-supplier relationships that is not available to the individual supplier. This is particular true when the characteristics of opto-electronics are taken into account. The technological development of fibre-optics is pulled by customers' needs, so that those at the top of the telecommunications industry drive the changes and their behaviour ripples down through the overall chain. A top-down perspective therefore fits the evolutionary development of the industry. Second, most of the available literature on the shift to co-

operation in supply-chain management takes the view of the buyer, whose role is considered fundamental.

6.5 The questionnaire

This section describes the survey questionnaire. The design for the interviews is described in Chapter 9, after the issues these sought to explore, resulting from the survey findings, have been discussed.

The survey instrument drew heavily on the experiences reported in case studies on supply-chain management in the literature. Most of this material refers to the automotive industry, but cases are also available in aerospace, semi-conductors and consumer electronics, construction engineering, textile and fashion, and financial services. Informal talks with experts in the opto-electronics industry allowed us to adapt existing material to the specific characteristics of this industry.

In addition, the questionnaire was especially designed with regard to the operationalised variables defined in Chapter 5 and covers several aspects of supply-chain management and organisational performance. Thus, we are reminded that, from a methodological point of view, the study aims to **bridge the gap between different theoretical perspectives** by developing a theoretical definition of co-operative supply relationships that draws on various disciplinary fields and highlights their complementary nature.

The questionnaire is divided into **four sections**:

- Section I is concerned with the company's **strategy in purchasing** and its current practices in supply-chain management. It covers five of the six critical organisational areas described in Chapter 5 (supplier selection, commitment to the supplier, supplier's performance evaluation, role of the contract and conflict resolution).
- Section II considers **co-operation** between the company and a variety of relevant actors, including customers and suppliers, in relation to product development

and manufacturing. It covers the area of teamwork across organisational boundaries.

- Section III focuses on **efficiency and innovation** in terms of the sets of performance measures defined in Chapter 5.
- Section IV asks questions about **general company performance**.

Each section and the rationale for each set of questions are now discussed in turn, while the full questionnaire is set out in Appendix A.

● **SECTION I: SUPPLY-CHAIN RELATIONSHIPS**

Section I is concerned with the company's **strategy in purchasing** and its current practices in supply-chain management. Five of the six critical organisational areas described in Chapter 5 (supplier selection, commitment to the supplier, supplier's performance evaluation, role of the contract and conflict resolution) are covered.

The first two questions seek background information about the firm's organisation of purchasing. An important aspect is whether or not the firm considers supply-chain management as a strategically relevant issue, an area where changes should follow a clearly identified strategy.

1. How is the supply/purchasing function currently organised within the company?

- a. Number of people: _____
- b. Title of the unit: _____
- c. To which function/position does the supply/purchasing function report?
(Please give title)

2. Have there been any major changes in the company's strategy for supply-chain management and purchasing in the past five years? (Please tick the appropriate box)

YES	[]
NO	[]

If yes,

2.1 In what year(s)? _____

2.2 What was the main reason for the change(s) ? _____

2.3 In what did the change(s) consist ? _____

The identification of the six most important materials, parts and components for the firm (Q. 3-5) and their evaluation in terms of commercial and strategic importance are necessary to guarantee that the data are significant. In other words, we want to make sure that the information provided refers to core activities for the firm, and not to marginal ones. The availability in the market of suppliers is verified to make sure that the firm is actually free from market constraints in devising its own purchasing practices.

3. Please list the six most important materials/parts/components in terms of company purchasing expenditure and indicate the approximate percentage of overall company purchasing expenditure they each represent.

Material/part/component	Percentage of overall company purchasing expenditure
1. _____	[%]
2. _____	[%]
3. _____	[%]
4. _____	[%]
5. _____	[%]
6. _____	[%]

4. How important are these six materials/parts/components purchased by the company for the functionality of its final products? (Please tick as appropriate)

Materials/parts/components [as listed in Q. 4]	Extremely important	Quite important	Important	Relatively important	Not important
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]
5. _____	[]	[]	[]	[]	[]
6. _____	[]	[]	[]	[]	[]

5. How many suppliers are potentially available in the market for the provision of these six materials/components/parts? (Please tick as appropriate)

Materials/parts/components	A great many (more than 20)	Not quite so many (5 to 20)	Very few (fewer than 5)
1. _____	[]	[]	[]
2. _____	[]	[]	[]
3. _____	[]	[]	[]
4. _____	[]	[]	[]
5. _____	[]	[]	[]
6. _____	[]	[]	[]

Questions 6-9 assess whether or not changes in the firm’s supply-chain management are occurring - more or less independently from an explicit purchasing strategy - in line

with the changes reported in other industries. This information is relevant to assess how pervasive is the shift from antagonism to co-operation in buyer-supplier relationships and must be interpreted in the light of the data gathered in Section III about the importance for the firm of co-operation with third parties, suppliers included.

6. What has been the trend in the number of suppliers during the past five years? (Please tick as appropriate)

- a. Substantially increased (over 30 % more)

[]
- b. Moderately increased (10 to 30 % more)

[]
- c. No big change (between -10 and +10 %)

[]
- d. Moderately decreased (10 to 30% fewer)

[]
- e. Substantially decreased (over 30 % fewer)

[]

7. Which of the following practices is the company currently adopting for the supply of the six materials/parts/components listed above? (Please tick as appropriate)

Materials/parts/components	Multiple sourcing	List of preferred suppliers	Parallel sourcing of selected suppliers	Single supplier
1. _____	[]	[]	[]	[]
2. _____	[]	[]	[]	[]
3. _____	[]	[]	[]	[]
4. _____	[]	[]	[]	[]
5. _____	[]	[]	[]	[]
6. _____	[]	[]	[]	[]

8. Have any of the following practices become more or less important for the company in the past five years? (Please tick as appropriate)

	Significantly more important	Moderately more important	No change	Moderately less important	Significantly less Important
a. Multiple sourcing	[]	[]	[]	[]	[]
b. List of preferred suppliers	[]	[]	[]	[]	[]
c. Parallel sourcing of selected suppliers	[]	[]	[]	[]	[]
d. Single supplier	[]	[]	[]	[]	[]

9. How long has your company had a commercial relationship with your suppliers as a whole? (Please tick as appropriate)

	more than 10 years	5 to 10 years	less than 5 years
a. More than 75%	[]	[]	[]
b. 50% to 75%	[]	[]	[]
c. 25% to 50%	[]	[]	[]
d. Fewer than 25%	[]	[]	[]

Questions 10 to 17 measure the five critical organisational areas of supplier selection, commitment to the supplier, supplier’s performance evaluation, role of the contract and conflict resolution.

Question 10 concentrates on **commitment to the supplier**.

10. With what proportion of suppliers is the company currently adopting any of the following practices? (Please tick as appropriate)

	With all	With the majority	With a Minority	With None
a. Exchange of personnel and key human resources	[]	[]	[]	[]
b. Shared physical facilities /resources	[]	[]	[]	[]
c. Open books*	[]	[]	[]	[]
d. Supplier-specific investments**	[]	[]	[]	[]
e. Exchange of data on internal processes***	[]	[]	[]	[]

* Open books: transparency in private information related to costs and other accounting data

** Investments in training, or special machinery, or similar for a specific supplier

*** Internal processes, such as technological development and R&D, strategic planning, marketing

The use of one or more transparency practices indicates that the firm accepts that its commitment towards its suppliers goes beyond the scope of the individual exchange episode and extends over time. The more widely used the practices - in terms of both number and intensity – the higher the level of commitment and the more network-oriented the approach used by the firm in governing its supply relationships.

Questions 11 and 12 address the area of **supplier selection**.

11. Which of the following criteria are currently used by the company in selecting a supplier? (Please tick as appropriate)

	Always used	Used only in special cases	Not used at all
a. Financial performance	[]	[]	[]
b. Price	[]	[]	[]
c. Time and delivery	[]	[]	[]
d. Quality	[]	[]	[]
e. R&D design and capability	[]	[]	[]
f. Technical innovation	[]	[]	[]
g. Sound managerial practices	[]	[]	[]
h. Compatible culture	[]	[]	[]
i. Production flexibility	[]	[]	[]
l. Ease of communication	[]	[]	[]
m. Willingness to invest and share risk	[]	[]	[]
n. Good skill base and training	[]	[]	[]
o. Location	[]	[]	[]
p. Other (specify): _____	[]	[]	[]

12. Have any of the following criteria for selecting a supplier become more or less important for the company in the past five years? (Please tick as appropriate)

	Significantly more important	Moderately more important	No Chang e	Moderately less important	Significantly less important
a. Financial performance	[]	[]	[]	[]	[]
b. Price	[]	[]	[]	[]	[]
c. Time and delivery	[]	[]	[]	[]	[]
d. Quality	[]	[]	[]	[]	[]
e. R&D design and capability	[]	[]	[]	[]	[]
f. Technical innovation	[]	[]	[]	[]	[]
g. Sound managerial practices	[]	[]	[]	[]	[]
h. Compatible culture	[]	[]	[]	[]	[]
i. Production flexibility	[]	[]	[]	[]	[]
l. Ease of communication	[]	[]	[]	[]	[]
m. Willingness to invest and share risk	[]	[]	[]	[]	[]
n. Good skill base and training	[]	[]	[]	[]	[]
o. Location	[]	[]	[]	[]	[]
p. Other (specify): _____	[]	[]	[]	[]	[]

Criteria based on a supplier’s past performance are listed alongside criteria that express potential for future performance, such as innovation capability and technological strength. The width of the span of indicators used by the firm to select suppliers indicates the nature of supply relationships. The wider the span of selection criteria, the more supply relationships are governed by means of co-operation instead of market-oriented mechanisms.

Question 13 relates to the area of supplier’s performance evaluation.

13. Have any of the following factors for evaluating the performance of a supplier become more or less important for the company in the past five years? (Please tick as appropriate)

	Significantly more important	Moderately more important	No change	Moderately less important	Significantly less important
a. Compliance with technical requirements and specifications	[]	[]	[]	[]	[]
b. Warranty performance	[]	[]	[]	[]	[]
c. Delivery/Service	[]	[]	[]	[]	[]
d. New ideas generated by the supplier	[]	[]	[]	[]	[]
e. Other (specify):_____	[]	[]	[]	[]	[]

If the company shows increasing interest in criteria other than compliance to technical specification and requirements for evaluating its suppliers’ performance, a more network-oriented approach to supply-chain governance can be expected. In other words, in a co-operative supply relationship the evaluation goes beyond the limited terms and conditions of the individual exchange to include factors that might affect future performance.

Question 14 addresses the area of the **role of the contract**.

14. What is the average level of detailed specification of the contract with a supplier on non-technical issues (such as penalties, clauses for reassessing prices, provisions for unpredictable events, etc.?) (Please tick as appropriate)

- a. The contract is very detailed and exhaustive

[]
- b. The contract is relatively detailed, but there is scope for flexibility and adjustments

[]
- c. The contract is not very precise and things are specified along the way

[]

It directly measures the degree of flexibility and informality of the contract. High flexibility and informality are associated with network supply relationships, while very detailed contracts show a propensity towards arm’s length relationships.

Questions 15 to 17 refer to **conflict resolution**. In particular, question 15 measures the importance of the contract in case of conflict between the firm and one of its suppliers. When the contract constitutes the basis for conflict resolution, the underlying approach is ‘exit’ as described in Chapter 5. Alternatively, when the contract is put aside and

‘things are sorted out’, conflicts between the firm and its supplier are resolved by means of discussion and mutual adjustment.

15. If something goes wrong during the life of a contract, what is the normal company reaction? (Please tick as appropriate)

- a. Stick to the contract and use the lawyers []
- b. Renegotiate the contract, and listen to the supplier’s reasons []
- c. Put the contract aside, and try to “sort things out” []

16. Does the company use any of the following mechanisms for assessing the soundness of the overall relationship with its suppliers? (Please tick all that apply)

- a. Regular meetings for open and informal discussion []
- b. Occasional meetings for open and informal discussion []
- c. Periodical and formal grading against a check-list of well specified criteria) []
- d. Self certification []
- e. Other (specify): _____ []

17. It could help if you could indicate any significant actions or initiatives that have resulted from such reviews in recent years

● SECTION II: THE COMPANY’S MAIN PRODUCTS AND ITS GENERAL MANUFACTURING ORGANISATION

This section concentrates on the issue of co-operation between the company and a variety of relevant actors, including customers and suppliers, and covers the area of **teamwork across organisational boundaries**. The importance of co-operation for the firm is measured separately for each of the areas constituting the production process - research and concept design, design and engineering, and installation and distribution. The percentage of ‘make versus buy’ in manufacturing is also measured. The more suppliers are involved at the early stages of the production process, the more co-operative the relationship. In other words, when the firm works with its suppliers in the development of new products and shares its knowledge, the relationship is co-operative in nature.

Questions 18-20 identify the company’s main products.

18. Please list the company’s four most important products in terms of overall sales and indicate the approximate percentage of overall company sales they each represent. (If the company has fewer than four products, please indicate accordingly)

Main products	Percentage of overall company sales
1. _____	[%]
2. _____	[%]
3. _____	[%]
4. _____	[%]

19. How important are these products for the company’s future strategy and competitive success? (Please tick as appropriate)

Main products	Extremely important	Quite important	Important	Relatively important	Not important
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]

20. What is the current market situation for each of these main products? (Please tick as appropriate)

Main products	New market	Fast growing market	Market close to maturity	Mature market	Declining market
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]

Questions 21-28 consider the trends in co-operation in terms of the way the company organises its activities for existing and new products.

21. How much collaboration is there between the company and the following for the *research and concept development* of new products? (Please tick as appropriate)

	very high	high	medium	low	very low
a. Suppliers	[]	[]	[]	[]	[]
b. Customers	[]	[]	[]	[]	[]
c. External research institutes	[]	[]	[]	[]	[]
d. University laboratories	[]	[]	[]	[]	[]
e. Parent company (if relevant)	[]	[]	[]	[]	[]
f. Other companies	[]	[]	[]	[]	[]
g. Other (specify): _____	[]	[]	[]	[]	[]

22. Have any of the following become more or less important in the past five years for the *research and concept development* of new products? (Please tick as appropriate)

	more important	no change	less important
a. Suppliers	[]	[]	[]
b. Customers	[]	[]	[]
c. External research institutes	[]	[]	[]
d. University laboratories	[]	[]	[]
e. Parent company (if relevant)	[]	[]	[]
f. Other companies	[]	[]	[]
g. Other (specify): _____	[]	[]	[]

23. How much collaboration is there between the company and the following for the *design and engineering* of new products to develop them for production? (Please tick as appropriate)

	very high	high	medium	low	very low
a. Suppliers	[]	[]	[]	[]	[]
b. Customers	[]	[]	[]	[]	[]
c. External research institutes	[]	[]	[]	[]	[]
d. University laboratories	[]	[]	[]	[]	[]
e. Parent company (if relevant)	[]	[]	[]	[]	[]
f. Other companies	[]	[]	[]	[]	[]
g. Other (specify): _____	[]	[]	[]	[]	[]

24. Have any of the following become more or less important for the *design and engineering* of new products to take them into production in the past five years? (Please tick as appropriate)

	more important	no change	less important
a. Suppliers	[]	[]	[]
b. Customers	[]	[]	[]
c. External research institutes	[]	[]	[]
d. University laboratories	[]	[]	[]
e. Parent company (if relevant)	[]	[]	[]
f. Other companies	[]	[]	[]
g. Other (specify): _____	[]	[]	[]

25. What is the relative importance of “*make*” (internal manufacturing) versus “*buy*” (external supply) for the company’s main products as listed in Q. 18? (Please indicate the approximate balance between “make” and “buy” as a percentage)

Main products [as listed in Q.18]		MAKE	BUY	
1.	_____	[%]	[%]	= 100 %
2.	_____	[%]	[%]	= 100 %
3.	_____	[%]	[%]	= 100 %
4.	_____	[%]	[%]	= 100 %

26. What was the situation in relation to these products five years ago (or when they were introduced, if less than five years ago)? (Please indicate the approximate balance between “make” and “buy” as a percentage)

Main products

	MAKE	BUY	
1. _____	[%]	[%]	= 100 %
2. _____	[%]	[%]	= 100 %
3. _____	[%]	[%]	= 100 %
4. _____	[%]	[%]	= 100 %

27. How much collaboration is there between the company and the following for the *distribution/installation* of the company’s main products? (Please tick as appropriate)

	very high	high	medium	low	very low
a. Suppliers	[]	[]	[]	[]	[]
b. Customers	[]	[]	[]	[]	[]
c. Partners	[]	[]	[]	[]	[]
d. Other (specify):_____	[]	[]	[]	[]	[]

28. Have any of the following become more or less important for the *distribution/installation* of the company’s main products in the past five years? (Please tick as appropriate)

	more important	no change	less important
a. Suppliers	[]	[]	[]
b. Customers	[]	[]	[]
c. Partners	[]	[]	[]
d. Other (specify):_____	[]	[]	[]

● SECTION III: EFFICIENCY AND INNOVATIVENESS

Section III measures the company’s recent performance and trends in terms of efficiency and innovation. Questions for each of the operational measures in Table 5.3 are included. Certain questions, such as questions 29 and 33, also throw light on the competitive context faced by the firm and play a role in the correct interpretation of the firm’s performance.

29. What has been the trend in the *price* of the company’s main products as listed in Q. 18 during the past five years (or since they were introduced, if less than five years)? (Please tick as appropriate)

Main products [as listed in Q. 18]	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]

30. What has been the trend in the *overall product cost* of these four main products during the past five years, or since they were introduced (if less than five years) ? (Please tick as appropriate)

Main products	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]

31. What has been the trend in the *order-to-delivery time* (from the moment an order is received to delivery) for these four main products during the past five years? (Please tick as appropriate)

Main products	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]

32. What has been the trend in *productivity in manufacturing* for the company during the past five years in terms of the measures indicated? (Please tick as appropriate)

	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
a. Labour efficiency	[]	[]	[]	[]	[]
b. Material efficiency	[]	[]	[]	[]	[]
c. Plant utilisation	[]	[]	[]	[]	[]
d. Product cycle-time	[]	[]	[]	[]	[]

33. Have overall production volumes changed significantly for the company during the past five years? (Please tick as appropriate)

	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
Production volumes	[]	[]	[]	[]	[]

34. What has been the trend in the *time to market* (from research and concept development to first manufacturing for sale) for the company’s new products during the past five years? (Please tick as appropriate)

	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
Time to market	[]	[]	[]	[]	[]

35. How many new products has the company developed in (a) the last 12 months, and (b) in the past five years? (Please indicate the number of new products)

a. in the last 12 months	[]
b. in the past 5 years	[]

36. What is the relative importance, in terms of overall company sales, of new products developed by the company in the past five years ? (Please tick the box corresponding to the appropriate category)

	Percentage of present company sales			
	more than 75 %	50% to 75%	25% to 50%	below 25%
a. Products that are totally new	[]	[]	[]	[]
b. Products that are significant up- grading over previous generations	[]	[]	[]	[]
c. Products that are minor improvements over previous generations	[]	[]	[]	[]

37. What percentage of current sales derives from products licensed to you by other companies (Please indicate the approximate percentage)

a. Percentage of current sales derived from products licensed to you by other companies	[%]
---	--------

38. What percentage of current revenue derives from products which the company has licensed to others?

a. Percentage of current revenue derived from products you have licensed to other companies	[%]
---	--------

● SECTION IV: GENERAL DATA ABOUT THE COMPANY

This section asks for data on the company, such as recent financial performance and size.

39. What has been the trend in company financial performance during the past five years? (Please tick as appropriate)

	Increased by more than 10%	Increased by up to 10%	No change	Decreased by up to 10%	Decreased by more than 10%
a. Turnover	[]	[]	[]	[]	[]
b. Royalties (if relevant)	[]	[]	[]	[]	[]
b. Profit before interest and tax	[]	[]	[]	[]	[]
c. Return on Capital	[]	[]	[]	[]	[]

40. Number of company’s employees at present time: _____

41. Current annual sales revenue: _____

42. What is the approximate percentage of sales in the UK and abroad?

Percentage of overall company sales	
a. Sales in the UK	[%]
b. Sales abroad	[%]
<hr/>	
[100 %]	

6.6 The sample

The target population consists of all UK firms involved in the manufacturing and installation of optical communications systems. These are the firms involved in providing the end-customers with the necessary ‘hardware’ for fibre-optics communications. The big systems operators, who provide the end-customers with the actual service, are therefore excluded. The sampling frame was derived from two lists of firms operating in this particular segment of the opto-electronics industry - the members of the Fibre-optic Industry Association (167 corporate members) and the Fibre-optics, Lasers and Opto-Electronic Directory (126 companies).

Firms exclusively involved in distribution of hardware components were excluded. Formally independent firms, UK subsidiaries of multinational groups, as well as divisions of bigger companies for which it is possible to collect specific data, were

included in the sample. The total sample derived from these sources consisted of 132 firms.

A preliminary version of the questionnaire was tested by means of a pilot study involving six firms, whose co-operation had been secured during previous contacts. A first mailing shot was sent in January 1998, followed by a round of telephone calls to make sure the questionnaires had reached the key contacts in the firms. These were identified with the co-operation of the Fibre-optic Industry Association, who provided a list of names and addresses. The key contacts were asked to fill in the questionnaire themselves if in a suitable position to do so or, alternatively, to pass the questionnaire to the ideal respondent (the person in charge of purchasing and supply-chain management). Each envelope contained a cover letter, a copy of the questionnaire, and a pre-stamped self-addressed envelope for return. A second mailing shot was sent six weeks later, with a remainder. In the following weeks, telephone calls were made to boost the response rate. The data collection process ended early in July 1998, and data analysis began immediately. The preliminary results from the survey influenced the structure of the follow-up interviews, which were planned in December 1998 and carried out between January and March 1999.

CHAPTER 7 – SURVEY FINDINGS: THE EVIDENCE ON ORGANISATIONAL PROCESSES

This Chapter presents the results of the questionnaire survey and analyses the evidence on the six organisational areas at the centre of our measurement efforts. Its main objective is to assess whether or not, and in case to what extent, co-operation is used to govern supply relationships in the UK optical communications systems industry.

The evidence for the six areas of teamwork across boundaries, supplier selection, commitment to the supplier, supplier's performance evaluation, role of the contract and conflict resolution is supplemented by general background information on the firms included in the analysis. This includes data on the organisation of the purchasing function, on the purchasing strategy followed by the firms and on their general supply practices.

Two discriminatory variables are identified - size and primary activity - and successively used throughout the analysis to highlight significant differences between groups of respondents. Primary activity is particularly important because it allows us to take the impact of technology into account. The analysis discriminates between manufacturers and installers. The group of manufacturers, being predominantly composed in our sample by firms whose technological core is copper-based technology and who have diversified into optical technology in response to the threat of substitution, represents the technologically mature context. The association between the group of installers and the context of a radical emerging technology is less rigorous. An analysis of the characteristics of the firms in the sample, however, offers a few justifications for our choice. First, installers are young firms compared to manufacturers - about 10 years old on average - with little if any history in an exclusively copper-dominated environment. Second, a significant proportion operates – if not exclusively - in sophisticated niches of the market, where being at the forefront of the new technology is a necessary requisite to meet customer needs. Third, information about the strategic mission of the firm and the circumstances connected to its birth – such as, for example, the background of the founder – support our assumption. The interpretation of the

results, however, must take into account the imperfect correlation between the group of installers and the context of a radical emerging technology.

The Chapter ends with a discussion on the overall development of supply relationships in the UK optical communications systems industry.

7.1 Response rate and general characteristics of respondents

A pilot study was carried out to develop the final version of the survey instrument. The firms co-operating in this were excluded from the final mailing list. The revised questionnaire was sent to a sample of 132 firms. Two successive mailings produced forty-one completed questionnaires. In addition six companies declared they were not willing to participate in the study; three refused to fill in the questionnaires because they considered themselves unsuitable candidates due to the minimal scale of their involvement in fibre-optics; and three questionnaires were returned unopened. In a few cases, missing data was filled in from follow-up telephone interviews with identifiable firms. An analysis of the overall response rate is shown in Table 7.1.

Table 7.1 Analysis of the overall response rate

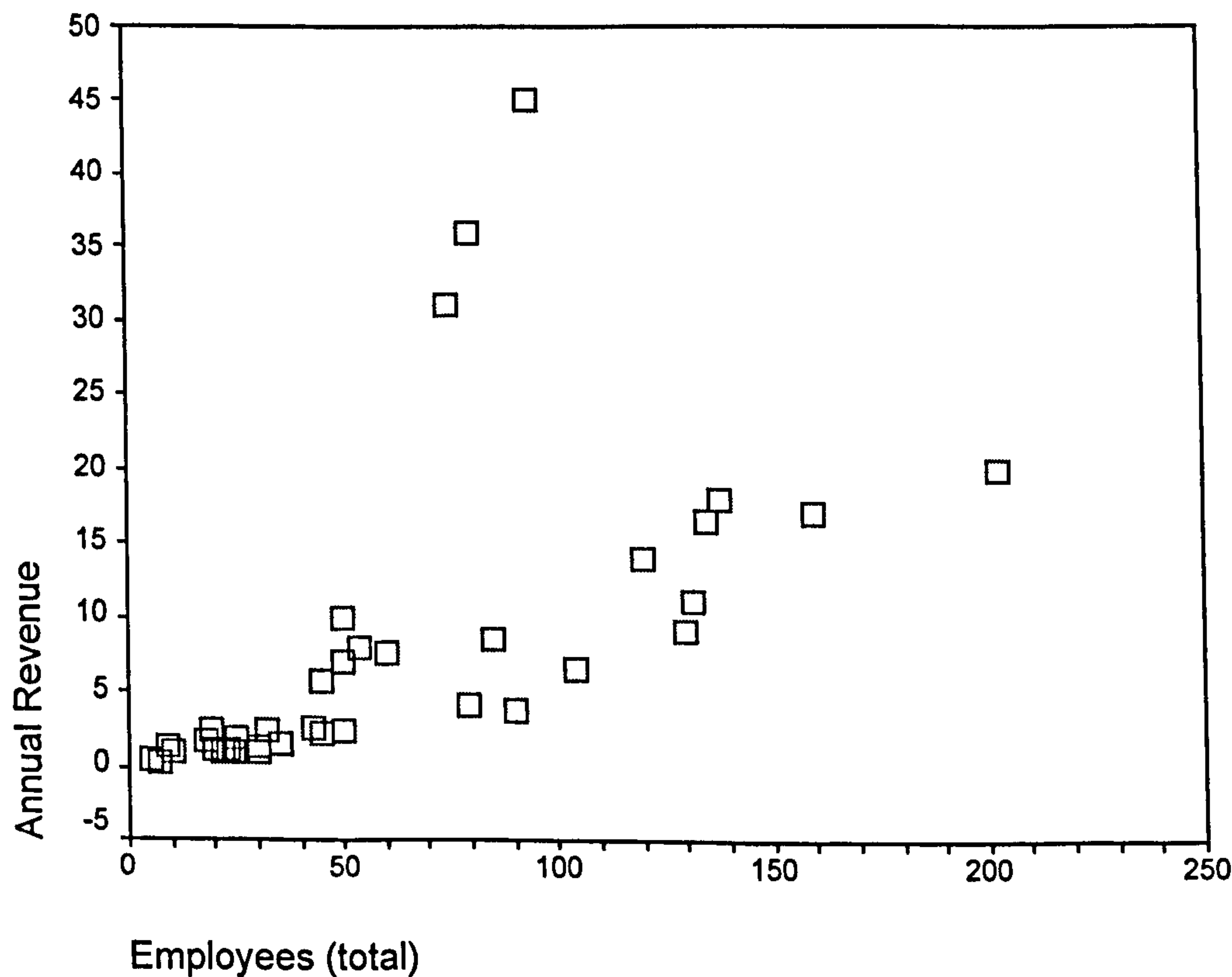
	Number of firms	Percentage
Overall sample	132	100%
Usable responses	41	31%
Not willing	6	5%
Not suitable	3	2%
Returned unopened	3	2%
Total responses	53	40%
Unaccounted for	79	60%

At first the analysis concentrates on general characteristics of the respondents and focuses on size, primary activity, ownership and spatial distribution of firms to highlight any biases in the study, and to characterise the sample. This leads to the identification of two variables - size and primary activity – which significantly discriminate between firms and become the basis for interpreting differences in the data.

Size - Size is measured by means of two indicators - annual revenue and employees. The scatter-plot of respondents according to both indicators is shown in Figure 7.1. Mean annual revenue for the sample is £7.9m (range £0.2m- £45m). Mean number of employees is 59 (range 5-203). According to both indicators, all respondents can be classified as SMEs (small and medium sized enterprises). As a matter of fact, the whole UK fibre-optics industry is composed of relatively small companies, and it is therefore possible to exclude any bias towards a particular size category in the study.

When taking both indicators into account, two major groups can be identified (see Figure 7.1). The first group is quite compact and comprises small companies, characterised by annual revenue of approximately less than £5m and with up to 45 employees. The second group is more dispersed and consists of larger companies. Their annual revenue is in the range £5m-£45m, with number of employees varying from 45 to 203. In this second group there seems to be a relatively linear relationship between annual revenue and employees, with three noticeable exceptions where a relatively high annual revenue is accompanied by a relatively small number of employees.

Figure 7.1 Size: scatter-plot of respondents according to annual revenue and employees



Size is used as a primary, not industry-specific, discriminating variable. Firms are labelled ‘small’ and ‘large’, and significant differences between the two are reported throughout the Chapter.

Primary activity - The study analyses the development of supply relationships among firms operating in the optical communications systems industry up to the level of system integrator. In terms of applications, most of them are primarily involved in WAN, LAN and subscribers’ connections. Chapter 4 shows how, due to the specific characteristics of opto-electronics technology and the co-existence of traditional copper-based and optical components in communication systems, firms of a heterogeneous nature populate this industry segment. The range of products is varied, and includes optical fibre, fibre cables, passive and active components, cable assemblies and other devices for the manufacturing and installation of optical communication systems. Consequently, the study includes firms who differ in term of their primary activity. Some firms are exclusively manufacturers of components; some are exclusively installers of systems; some are involved in both manufacturing and installation. Firms that install communication systems are generally involved with both copper and optical components because of the co-existence within the same system of the two technologies. Manufacturing firms can either be general providers of copper-based and optical components, or specialist providers of optical components only, with no involvement whatsoever in copper technology. The heterogeneity of the industry is a fundamental characteristic to take into account in the analysis and interpretation of the data.

The key distinction in terms of activity is between firms that are exclusively or primarily involved in manufacturing of components and firms that are exclusively or primarily involved in installation of systems. As anticipated earlier in this Chapter, with our sample this distinction leads to the identification of two groups - respectively labelled ‘manufacturers’ and ‘installers’¹ – that correspond to different technological

¹It is possible to distinguish between “manufacturers” and “installers” by analysing the profile of each individual firm given in the two Directories used to develop the sample frame and complementing this information with interview data.

environments. ‘Manufacturers’ are associated with a technologically mature context, whereas ‘installers’ are associated with the context of a radical emerging technology.

Primary activity is used as the second discriminating variable in the study and is, in fact, a proxy for the degree of maturity of the core technology of the firm. When differences between installers and manufacturers emerge, these are reported in detail. Figure 7.2 shows the distribution of respondents by size and primary activity. Manufacturers tend to be larger firms than installers.

Figure 7.2 Distribution of respondents by size and primary activity

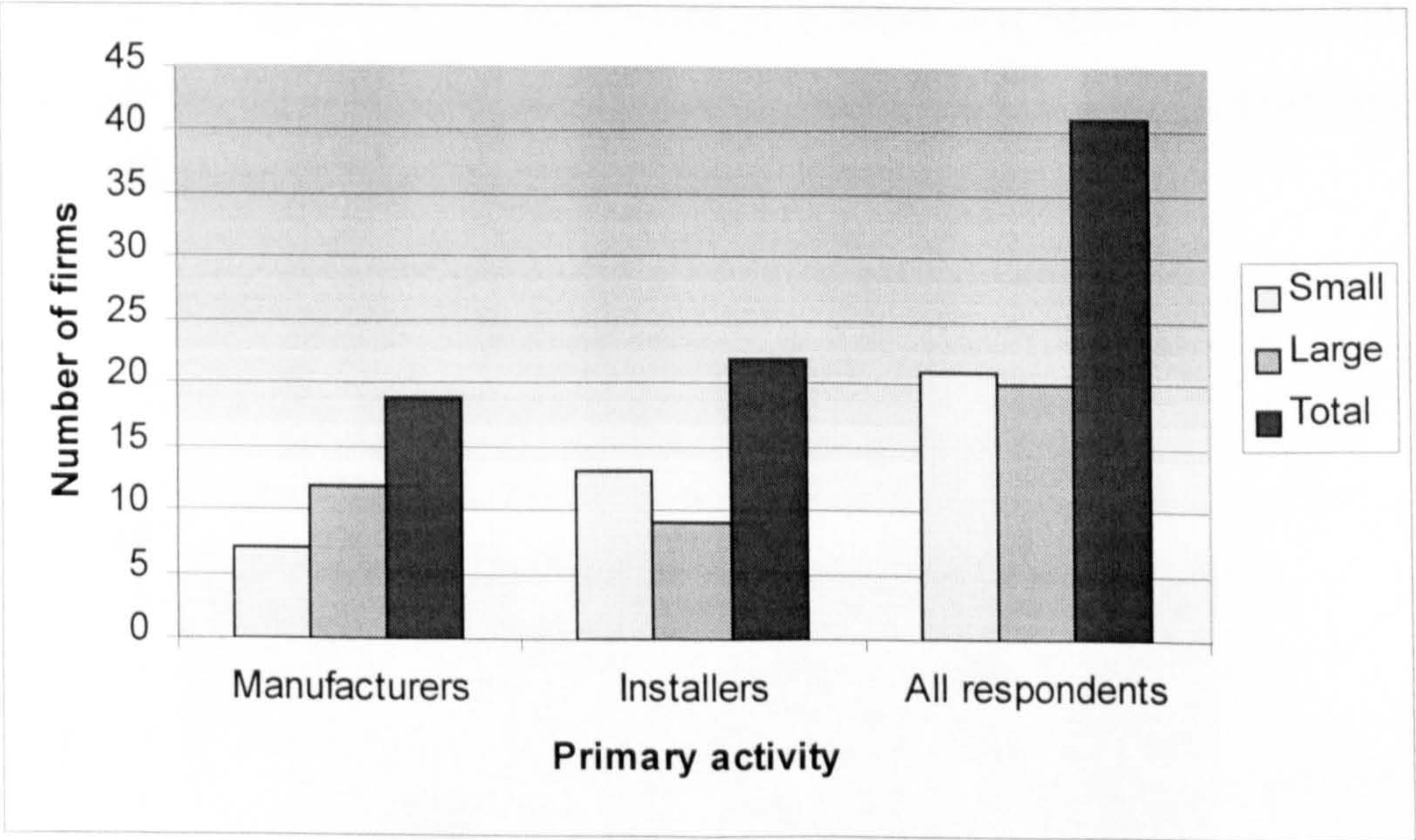


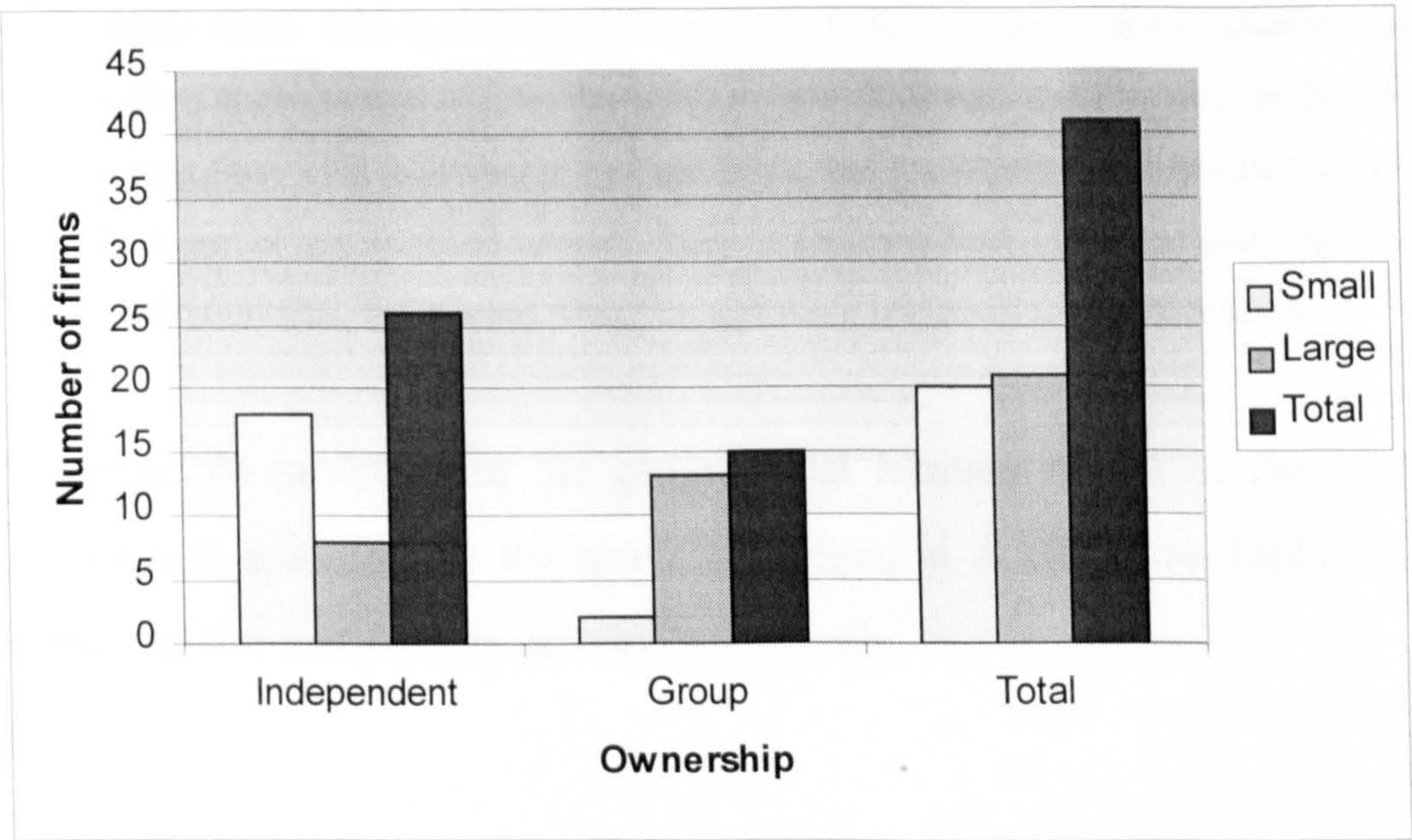
Table 7.2 analyses size more in detail.

Table 7.2 Manufacturers vs. installers by size: a comparison

	Manufacturers	Installers	All respondents
Mean annual revenue	£10.4m	£5.5m	£7.9m
Annual revenue: range	£0.5-45m	£0.2-20m	£0.2-45m
Mean number of employees	59	59	59
N. of employees: range	5-135	7-203	7-203

Ownership structure - The distribution of respondents according to ownership and size is shown in Figure 7.3, and distinguishes independent firms that are autonomous legal entities from those that are part of a group, owned by UK or multinational organisations, or are divisions of large firms specialising in fibre-optics.

Figure 7.3 Ownership: distribution of respondents by size



Small firms tend to be formally autonomous and independent, while large ones are more likely to be part of a wider organisation. 73% of installers, moreover, are independent entities as against 53% of manufacturers. Because of these overlaps, ownership structure

is not used as an independent discriminating variable. In other words, differences between 'independent' and 'group' firms are not explicitly reported.

Spatial distribution - The spatial distribution of respondents reflects the geographical distribution of the target population established in a parallel survey of the UK opto-electronic industry by Hendry and Brown (1998). There is, therefore, no over-representation of a specific geographical area that cannot be explained by the natural distribution of firms in the industry in the UK. The classification developed by Hendry and Brown (1998, 1999) constitutes a useful basis to distinguish firms geographically. This shows four main groups, and is based on a combination of theoretical considerations and empirical evidence:

Group One. This is defined as Wales and Scotland, and is characterised as the "institutional cluster". This reflects a strong regional government presence and an active research factor in the form of strong university departments.

Group two. This is defined as East Anglia and adjacent counties, and is characterised as the "mileux type" of industrial district. Firms in this group derive part of their strength from the wide range of technological based industries located in these areas.

Group three. This is defined as Hampshire, Berkshire and adjacent counties, and has the highest concentration of firms operating in opto-electronics and photonics in the UK.

Group four. This is defined in residual terms, and is comprised of firms that do not appear to form part of any localised network. There is some evidence of an emerging regional cluster in the Oxford area, but it is not strong enough when compared to the other three.

It is possible to determine the geographical location for 40 of the 41 respondents². Distribution according to the above classification is shown in Tables 7.3 and 7.4 in relation to size and primary activity respectively.

²The envelope containing the questionnaire was individually addressed to the key contact in the firm. So was the cover letter, as well as the remainder. The option was, however, given, to return the questionnaire anonymously. Most of the respondents did not choose this option and it was therefore possible to reconstruct the spatial distribution of respondents.

Table 7.3 Spatial distribution of respondents according to size

	Small	Large	Total		Hendry and Brown's Total
	n. of firms	n. of firms	n. of firms	%	%
GROUP ONE	5	2	7	18	14
GROUP TWO	7	5	12	30	32
GROUP THREE	4	8	12	30	23
GROUP FOUR	4	5	9	22	31
	20	20	40	100	100

Table 7.4 Spatial distribution of respondents according to primary activity

	Manufacturers	Installers	Total		Hendry and Brown's Total
	n. of firms	n. of firms	n. of firms	%	%
GROUP ONE	4	3	7	18	14
GROUP TWO	6	6	12	30	32
GROUP THREE	5	7	12	30	23
GROUP FOUR	3	6	9	22	31
	18	22	40	100	100

7.2 The organisational structure of purchasing

Data on the organisation of purchasing provide a background for interpreting firms' practices in supply-chain management.

Number of employees in purchasing - Figure 7.4 shows the distribution of firms according to the number of employees in purchasing.

Figure 7.4 Number of employees in purchasing: distribution of firms



Taking size into account, small firms never employ more than three people in purchasing, while large firms employ up to six people. The majority of small firms (52%) employ two people in purchasing and supply, whereas for large firms three is most common. A positive correlation between the size of the firm and the number of people employed in purchasing could, therefore, be assumed. However a more accurate analysis shows that the picture is not so clear-cut. Some small firms devote, in relative terms, a considerable amount of resources to purchasing and supply, while there are some fairly large firms that do the opposite, and devote relatively few resources to this activity.

Beyond size, other factors may affect the amount of resources devoted by firms to purchasing, as measured by the number of people employed in this area. For example, not-independent firms might be forced by group policies to supply themselves from sister-companies. Another possible factor might be the recent history of the individual firm, and in particular its strategy in purchasing. A higher number of people employed in purchasing and supply-chain management is, in fact, often associated with recent changes in the overall company strategy towards supply-chain management. Of the 17 firms that report a recent change in their strategy towards supply-chain management, 10

have units of three or more people in charge of this area, 6 have at least two people, and only one has a single-person unit.

The nature of the activity can also offer a partial explanation, combined with the complexity of the goods or materials to be purchased. More complex types of purchasing may require more resources. Installers are smaller than manufacturers, but they tend to employ more people in purchasing with an average number of 3 employees against the average 2 in manufacturing firms. The range is also wider for installers, from a minimum of 1 to a maximum of 6 against a minimum of 1 and a maximum of 5 for manufacturers.

Purchasing unit and line of reporting - The names used to identify the organisational unit in charge of purchasing vary, and there is also variation as to the line of reporting. Figures 7.5 and 7.6 show the distribution of respondents according to, respectively, macro-classes of denomination and line of reporting.

Figure 7.5 Macro-classes of denomination of the unit in charge of purchasing: distribution of respondents

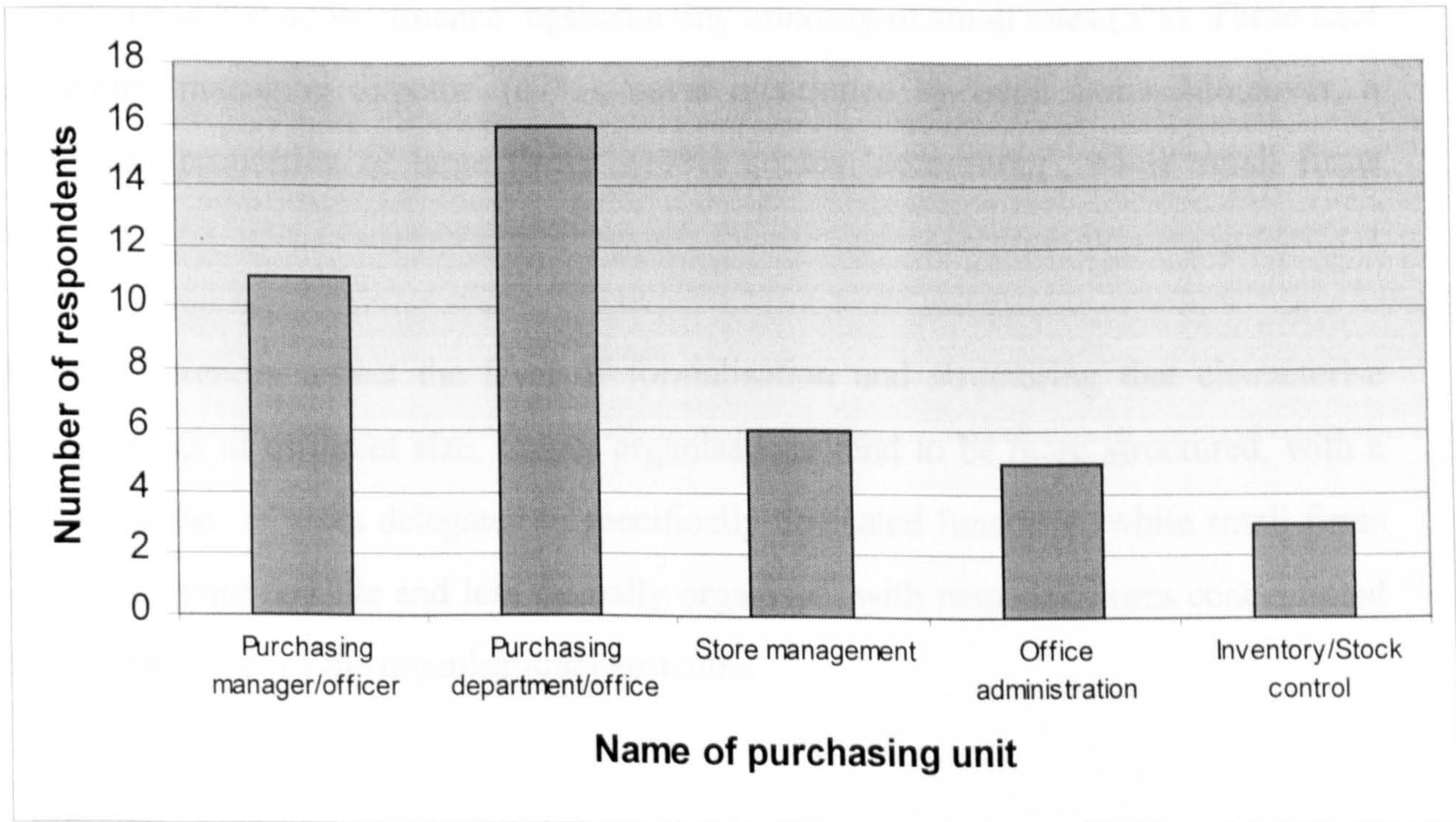
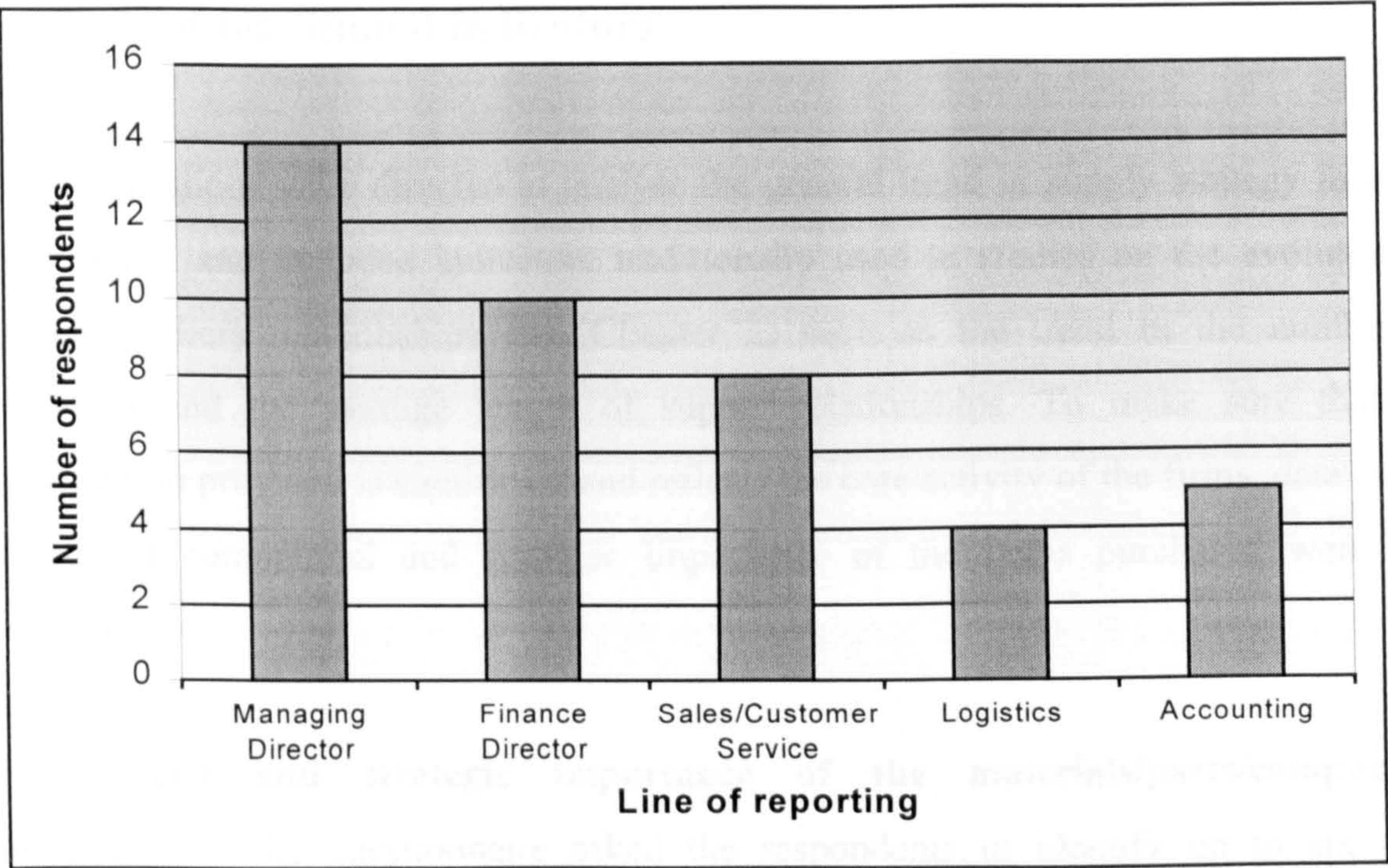


Figure 7.6 Line of reporting: distribution of respondents



‘Office administration’ is used by 29% of small firms, but large ones never use this denomination. The opposite is true of ‘inventory/stock control’, used by 22% of large firms and totally unfamiliar to small ones. As to the line of reporting, the majority of large firms (43%) quote ‘finance’ against a tiny minority of small ones (5%). These tend to favour “managing director” (67%), never mentioned by large firms. Moreover, a significant proportion of large firms (19%) quotes ‘accounting’, while small firms never do.

These differences reflect the level of formalisation and structuring that characterise organisations of different size. Larger organisations tend to be more structured, with a higher number of tasks delegated to specifically dedicated functions, while small firms tend to be more flexible and less formally organised, with responsibilities concentrated at the upper level of the organisational structure.

7.3 General evidence on change in supply-chain management: an analysis of traditional indicators

A few questions were directed to analyse the general trend in supply strategy in opto-electronics, and included indicators traditionally used in studies on the evolution of buyer-suppliers relationships (see Chapter 2) such as the trend in the number of suppliers and the average length of supply relationships. To make sure that the information provided is significant and reflects the core activity of the firms, data on the degree of commercial and strategic importance of the items purchased were also collected.

Commercial and strategic importance of the materials/parts/components purchased - The questionnaire asked the respondents to identify up to six main materials, parts, or components purchased by the firm and to answer questions on supply practices with reference to those six³. A total of 196 items are listed. The degree of commercial importance is measured as the percentage of the overall purchasing expenditure represented by the main six items listed by each firm. The data show that, on average, the items listed by each company represent 62% of the overall company purchasing expenditure. The degree of strategic importance of the same items is expressed in terms of their relative importance for the functionality of the final product offered by the firm. The data are summarised in Table 7.5

³ As stated in Chapter 5, the identification of the six most important materials, parts and components for the firm (Q. 3-5) and their evaluation in terms of commercial and strategic importance are necessary to guarantee that the data are significant. We want to make sure that the information provided refers to core activities and not marginal ones.

Table 7.5 Degree of strategic importance of the main six items purchased by the firm

Degree of strategic importance of the items purchased	Percentage of respondents
Extremely important	69%
Quite important	13%
Important	15%
Relatively important	3%
Not important	-

Availability in the market of suppliers - The availability in the market of suitable suppliers for the 196 materials, parts, or components listed by the firms, is an important pre-requisite for the significance of the survey data. In other words, it is important to verify that the adoption of certain purchasing practices by a firm is the product of its own decisions and is not dictated by external conditions – such as a shortage of suppliers in the market. Table 7.6 summarises the data on the availability of suppliers.

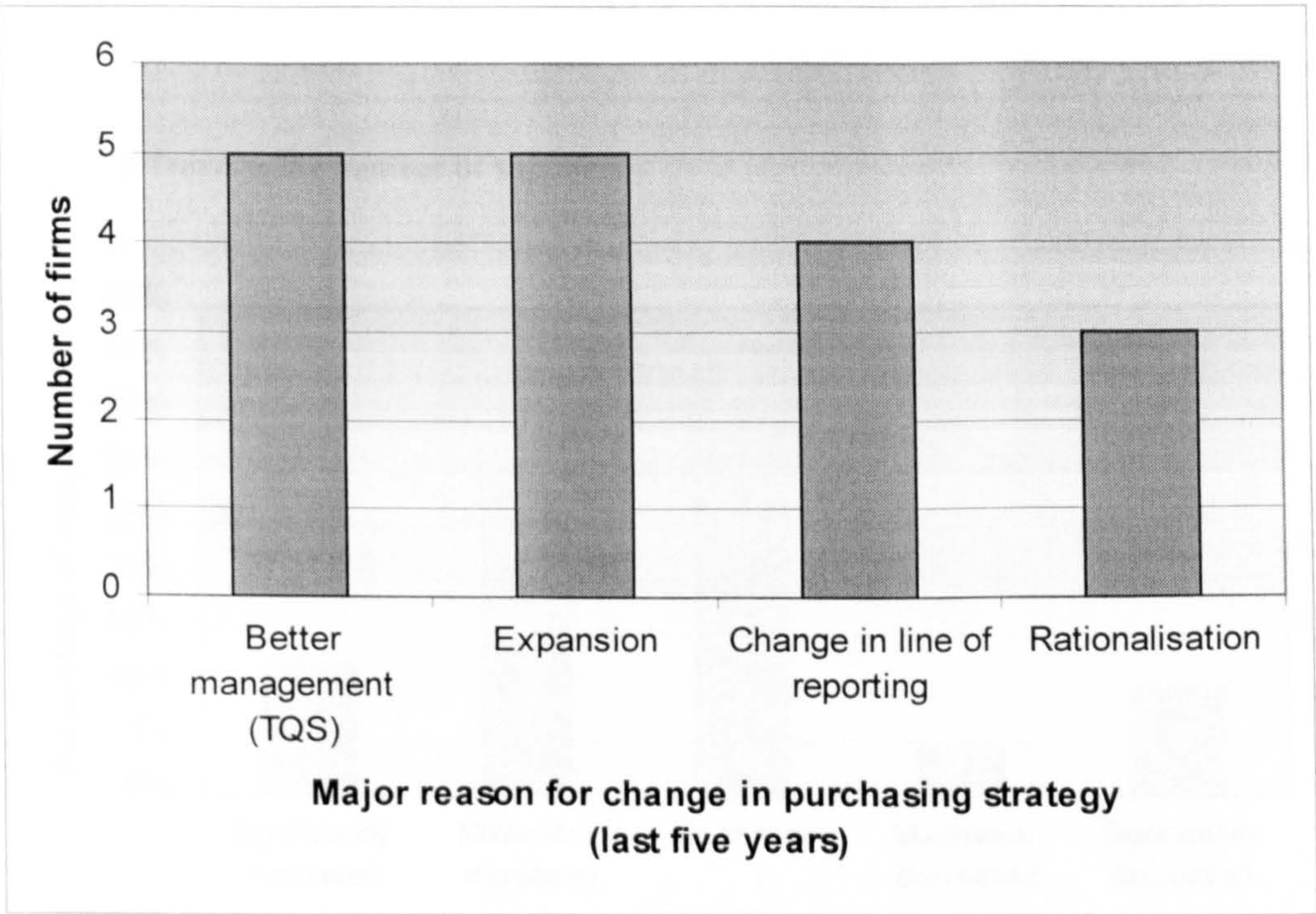
Table 7.6 Availability of suppliers in the market for the 196 items listed by the respondents

Number of suppliers available in the market	Percentage of total number of items in the category
More than 20 suppliers are available	39%
5 to 20 suppliers are available	40%
Less than 5 suppliers are available	21%

There seem to be no major external obstacles, such as market restrictions, to a firm's freedom to shape its own purchasing strategy. Moreover, as shown by Hendry and Brown (1998), firms in the UK fibre-optics industry make extensive use of international suppliers. Firms' purchasing choices are therefore by no means limited to local, regional or even national providers.

Purchasing strategy - Less than half the respondents (42%) have recently⁴ experienced radical changes in supply strategy. The reasons for change vary, as shown in Figure 7.7.

Figure 7.7 Major rationale for change in supply-chain management strategy



When size is taken into account, 52% of large firms have recently experienced a major change in their overall supply strategy against 33% of small ones. The reasons behind the change are different in the two groups. The majority of small firms (71%) ascribe the change to ‘expansion’, with the remaining 29% quoting ‘better management and adoption of quality-systems’, which is also the main reason for the majority of large firms (37%). ‘A change in the internal line of reporting’ is the second main reason for large firms (36%), followed by ‘increased focus and rationalisation’ (27%).

A higher proportion of manufacturers (47%) than of installers (39%) have recently experienced changes in their overall purchasing strategy. The main rationale for change for manufacturers is ‘increased focus and rationalisation’ (22%), while for installers it is ‘expansion’ (44%). This could be partially linked to differences in size between the two groups.

Trend in the number of suppliers - The trend in the number of suppliers for a firm is often used as an indicator of changes in supply-chain management. In general terms, a

⁴ The time-horizon chosen for the study is five years.

reduction in the number of suppliers is expected when co-operation is preferred to more aggressive forms of behaviour in supply relationships. Figure 7.8 shows the survey data.

Figure 7.8 Trend in the number of suppliers

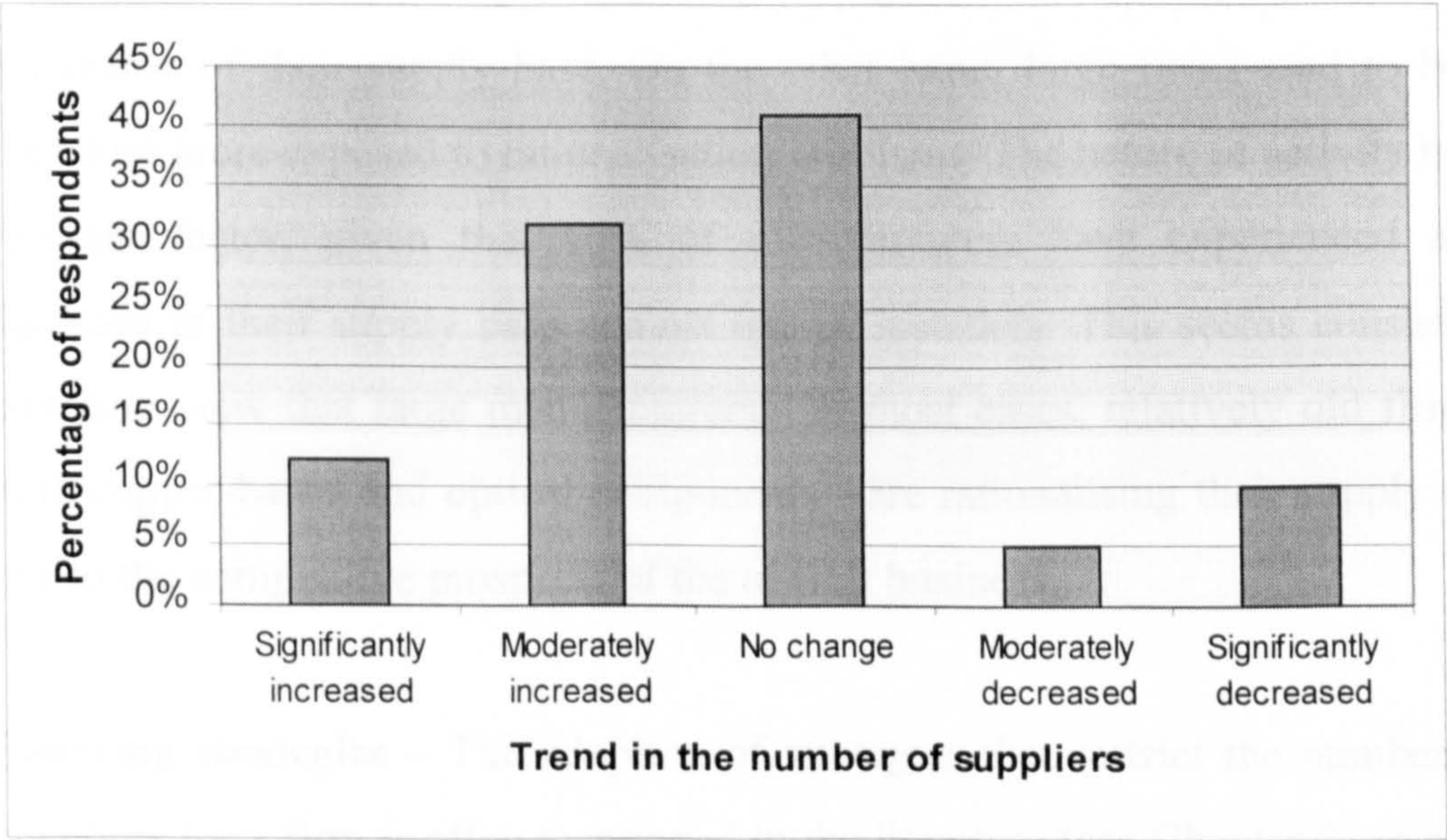
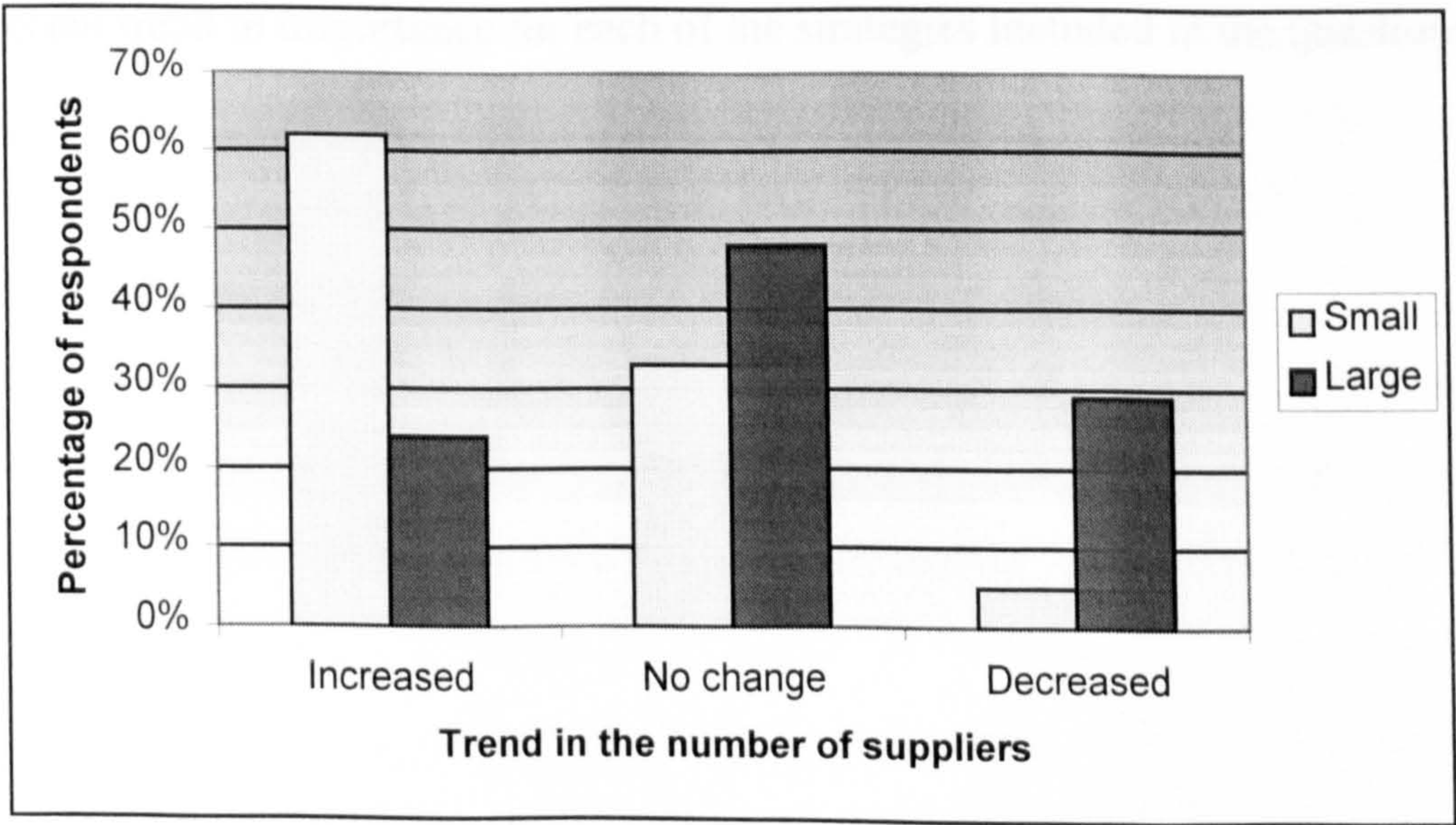


Figure 7.9 summarises the difference between small and large firms.

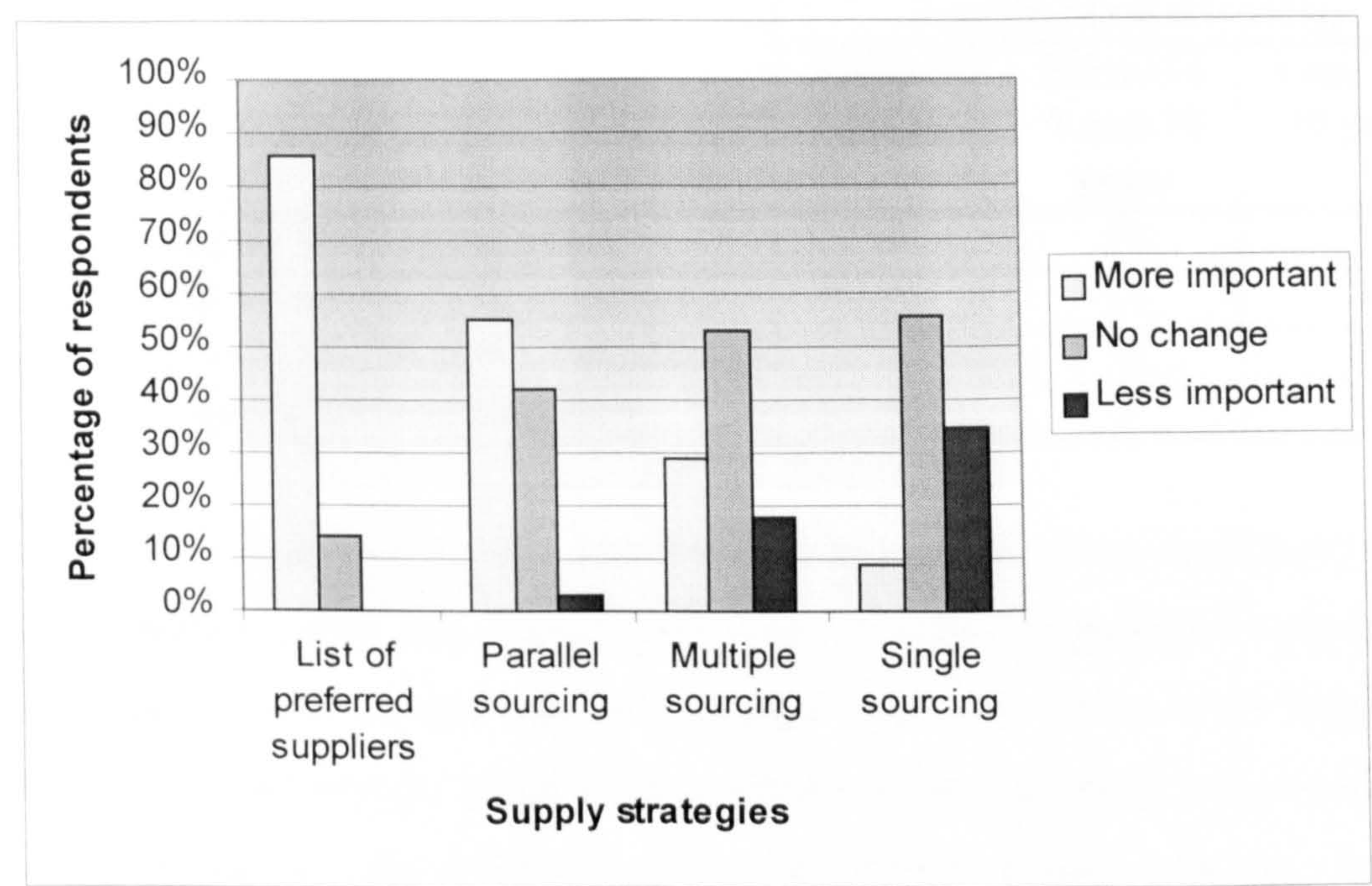
Figure 7.9 Trend in the number of suppliers: small versus large firms



A growth pattern is quite definite for small firms, while the situation is mixed for large firms (but with a stronger tendency towards a decrease in the number of suppliers). A possible explanation for the increase in the number of suppliers in both groups is the increase in the volume of activity experienced by firms throughout the industry. Small firms are, moreover, younger and fast growing, and this could partially account for the expansion of their supply base. On the other hand, large firms tend to be older, and therefore more exposed to rationalisation problems. The nature of activity may also be a relevant factor, given that 16% of manufacturers have experienced a substantial decrease in their supply base against 6% of installers. This seems consistent with the common view that large manufacturers - in most cases, relatively old firms providing both copper-based and optical components - are rationalising their supply base with an eye to the competitive prospects of the overall business.

Sourcing strategies – The adoption of strategies that restrict the number of potential suppliers for a firm is often mentioned in the literature (see Chapter 2) as characterising co-operative approaches to supply-chain management. The sourcing strategies listed in the questionnaire are not necessarily mutually exclusive. A firm can use multiple strategies depending on the nature of the items purchased, and the survey actually shows that none of the respondents relies on a single practice. Firms discriminate between categories of suppliers, and relate to these in different ways. Figure 7.10 shows the recent trend in importance for each of the strategies included in the questionnaire.

Figure 7.10 Recent trend in importance of the key supply strategies



Multiple sourcing is the practice normally associated with antagonistic supply relationships, and the data show that its importance has diminished in some cases and increased in others. In particular, it has become both less and more important for a higher proportion of large firms than of small ones. In other words, it seems that large firms have changed their attitude towards multiple sourcing more decisively than small ones. Taking primary activity into account, multiple sourcing has become less important for 32% of installers, but it has not lost importance for manufacturers. On the contrary, 25% of manufacturers consider this practice as more important, compared to 18% of installers. The reasons for this pattern are not clear, and are actively explored later in the follow-up interviews.

Average length of relationships with suppliers - The length of supply relationships is another typical indicator used in previous studies to analyse changes towards co-operation in supply relations (see Chapter 2). The questionnaire asked each firm to indicate the relative percentage of suppliers for three different time lengths⁵. The data are summarised in Table 7.7.

⁵ These are “more than 10 years”, “5 to 10 years”, and “less than 5 years”.

Table 7.7 Average length of supply relationships: frequency

	Length of relationship		
	Over 10 years	Between 5 and 10 years	Less than 10 years
Over 75% of suppliers	6	14	7
Between 50-75% of suppliers	--	13	4
Between 25-50% of suppliers	1	2	18
Below 25% of suppliers	1	1	--

Large firms tend to have long established relationships with a significant proportion of their suppliers, with only a small percentage of recently developed ones (60% of large firms have 5 to 10 years long relationships with over 75% of their suppliers). Small firms, quite differently, seem to be polarised at two extremes. On one side there is a small sub-set of small firms with a long established history with the vast majority of their suppliers. On the other side, a bigger sub-set of small firms engage in short-standing relationships with a significant percentage of their suppliers.

Recent growth and diversification can explain the need for both large and small firms to expand their supply base, and therefore account for at least some of the short-standing relationships observed in the two size groups. As to small firms, the two sub-sets can be explained by taking the age of the firm into account. Older small firms have established supply relationships of long duration with a higher proportion of the overall supply base than new ones.

7.4 The evidence on the six organisational areas

In Chapter 6 we have indicated the specific questions dedicated to the analysis of the six organisational areas that are critical for the study of co-operation in supply relationships from a governance perspective. This Section presents the results in detail.

Teamwork across organisational boundaries - This relates to the existing division of labour between buyer and supplier. The more suppliers are involved and actively participate in the early stages of the overall production process, the more co-operative

the nature of the mechanism governing the relationship. The overall production process of the firm is divided into four main stages, research and concept development, design and engineering, manufacturing and distribution/installation.

To make sure that the data are significant and represent the core activity of the firm, the questionnaire asked each firm to identify the four principal product lines⁶ and to answer the questions on collaboration in relation to those four. The product lines are also rated in terms of their relative degree of commercial and strategic importance. The degree of commercial importance is measured as a percentage of overall company sales. The data show that, on average, the four product lines represent 79% of a firm's overall sales. 82% of the product lines listed are, moreover, considered as extremely important for the company's future strategy and competitive success. In terms of market prospects, 5% of the products are perceived to be in declining markets; 12% of the products in, respectively, mature markets and in markets close to maturity; 68% in fast growing markets; and, 3% in new markets.

The balance of 'make' versus 'buy' in manufacturing has not changed significantly in the past five years. Sub-contracting in this area is not growing and, if anything, integration has become more important. Figures 7.11 to 7.13 summarise the data on collaboration between the firm and suppliers in the areas of research and concept design, design and engineering, and installation/distribution, and highlight the differences between the groups identified by size.

⁶ The choice to concentrate only on four product lines is justified by the common "80:20" rule, according to which 80% of a company's sales derive from 20% of its products.

Figure 7.11 Collaboration in research and concept design: Small vs. Large

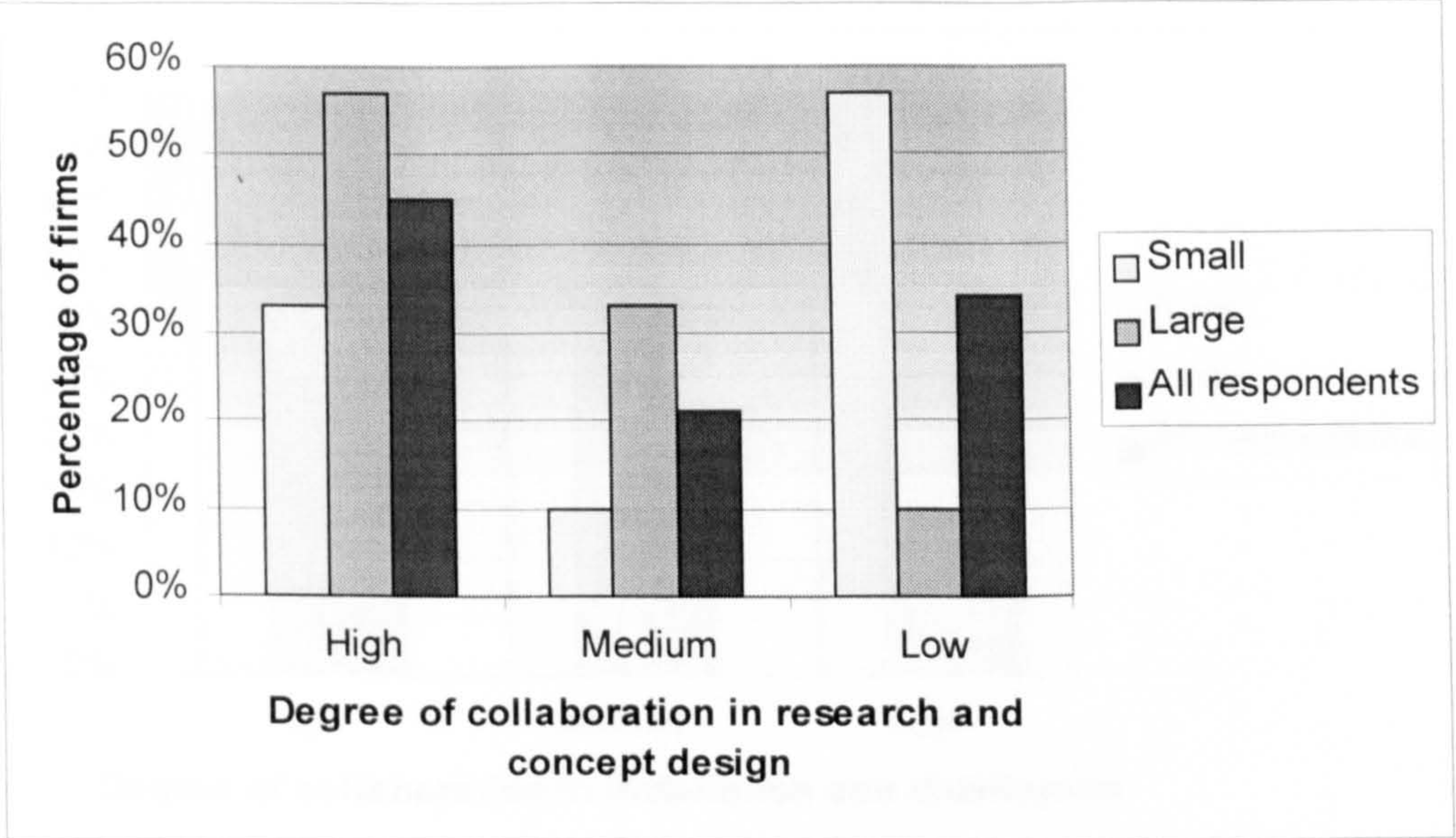


Figure 7.12 Collaboration in design and engineering: Small vs. Large

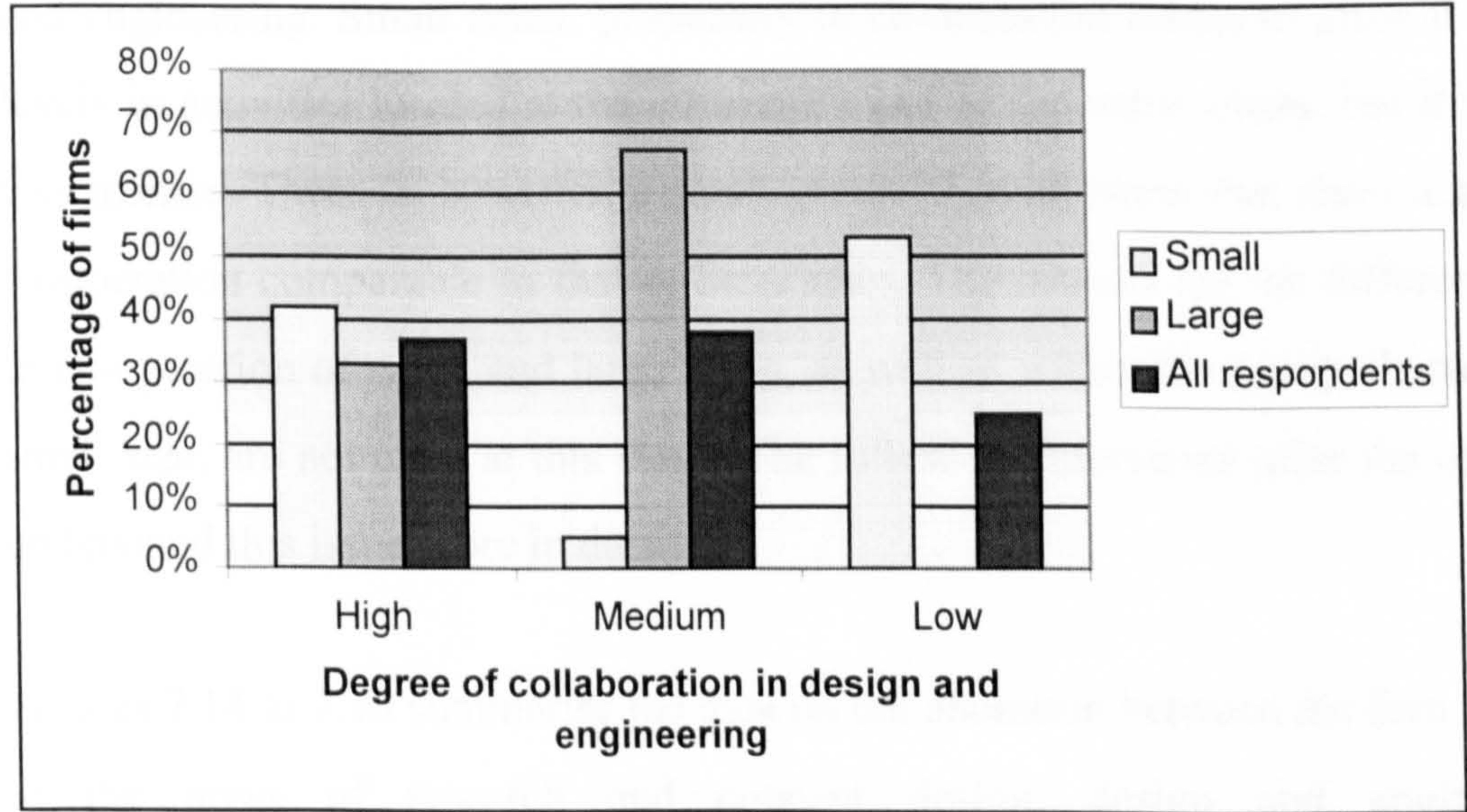
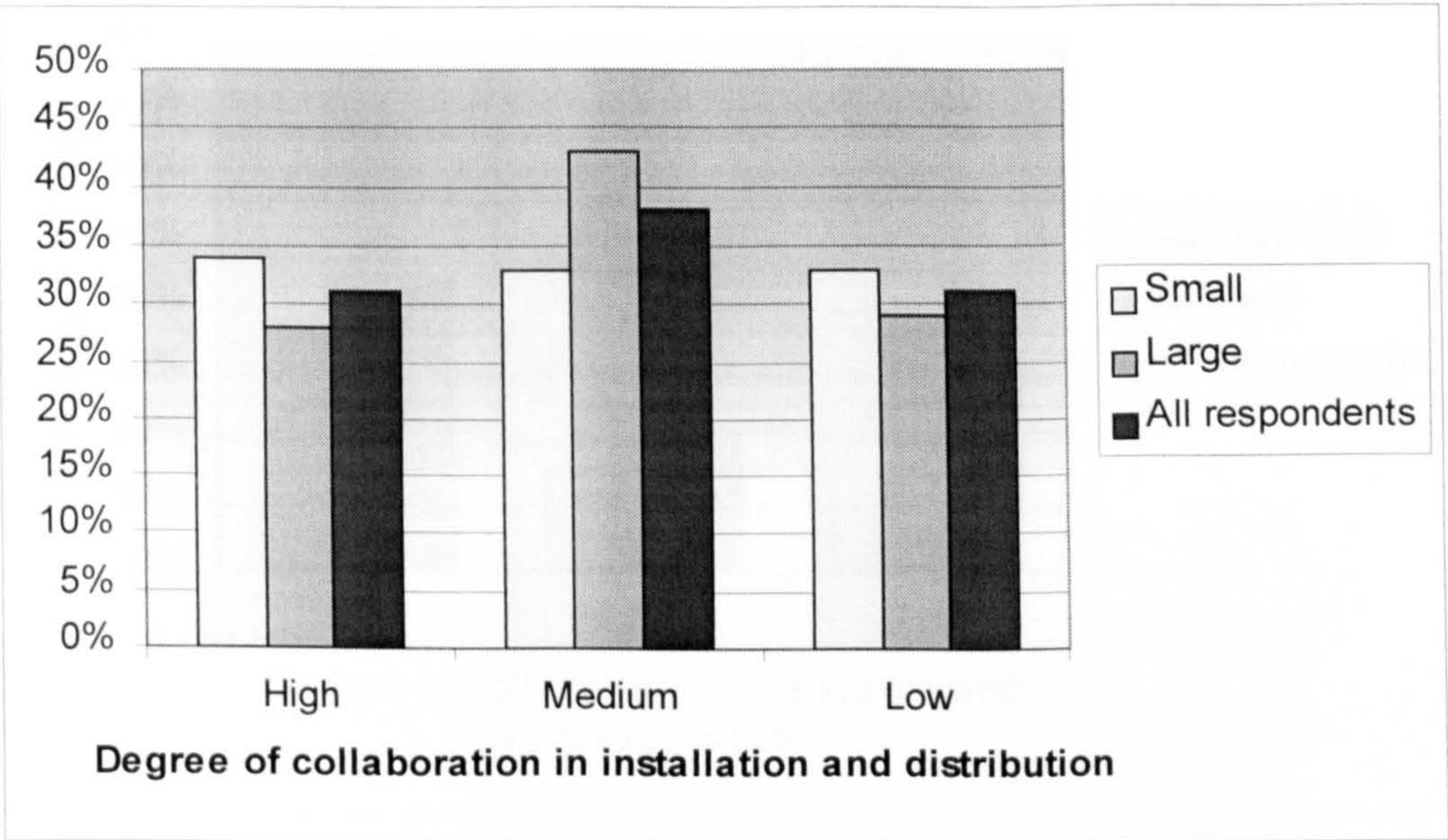


Figure 7.13 Collaboration in installation and distribution: Small vs. Large



Large firms appear more oriented towards co-operation than small ones, and the data relative to the other actors confirm this. This is particularly true of activities located at the upper end of a firm's value chain, such as research and concept design, and design and engineering. Small firms' propensity to co-operation seems to grow to large firms' levels in activities located at the customer's end of the value chain, but it is in general less intense. There is, however, a small group of small firms that show a propensity to co-operation comparable to that of large ones. The reasons for the different propensity to co-operation of small and large firms, as well as within the group characterised by a small size, are not clear at this stage. The follow-up interviews offer the opportunity to understand this issue more in detail.

Figures 7.14 to 7.16 summarise the data on collaboration between the firm and suppliers in the areas of research and concept design, design and engineering, and installation/distribution, and highlight the differences between the groups identified by primary activity.

Figure 7.14 Collaboration in research and concept design: Manufacturers vs. Installers

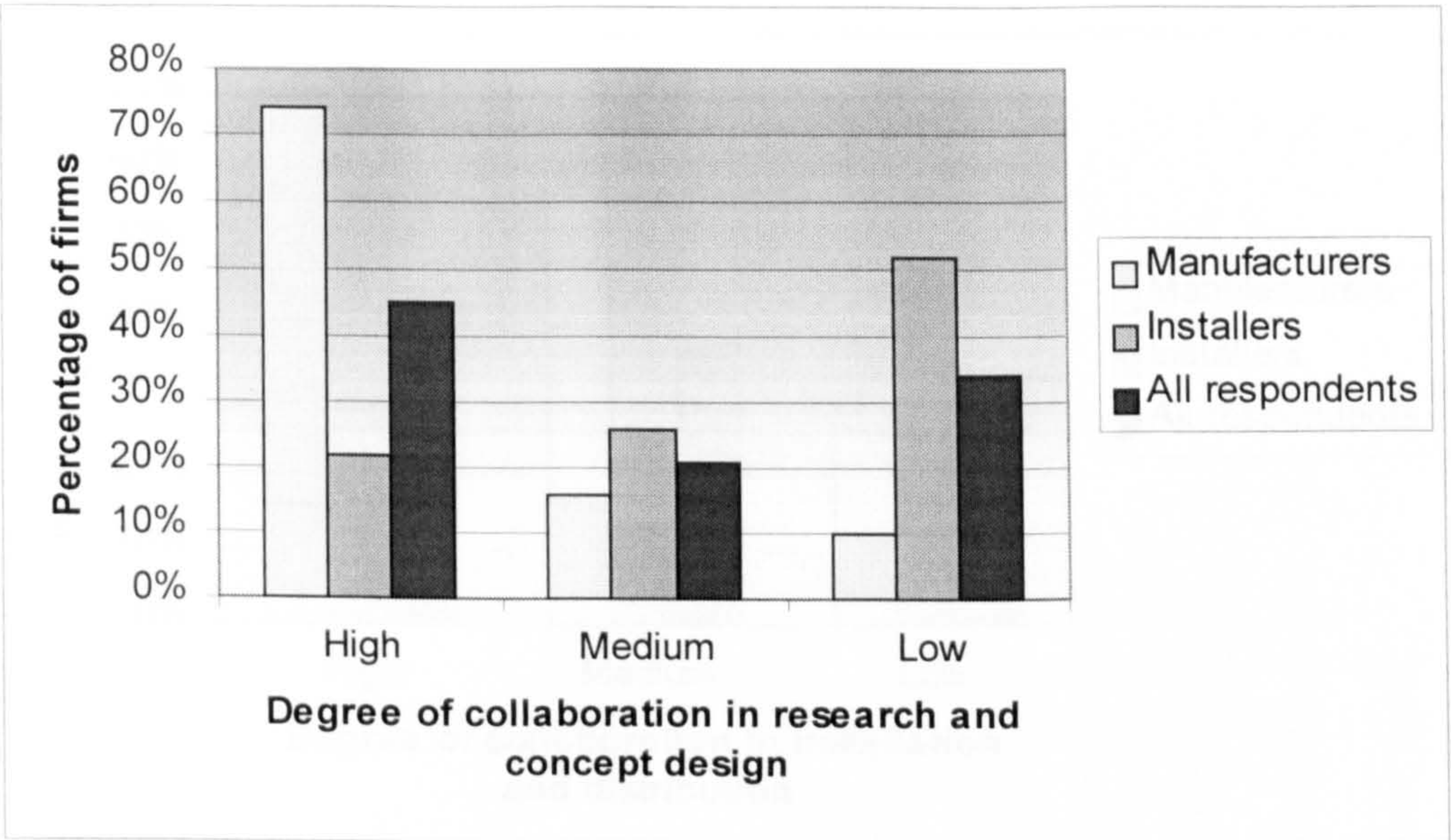


Figure 7.15 Collaboration in design and engineering: Manufacturers vs. Installers

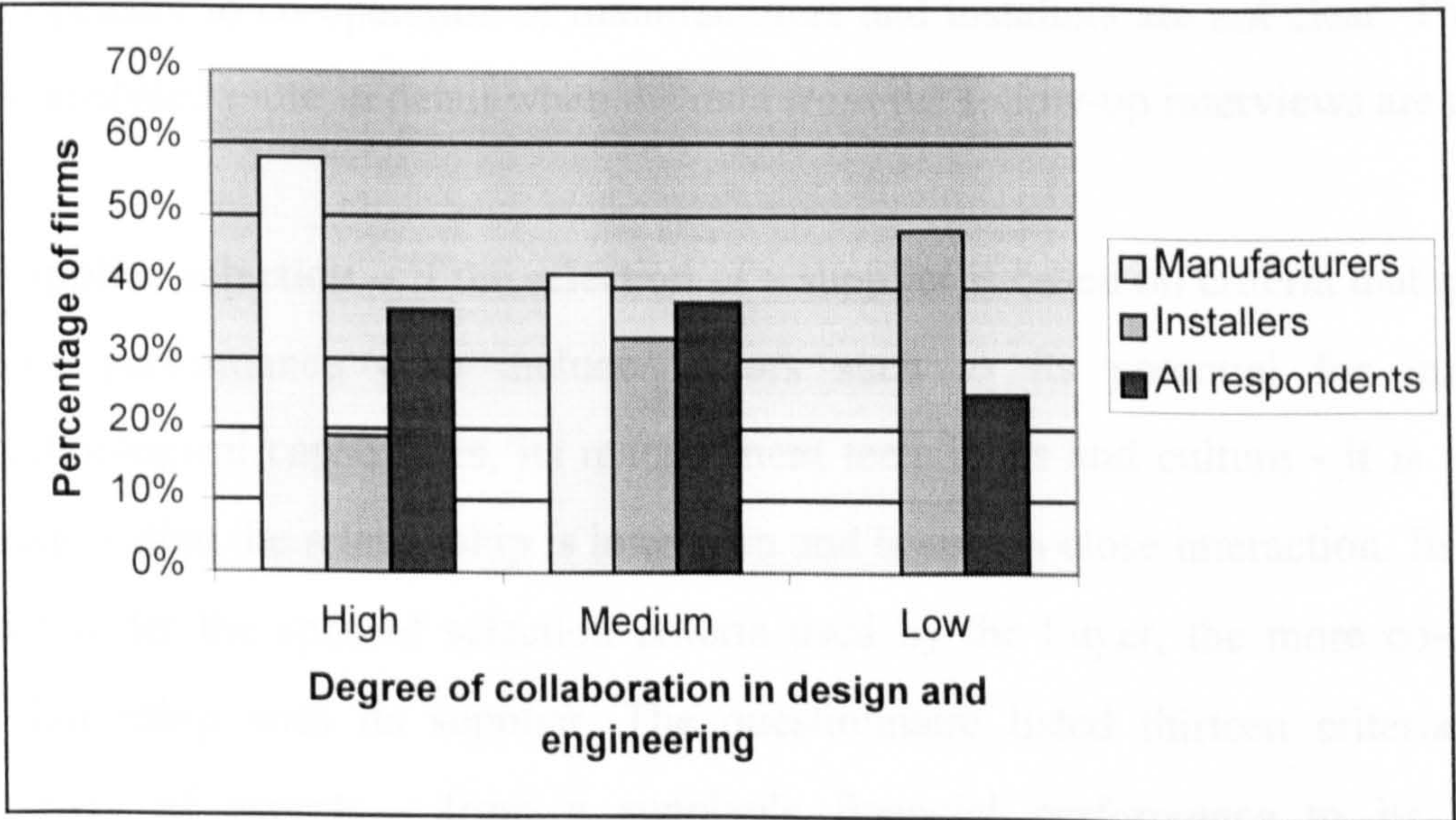
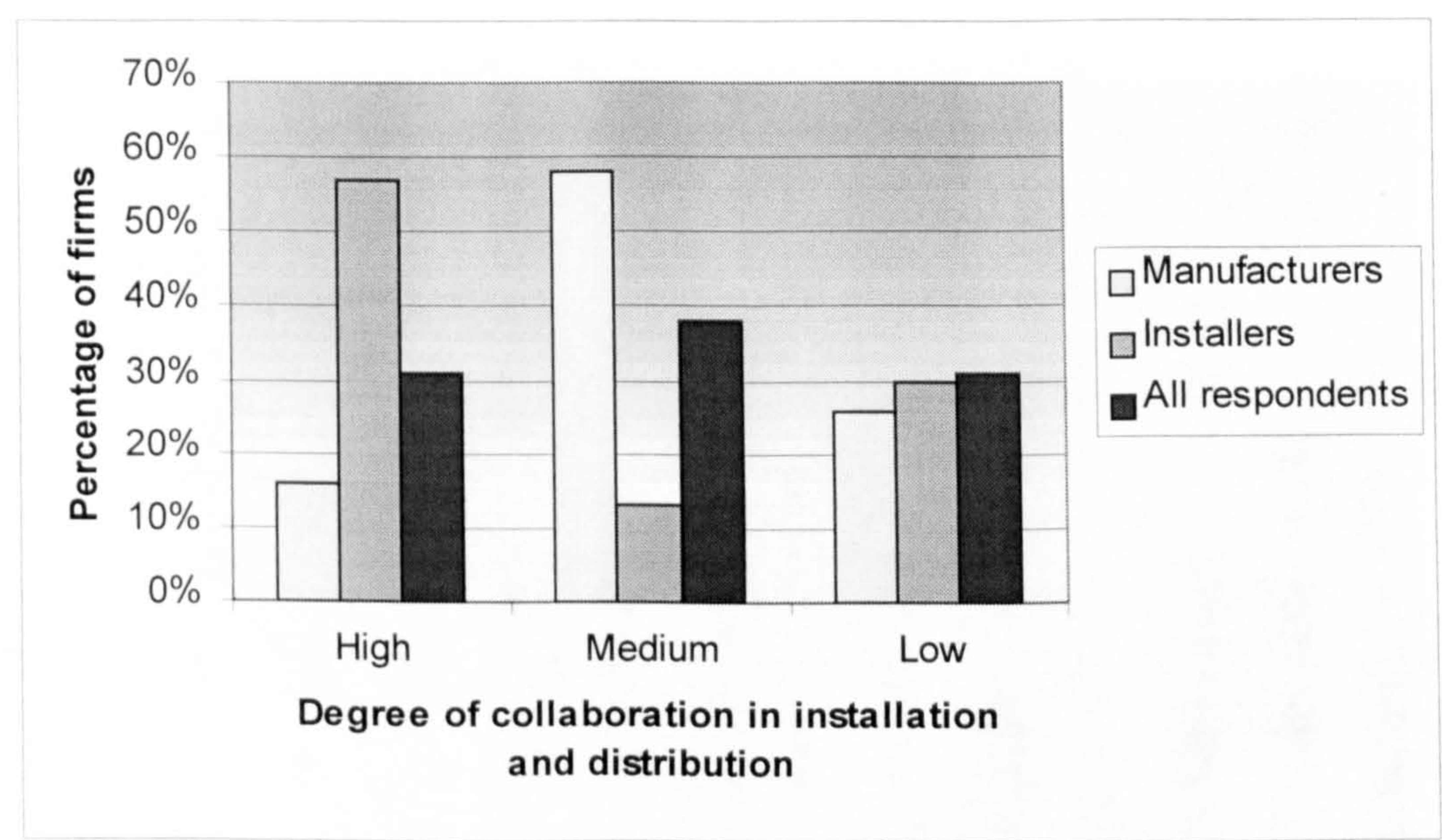


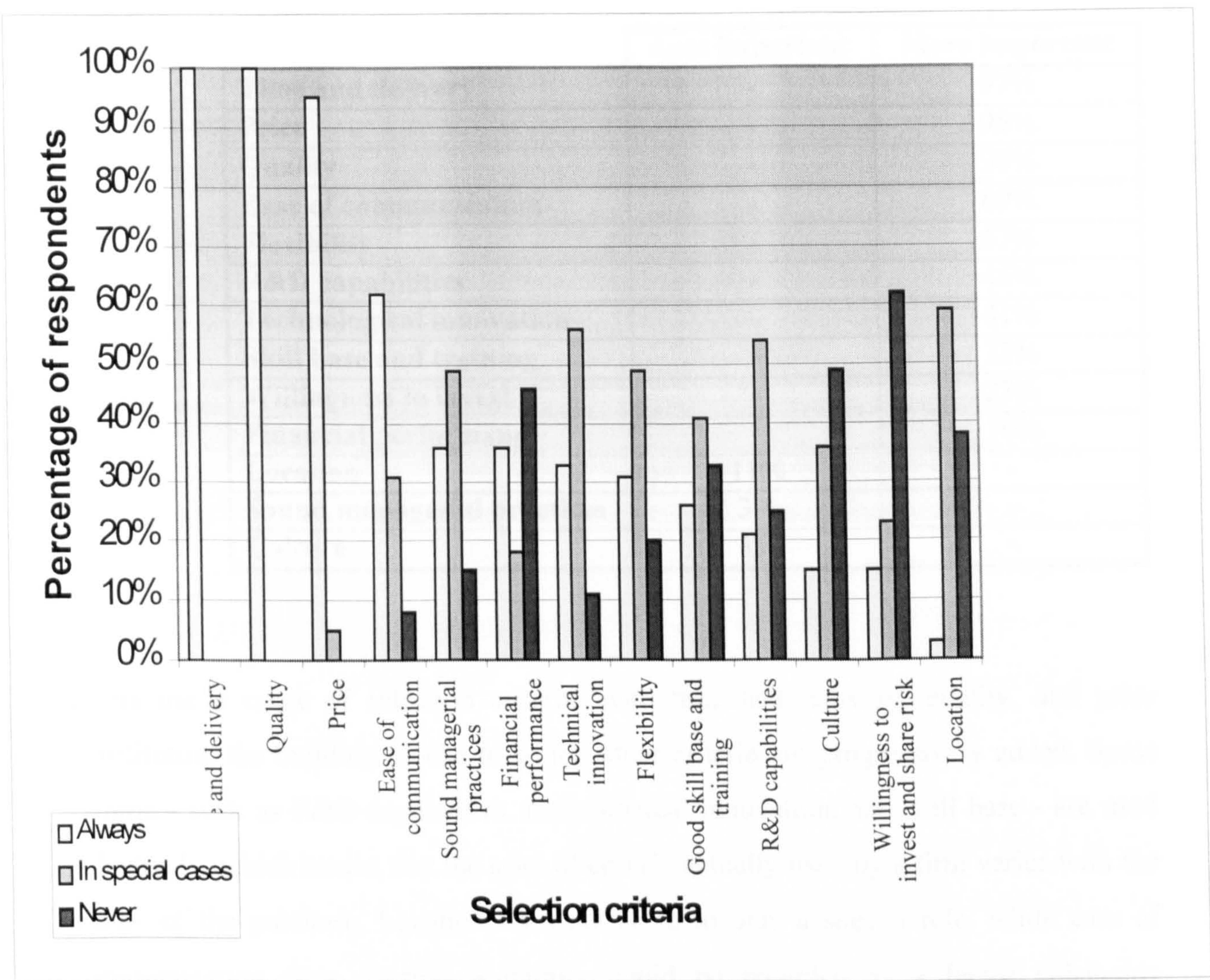
Figure 7.16 Collaboration in installation and distribution: Manufacturers vs. Installers



Manufacturers are generally more oriented towards co-operation than installers, with differences disappearing at the customer's end of a firm's value chain, in areas such as installation and distribution. As for small and large firms, the reasons for the different propensity to co-operation of manufacturers and installers are not clear. This issue will be analysed more in detail when the data from the follow-up interviews are available.

Supplier selection – If the selection of a supplier is based on criteria that go beyond its past performance - to include factors such as its potential for innovation, its technological capabilities, its management techniques and culture - it is reasonable to assume that the relationship is long-term and based on close interaction. In other words, the wider the span of selection criteria used by the buyer, the more co-operative the relationship with its supplier. The questionnaire listed thirteen criteria, covering a variety of aspects - from a supplier's financial performance to its potential for technological innovation. Figure 7.17 summarises the data on the relative intensity of utilisation of these criteria.

Figure 7.17 Intensity of use of selection criteria



Very few selection criteria have lost importance in the recent past, the majority becoming more important. Table 7.8 shows their trend in importance.

Table 7.8 Selection criteria: trend in importance (percentage of respondents)

	Less important	More important
Time and delivery	-	97%
Price	-	95%
Quality	-	90%
Ease of communication	-	69%
Flexibility	-	67%
R&D capabilities	-	46%
Technological innovation	-	41%
Skill base and training	-	33%
Willingness to invest	-	23%
Financial performance	-	19%
Location	11%	-
Sound managerial practices	3%	-
Culture	3%	-

Firms use a range of selection criteria, with time and delivery, quality, and price constituting the building blocks to which other criteria are progressively added. Some criteria - such as R&D capabilities, technological innovation, and skill base - are used selectively, which means that the span of criteria actually used by a firm varies with the nature of the purchase. Location does not seem to play a special role, while ease of communication does. Spatial proximity could be regarded as a factor enhancing communication (the other factors affected being cost - hence price - and time and delivery, both regarded as fundamentally important), but even if this is the case the two do not appear as interchangeable.

Small firms tend to use all of the criteria to at least some extent in a higher percentage of cases (81%) than large ones (67%). The two groups also differ as to the trend in importance of some criteria. Ease of communication has become more important for a higher percentage of large firms than of small ones, while the situation is reversed for research and development capability, willingness to invest and share risks, financial performance, and location.

Technological innovation, research and development capabilities, willingness to invest and share risks, sound managerial practices, and culture have, moreover, become more

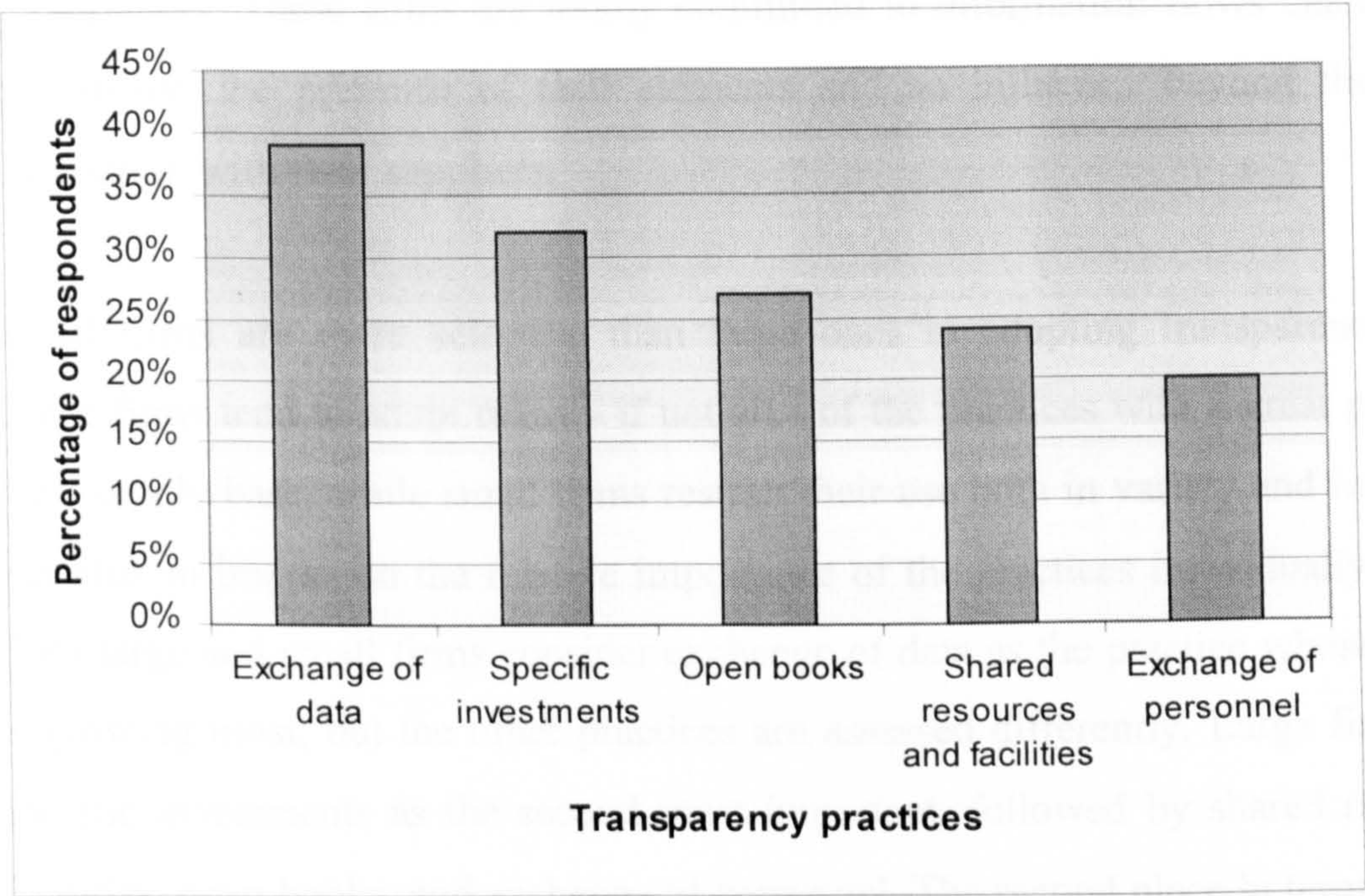
important for a higher percentage of manufacturers than of installers. This could reflect the position manufacturers occupy in the industry technological chain and their attempt to transform themselves from simple suppliers of components into systems suppliers. This transformation might propagate throughout the supply-chain, and change the role of their immediate suppliers, now called to perform wider and more sophisticated tasks. The selection criteria must now capture different, richer dimensions.

Commitment to the supplier - The use of ‘transparency practices’ such as open books, exchange of strategically sensitive data, exchange of key personnel, and idiosyncratic investments – that is, supplier-specific investments of both tangible (for example, shared facilities) and intangible (for example, training) nature - constitutes a measure of the level of commitment of a firm to its suppliers. The more widely used these practices - in term of both number and intensity⁷ - the higher the degree of commitment of the firm to suppliers and the more co-operative the nature of the relationship.

49% of respondents use at least one of the five transparency practices listed in the questionnaire⁸. This means that at least some of these firms’ information exchanges with their suppliers are characterised by the attributes associated with co-operation. The problem is which practices – that is, how many – and how intensively – that is, with what proportion of suppliers. Figure 7.18 summarises the relative degree of utilisation of the transparency practices without taking into account the intensity of utilisation.

⁷Intensity in the use of a practice is connected to the number of suppliers with whom it is used. Four options are identified in the questionnaire - respectively, with none, with a minority, with a majority, with all.

Figure 7.18 Transparency practices: degree of utilisation



As to the number of transparency practices adopted, firms use different combinations. The most widely used practice is ‘exchange of data’ and the least is ‘exchange of personnel’. However, the intensity of use of a specific practice is also relevant when trying to evaluate the degree of co-operation in information exchanges between buyers and suppliers. When analysing the data according to intensity of use, ‘open books’ is the practice more often used with all suppliers (12%) while the others are used more selectively. The 49% of respondents above can be split into three groups:

Group One (37% of respondents) is composed of firms that use only some practices with varying intensity. These firms are extremely selective in the establishment of co-operative information exchanges with their suppliers.

Group Two (5% of respondents) is composed of firms that use all the practices with the majority of suppliers. These firms are more oriented than those in Group One towards the establishment of co-operative information exchanges, but keep discriminating between different categories of suppliers.

⁸ These are exchange of personnel and key human resources, shared physical facilities and resources, open books, supplier-specific investments made by the buyer, and exchange of data on internal, strategically important processes (see Chapter 5).

Group Three (7% of respondents) is composed of firms that use all the practices with all suppliers. These firms are totally committed to information flows characterised by reciprocity, the presence of tacit elements and an influence beyond the individual transaction with their suppliers.

Small firms are more selective than large ones in adopting transparency practices. Large firms tend to adopt many - if not all - of the practices with a great proportion of their supply base, while small firms restrict their use both in variety and intensity. Size has also an impact on the relative importance of the practices individually considered. Both large and small firms consider exchange of data as the practice whose importance is growing most, but the other practices are assessed differently. Large firms consider specific investments as the second most important, followed by shared resources and facilities, open books, and exchange of personnel. The second place in terms of growing importance for small firms is shared by exchange of personnel and open books, followed by, respectively, specific investments and shared resources and facilities.

Taking primary activity into account, 53% of installers adopt at least one transparency practice, against 42% of manufacturers. Installers are also more selective - in both variety and intensity of the practices used - than manufacturers. Their relative perception of the importance of some of the practices is, moreover, different. In particular, installers tend to prefer exchange of personnel, while manufacturers are more inclined towards shared resources and facilities.

Supplier's performance evaluation – The growing importance of factors other than compliance to technical and contractual specifications is indicative of increasing networking between the firm and its suppliers. In particular, when elements such as 'innovative ideas' are introduced in a supplier's evaluation, it seems safe to assume that a co-operative approach is in place.

All the performance evaluation factors listed in the questionnaire⁹ have become more important in the recent past, which has led to a broadening of the range of criteria used in performance evaluation. Table 7.9 summarises the survey data.

Table 7.9 Performance evaluation criteria: trend in importance (percentage of respondents)

	Less important	More important
Compliance to technical requirements and specifications	-	91%
Delivery and service	-	91%
Warranty performance	-	81%
Ideas generated by supplier	-	50%

Manufacturers and installers show different attitudes towards ‘new ideas generated by suppliers’. 26% of manufacturers maintain that this criterion has become significantly more important and 42% say it has become significantly so. Installers’ judgement is less clear-cut, with 35% saying that new ideas from suppliers have become moderately more important in recent times.

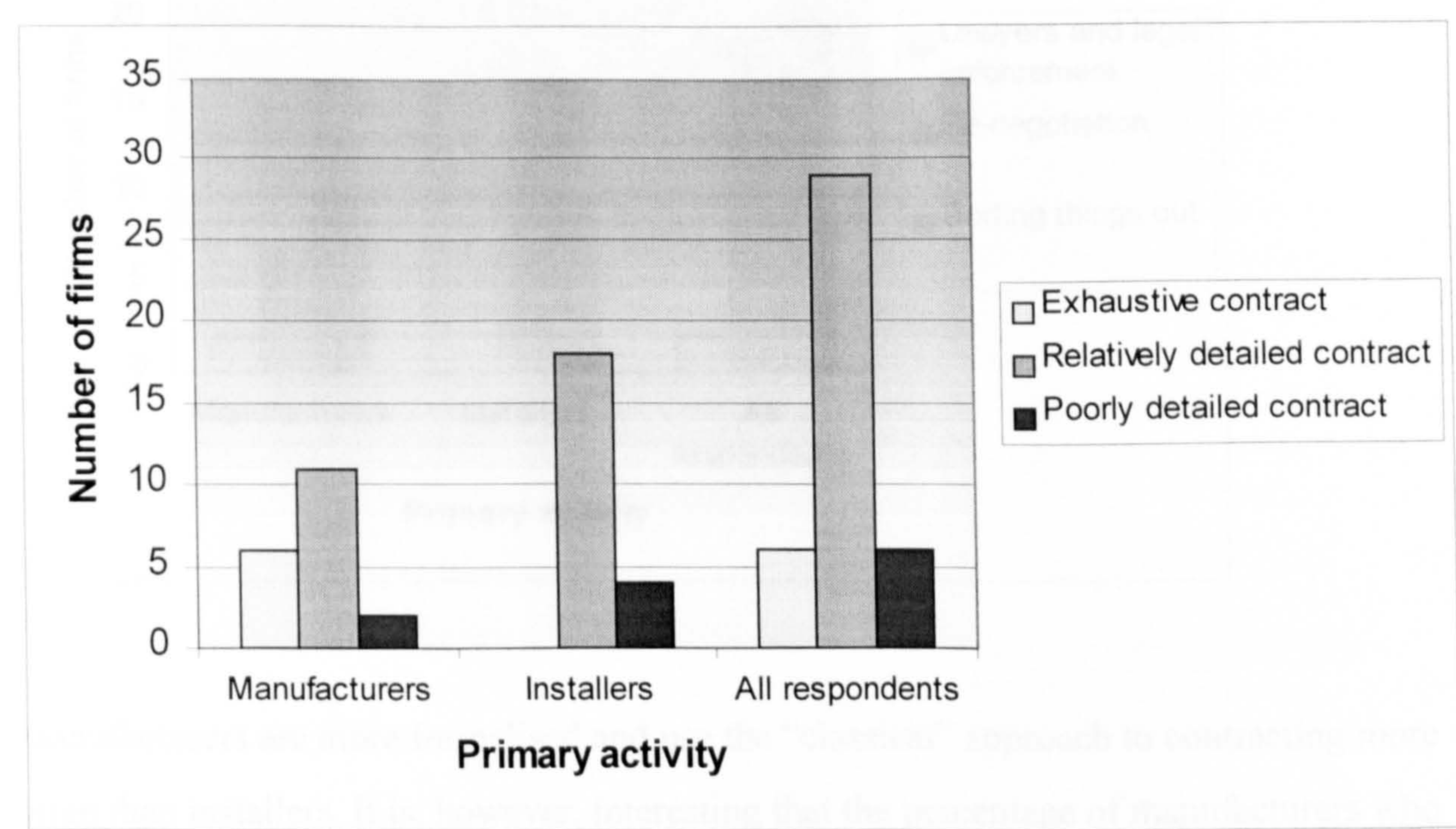
This could be explained by the transformation from simple suppliers of components to system integrators undertaken by manufacturers, and its impact backwards on the supply-chain. Manufacturers' suppliers are called to a more complex and enriched role, being delegated part of the tasks once directly performed by the manufacturers. The more the industry approaches maturity, moreover, the more relevant every possible area for potential improvement becomes. Suppliers' importance may accordingly grow because they represent a source of innovation that has not been fully exploited in the past. In other words, as the industry approaches maturity the original sources of innovation might be declining, leaving room for a thorough search in directions previously not pursued.

Role of the contract – The relationship between buyer and supplier is generally regulated by means of a contract. However, contracts can vary quite significantly

⁹These are compliance to technical specifications and requirements, delivery and service, warranty performance, new ideas generated by suppliers.

according to their relative degree of specification¹⁰. The more detailed the contract, the more market-oriented the relationship between a firm and its suppliers. Conversely, loosely defined contracts with a high degree of in-built flexibility are symptomatic of co-operative supply relations. Figure 7.19 summarises the data on the degree of specification of the contract for all respondents, and the two groups of manufacturers and installers.

Figure 7.19 Degree of specification of the contract: Manufacturers vs. Installers



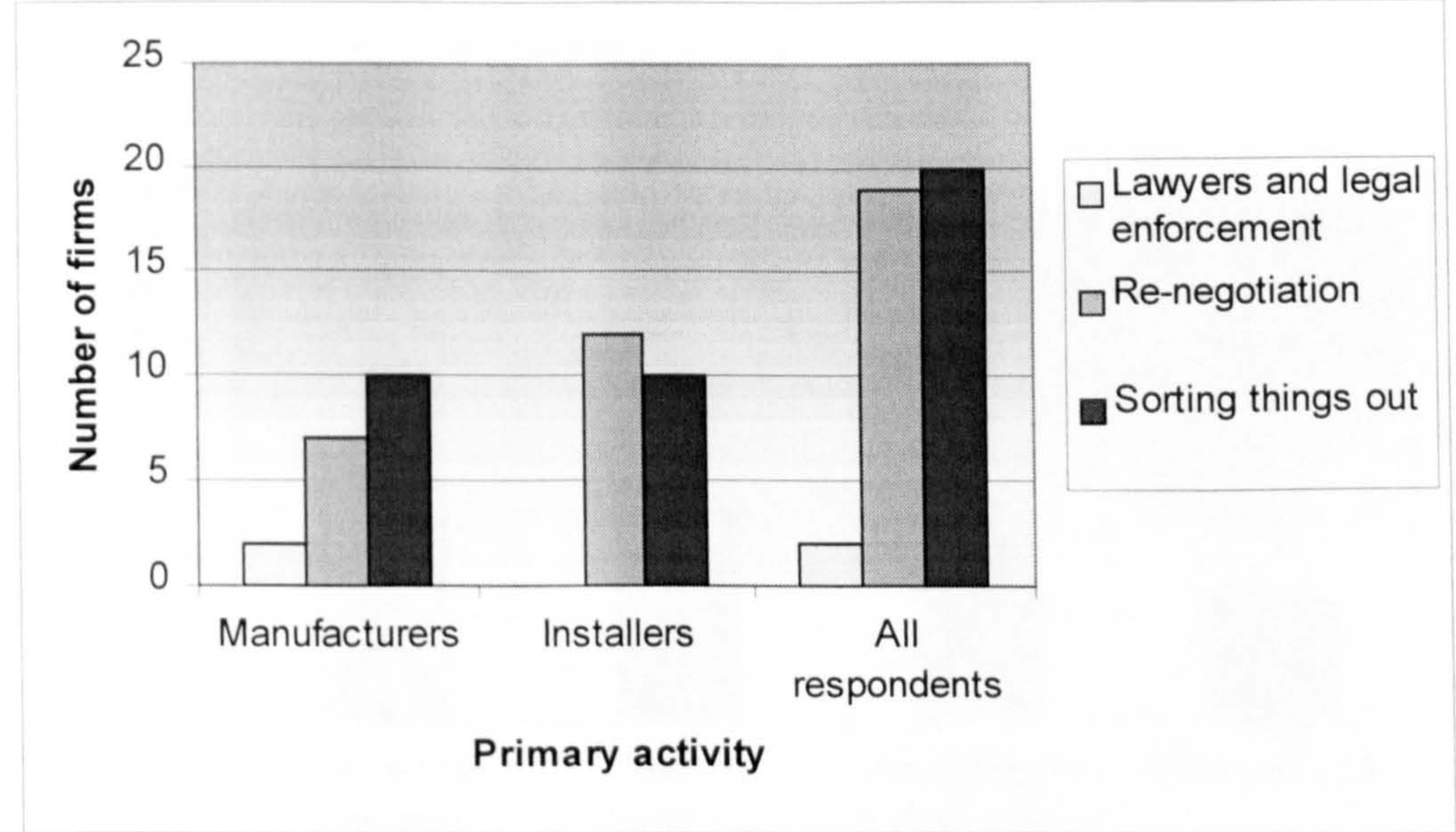
Installers generally adopt a less formalised approach. Contracts are flexible and leave room for adjustments. A certain degree of flexibility is probably required by the very nature of the activity performed, given that installers do not normally have a full knowledge of the specific details of the project they are in charge of when they first contact a supplier. Too much depends on factors that are outside their control and that are often impossible - or too expensive - to anticipate.

Conflict resolution - When the contract and its enforcement constitute the primary mechanism for solving conflict between the firm and its suppliers, the relationship is governed by market-oriented mechanisms. Conversely, the more conflict resolution is

¹⁰ The three alternatives included in the questionnaire are exhaustive, relatively detailed, and very poorly detailed contracts.

based on trust, open dialogue and mutual adjustment, the more co-operative the relationship. Figure 7.20 summarises the data on three conflict resolution mechanisms¹¹ for the totality of respondents and for the two groups of manufacturers and installers.

Figure 7.20 Conflict resolution mechanisms: All respondents, Manufacturers and Installers

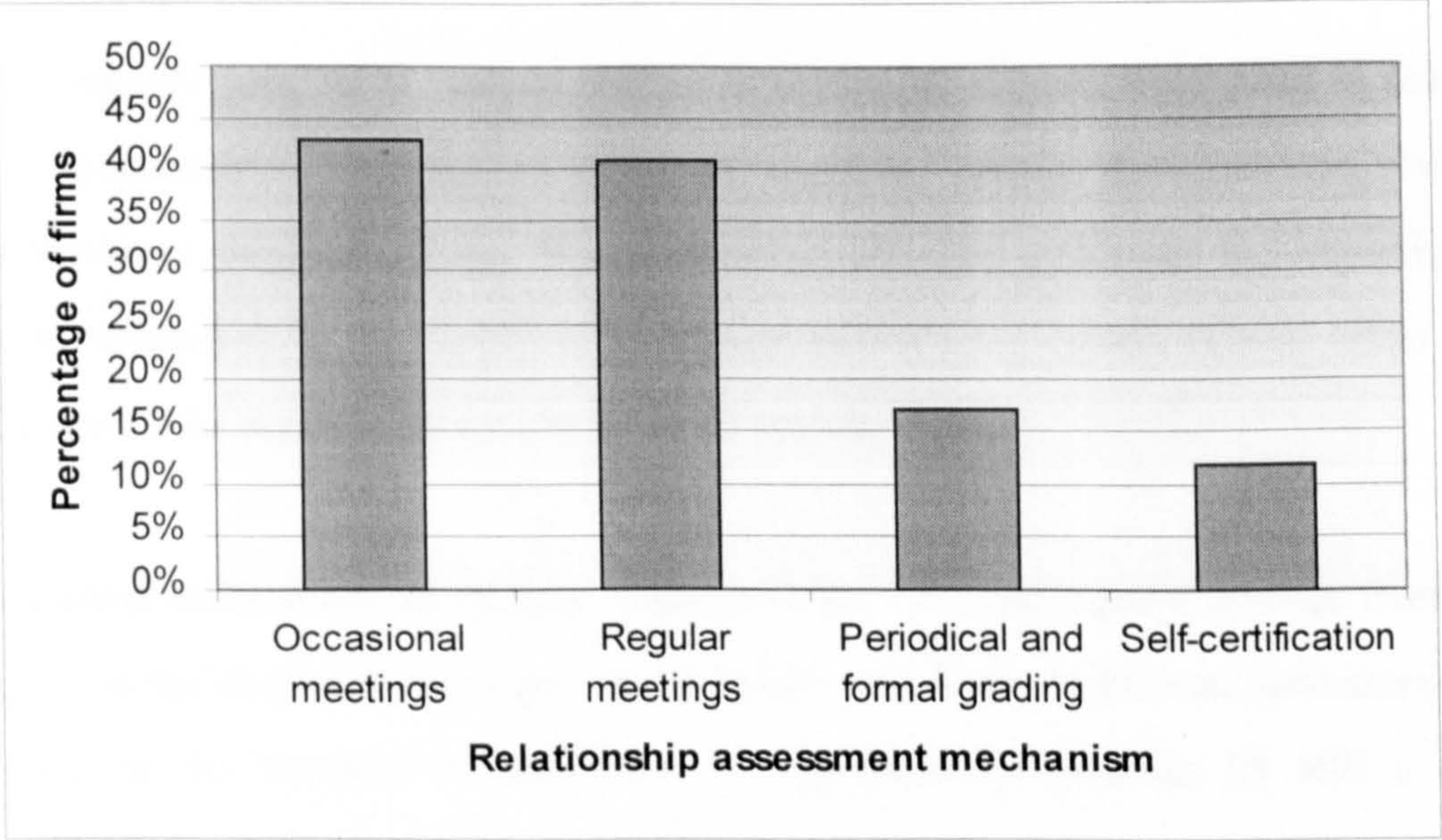


Manufacturers are more formalised and use the “classical” approach to contracting more often than installers. It is, however, interesting that the percentage of manufacturers who use legal enforcement as the normal way to resolve conflicts is much lower than the percentage of manufacturers who use an exhaustive, “classical” contract. According to the theory, legal enforcement should always be used to solve conflicts when exhaustive contracts are put in practice. The data show this is not always the case. A more flexible approach is adopted even in combination with ex-ante exhaustive contracts, and “voice-oriented” (Helper, 1991) options for solving conflicts are preferred. It is also interesting that manufacturers are more likely than installers to opt for a totally informal solution (“sorting things out”).

¹¹ The three alternatives included in the questionnaire are going to the lawyers and legal enforcement, re-negotiation on the basis of the contract, and sorting things out.

Relationship assessment mechanisms - Beyond the assessment of individual deals between the firm and its suppliers, control mechanisms extend to monitoring the general development of supply relationships as a whole. The questionnaire includes four mechanisms to take into account different degrees of formalisation and structuring¹². A firm can use a combination of these. Figure 7.21 summarises the survey data.

Figure 7.21 Relationship assessment mechanisms



Meetings- occasional or regular - are generally preferred to more formal and structured ways. Large firms and small ones differ in terms of their relative preference for regular vs. occasional meetings, with 76% of large firms adopting regular meetings and 95% of small firms occasional ones. This might simply reflect the different orientation of small and large firms towards formalisation and the development of structures and routines.

¹² These are regular meetings, occasional meetings, periodical and formal grading against a checklist of criteria, and self-certification.

7.5 The emergence of the network supply-chain: the case of the UK optical communications systems industry

The first research question in Chapter 5 addresses the issue of the relevance of the network supply-chain - a governance structure based on co-operation as the fundamental principle to regulate supply relationships – for the UK optical communications systems industry.

The survey data show that co-operative forms are significantly used in the UK optical communications systems industry to regulate supply relationships, but *there are differences between firms*. We summarise the key evidence distinguishing between general indicators on supply relationships and the six organisational areas identified in Chapter 5 to operationalise the network supply-chain.

General indicators on supply relationships - Mixed signals emerge from data on the general development of supply relationships and from traditional indicators - such as the trend in the number of suppliers. A significant proportion (if still a minority) of respondents report a *major change in purchasing strategy* around the years 1996-1997. This shows that things are changing, but the shift from market-oriented mechanisms to co-operation in supply relationships has just gathered pace. There is growing awareness of the importance of co-operative supply relationships, but only for a qualified minority of firms this does lead to explicit and formal changes in strategy. More often, the pattern towards co-operation is revealed through a series of individual changes in day-to-day practices and behaviours. In other words, the strategy change is emergent in nature (Mintzberg, 19).

As to the *number of suppliers*, only 15% of respondents – mainly large manufacturers - show a decrease. It could be argued that these firms who have developed co-operative relations with their suppliers, while the rest are lagging behind and are still bound to a market-oriented approach. Other elements must be taken into account, however, especially in the light of the increase in the use of *supply strategies* – such as lists of preferred suppliers – *based on co-operation*. First, almost all respondents (98%) have

experienced increasing levels of activity¹³. This could account for the expansion of the supply base without necessarily implying the use of aggressive approaches in purchasing. In other words, new suppliers might be dealt with in relatively co-operative ways. The age of the company is a second element. Relatively young firms – especially installers and specialist manufacturers - might be more interested in establishing new supply relationships than in rationalising old ones. Finally, some firms may still find multiple sourcing an efficient strategy for at least some of the required materials/components - probably the less strategically important ones. This means that far from adopting one approach for all types of supply, these firms are discriminating, and treat different classes of suppliers in different ways.

The six organisational areas – The evidence can be summarised as follows:

1. *Teamwork across organisational boundaries.* Our data show that a significant percentage of firms heavily involve their suppliers in activities such as research and concept design (45%) and design and engineering (38%). These percentages change when primary activity is taken into account and become 74% and 59% for manufacturers respectively, and 22% and 19% for installers.
2. *Supplier selection.* Our data show that this span is wide, with time, delivery, quality and price as the building blocks of a multi-dimensional system of selection. These basic criteria are, in fact, complemented by others that express a supplier's potential contribution in areas such as innovation and technological development (34% use this type of criteria regularly and 57% in a more selectively) or reflect its R&D capabilities (22% use this type of criteria regularly and 54% more selectively). A significant proportion of respondents also use criteria that capture 'soft' dimensions of a supplier's profile, such as its managerial culture and practices (37% use this type of criteria regularly and 49% more selectively) and ease of communication (62% use this type of criteria regularly and 32% more selectively).

¹³ For 71% of respondents, the increase in the volume of activity has been of "significant magnitude".

3. *Commitment to the supplier.* Our data show that 49% of respondents use at least one of these transparency practices, the percentages being 53% and 42% respectively for installers and manufacturers. Also, the most frequently adopted practice is supplier-specific investments for manufacturers and exchange of key personnel for installers.
4. *Supplier's performance evaluation.* Our data show that in the UK optical communications systems industry new dimensions are taken into account in evaluating suppliers' performance. For example, the contribution offered by suppliers in terms of new ideas for improved efficiency and innovation has become more important in the past five years for 50% of the respondents.
5. *Role of the contract.* Our data show that firms in the UK optical communications systems industry tend to recognise the value of the contract as a mechanism that allows for the rules of the relationship with their supplier to be made explicit. Contracts are, consequently, as detailed as the specific negotiating circumstances allow.
6. *Conflict resolution.* Our data show that firms in the UK optical communications systems industry very rarely rely on the legal protection of the contract as the exclusive basis for conflict resolution. More, 50% of respondents 'put the contract aside' in case of conflict with their suppliers and opt for methods exclusively based on trust.

On the whole, our evidence indicates that a significant proportion of firms in the UK optical communications systems industry use co-operation as the fundamental principle to govern supply relationships and therefore corroborate and reinforce findings from previous studies (Lamming, 1989; Lorenzoni, 1992; Normann and Ramirez, 1993). This supports the idea that the diffusion of the network supply-chain is not confined to traditional industries with established technologies – such as automotive - but affects high-tech industries as well as industries where the technology is still at a development stage.

The data, however, also show that this pattern is not homogeneous across the industry. Firms differ in terms of the areas most affected by the shift from market-oriented to co-operation-oriented forms of governance. The element that discriminates between groups of firms characterised by different approaches to co-operation is the *degree of maturity of the core-technology of the firm*, in our analysis represented by the distinction between manufacturers and installers. Whether a firm is operating within the context of an established technology or of an emergent, dynamic one has an impact on the form of governance used to regulate supply relationships. The question is ‘how?’ and will be answered in Chapter 10 on the basis of a combined analysis of survey, correlation and interview data.

CHAPTER 8 – CO-OPERATIVE SUPPLY RELATIONSHIPS AND ORGANISATIONAL PERFORMANCE: THE FINDINGS

The second objective of the research, as stated in Chapter 5, is to test the linkage between governance forms in the supply-chain and organisational performance. In order to do so, we correlated measures of co-operative governance in supply relationships (one for each of the six areas used to operationalise the network supply-chain in Chapter 5) and measures of efficiency and innovation.

We also explored the role of technology as an intermediate variable between governance and performance by discriminating between the two groups of manufacturers and installers. As anticipated in Chapter 7, in our sample manufacturers can be associated with a predominantly mature technological environment, whereas installers represent the radical, emergent technology.

Due to the specific purposes of a Ph.D. thesis, the analysis in this Chapter is very detailed and, therefore, not appealing for the average reader who is generally interested in key results and finds long lists of figures tiring and confusing. We therefore indicate here that the main results are summarised in Section 8.3 and that they do not require any specific knowledge of the analysis. For those interested, Section 8.1 presents the descriptive analysis of survey data on organisational performance, and Section 8.2 illustrates all the correlation coefficients calculated in the course of the study (Tables 8.4 to 8.15).

8.1 Overall trends in organisational performance of the sample firms

Three sets of indicators are used in the questionnaire to measure a firm's performance:

- Efficiency
- Innovation
- General financial indicators

The data measure a firm's performance trend for the five years prior to the research - or for a shorter time frame when appropriate.

8.1.1 Efficiency

Efficiency gains are monitored by tracking the trend of the following indicators:

- Overall product-cost
 - Labour productivity
 - Material productivity
 - Equipment/Plant utilisation
- Order-to-delivery time
 - Cycle-time

Various reasons justify the use of multiple indicators. First, efficiency is a multi-faceted concept that incorporates different dimensions, depending on the focus and level of analysis and measurement. Assuming that the firm is a complex production unit where different activities transform inputs into output, efficiency can be measured at the global level – that is, the firm level - or at intermediate ones – that is, specific activities or specific resources or inputs.

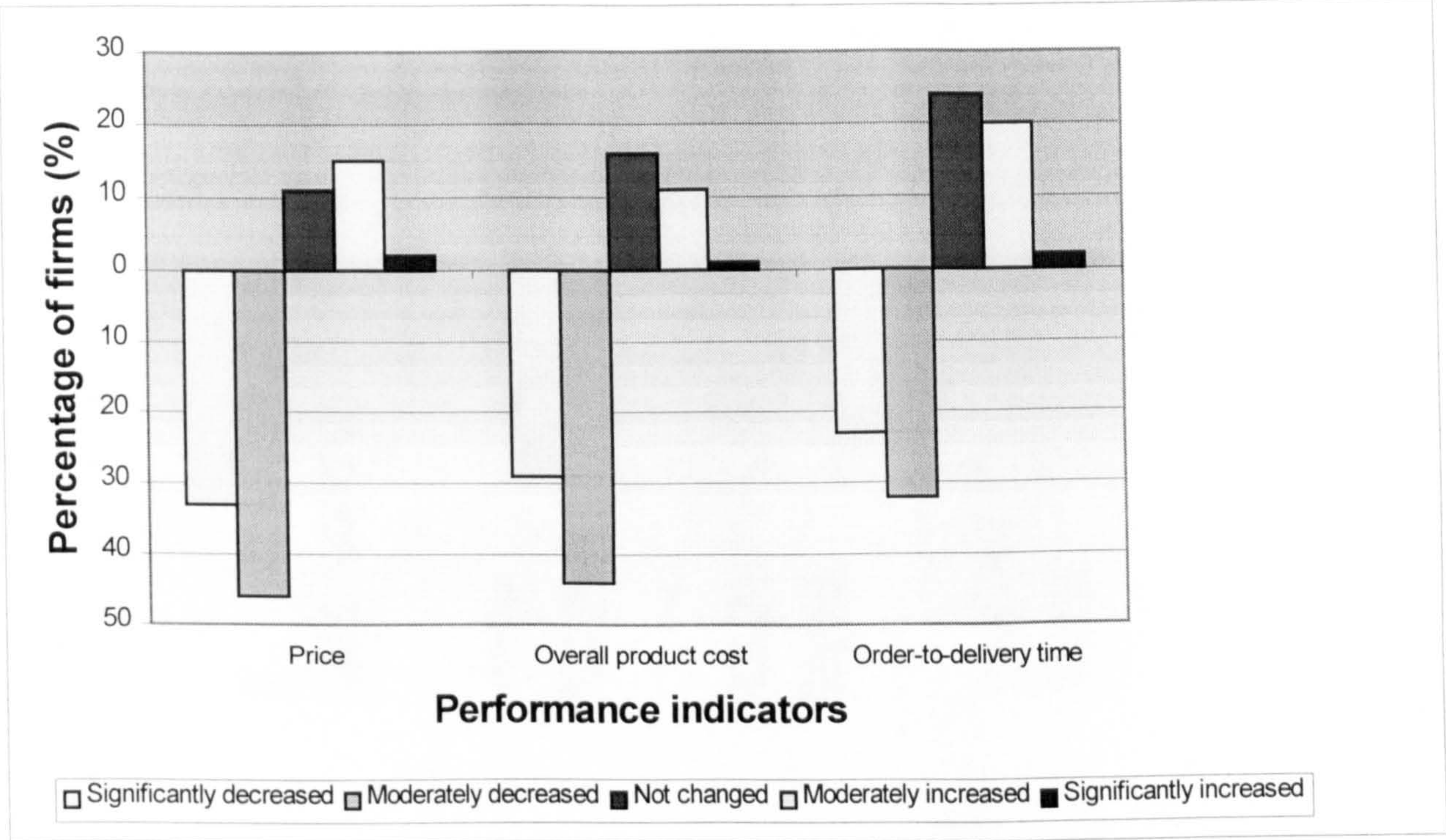
To capture this complexity, several measures are required. The study relies on two global measures of efficiency, 'overall product-cost' and 'order-to-delivery time' and a few partial ones – 'labour productivity', 'material productivity', 'plant/equipment utilisation' and 'cycle-time'. 'Overall product-cost' measures global efficiency by focusing on the output of the firm's overall production process; 'order-to-delivery time' measures global efficiency by concentrating on the process itself and capturing a dimension of efficiency – viz. time – not included in a simple cost measure. These two global measures are complemented by partial measures of efficiency. 'Labour productivity', 'material productivity' and 'equipment/plant utilisation' all concentrate on specific inputs and constitute separate components of the global measure 'overall

product-cost'. 'Cycle-time' is a partial measure of efficiency that captures the time dimension in manufacturing-related activities. It is a component of the broader 'order-to-delivery time' which includes activities beyond the scope of manufacturing – such as, for example, order handling.

The need to use both global and partial measures of efficiency in the study is reinforced because of fundamental differences among the sample firms in terms of primary activity and resource requirements. Fibre-optics manufacturers are generally characterised by huge investments in fixed capital for equipment and machinery, with research and manufacturing as the firm's core functions. The situation is quite different for installers with very low fixed assets, heavy reliance on skilled labour (mostly engineers), and system design and installation - with very little manufacturing – as the key functions. As a consequence, different measures of efficiency are required to take these structural differences into account. This is especially true of partial measures of efficiency. For example, 'plant/equipment utilisation' and 'cycle-time' are suited to manufacturers, while 'labour productivity' and 'order-to-delivery time' are more appropriate for installers. These differences in the relevance and suitability of different measures for different types of firm must be taken into account when analysing and interpreting the results.

Figure 8.1 shows the survey data for the global measures of efficiency, and also price.

Figure 8.1 **Price, Overall product-cost and Order-to-delivery time**

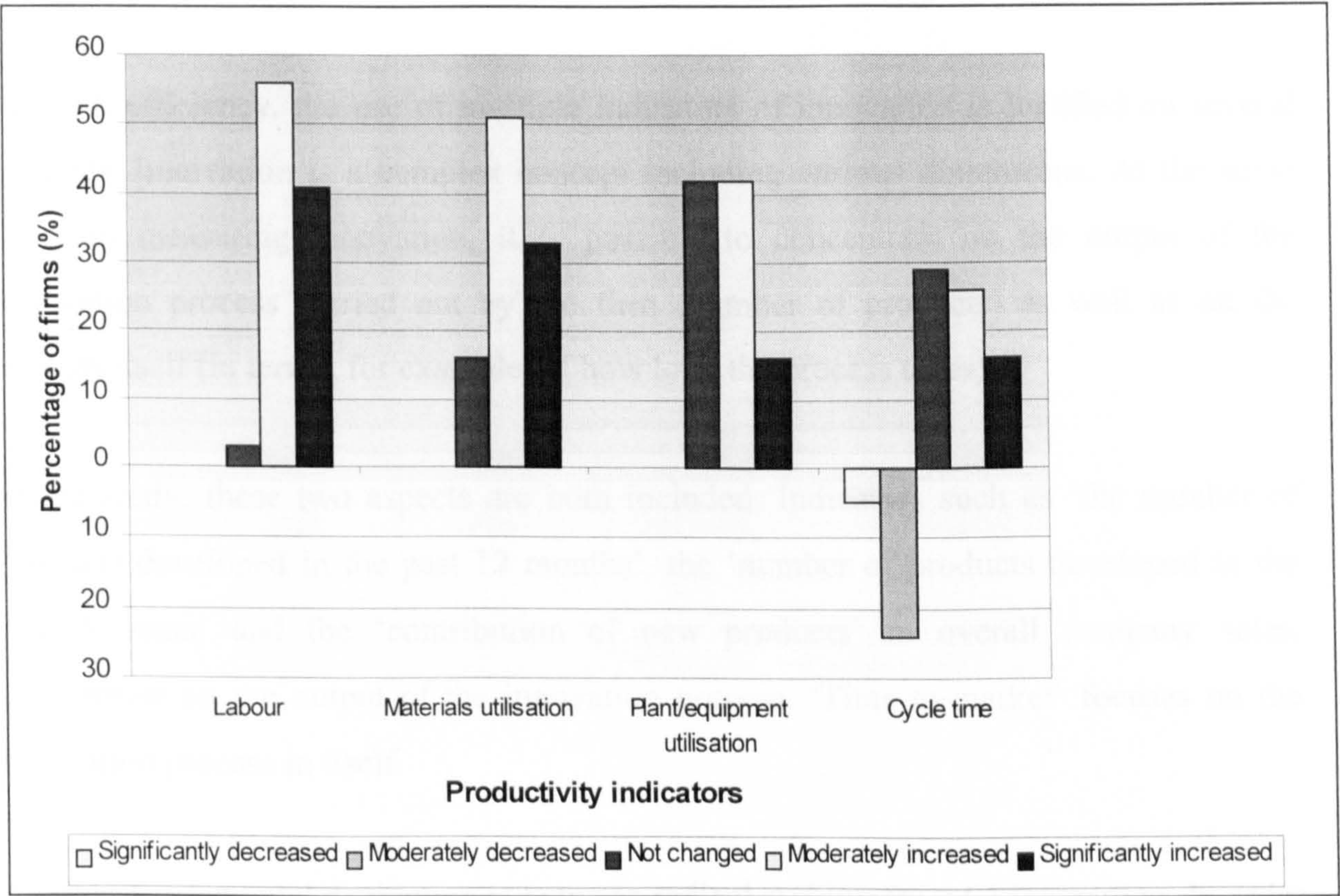


The parallel fall in prices and overall product-cost suggests that margins are generally falling in the industry, a sign of increasing competition and renewed efforts to improve efficiency. Of the two global measures of efficiency, ‘overall product-cost’ shows a more definite improvement, with a minority of firms experiencing an increase. The trend for ‘order-to-delivery time’ is more mixed, with a significant proportion of firms experiencing an increase and, therefore, deteriorating performance.

There are two main reasons for these trends. When primary activity is taken into account, it appears that only some installers (35%) experience an increase in ‘overall product-cost’. This is probably due to rising costs for their critical input, skilled labour: the reduction in prices for parts and components may be not enough to compensate fast-rising labour costs. The reasons for deteriorating performance in ‘order-to-delivery time’ are more complex, with both manufacturers (26%) and installers (14%) losing ground. A possible common explanation is that, in the face of increasing competition, some firms are trying to improve their position by up-grading their offer and moving towards more sophisticated segments of the industry. Increasing complexity can lead to longer times throughout the production and installation process, and consequently deteriorating performance.

Figure 8.2 shows the survey data for the partial measures of efficiency.

Figure 8.2 **Productivity improvement**



All the indicators, save for ‘cycle-time’, show improved performance and reinforce the view of an industry where the level of competitive pressure is constantly pushing firms in their search for opportunities for efficiency gains. As with ‘order-to-delivery time’, ‘cycle-time’ gives a mixed picture, with a significant proportion of firms – both manufacturers and installers - experiencing deteriorating performance. This reinforces the view that, in a general context of improved efficiency, some firms are trying to reposition themselves by up-grading their offer. Time is the dimension of efficiency most affected by this change.

8.1.2 Innovation

A variety of indicators are used to capture different aspects of the innovation process:

- Time-to-market
- Number of products developed in the past 12 months
- Number of products developed in the past 5 years
- Contribution of new products to overall company sales (%).

As with efficiency, the use of multiple indicators of innovation is justified on several grounds. Innovation is a complex concept including various dimensions. At the same time, in measuring innovation, it is possible to concentrate on the output of the innovation process carried out by the firm (number of products) as well as on the process itself (in terms, for example, of how long the process takes).

In the study, these two aspects are both included. Indicators such as ‘the number of products developed in the past 12 months’, the ‘number of products developed in the past 5 years’ and the ‘contribution of new products’ to overall company sales, concentrate on the output of the innovation process. ‘Time-to-market’ focuses on the innovation process in itself.

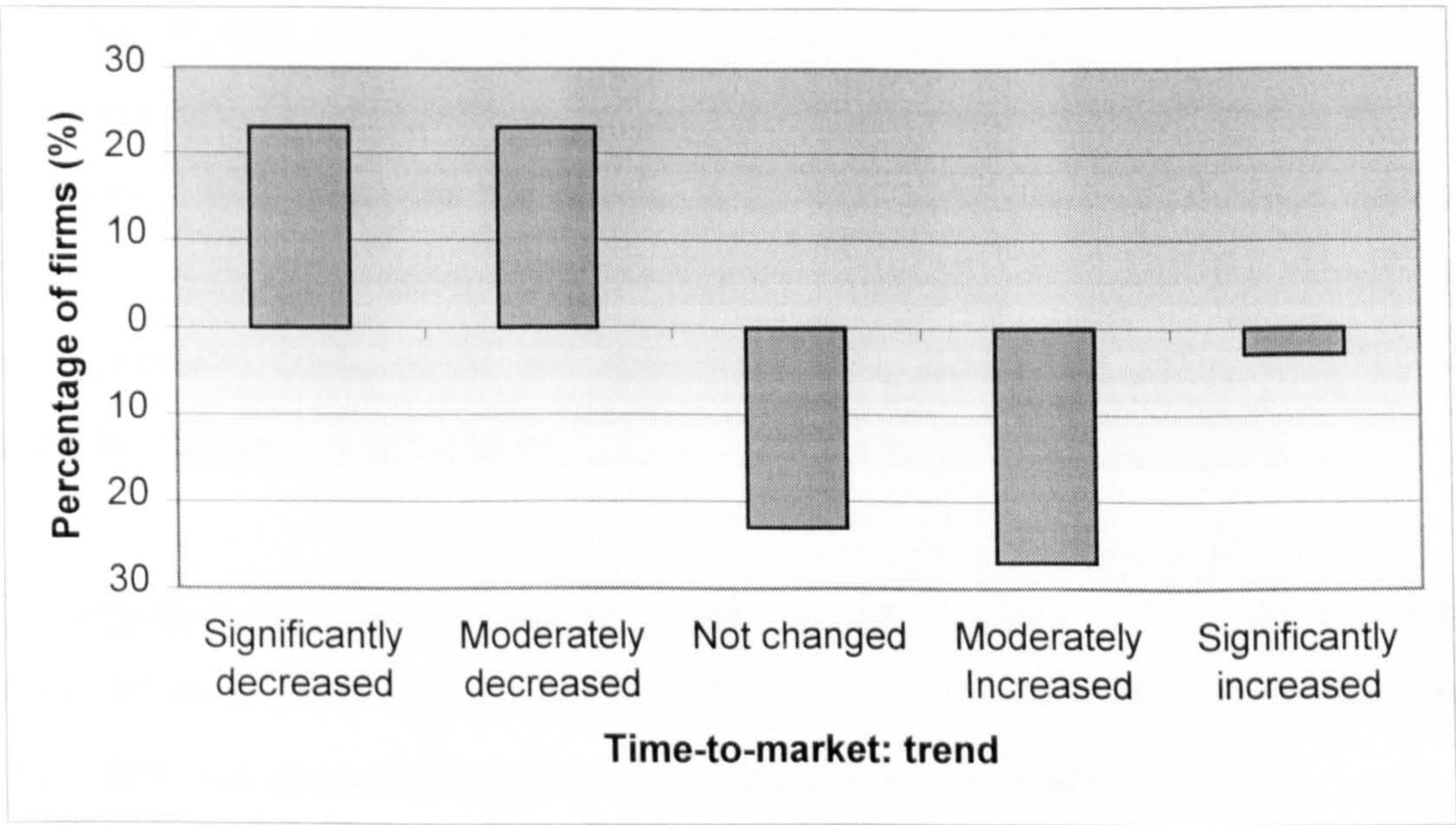
Another fundamental distinction is between radical and incremental innovation. In order to capture this aspect, the study measures the percentage of overall company sales derived from three categories of new products, each corresponding to a different level of ‘newness’ – products that are totally new, products that are up-grading over previous generations, and products that are minor improvements.

It is also necessary to use a variety of measures of innovation because of fundamental differences among the sample firms in terms of primary activity and their role in the overall industry innovation process. Fibre-optics manufacturers are generally more directly involved in basic research and development than installers, whose contribution to the innovation process is in facilitating the diffusion of successful new products and operating as filters and intermediaries between end-customers and manufactures. ‘Time-to-market’ and the ‘number of new products’ are more appropriate measures of innovation for manufacturers, while ‘the contribution of new products to overall company sales’ is more suitable for installers. Differences in the relevance and

suitability of different measures for different types of firm must be taken into account when analysing and interpreting the results.

Time-to-market – Time-to-market shows a mixed trend, as Figure 8.3 illustrates, with a high percentage of firms – both manufacturers (31%) and installers (30%) - experiencing an increase in its value and, therefore, deteriorating performance.

Figure 8.3 **Time-to-market for new innovations**



The data on time-to-market are partial because nine installers and three manufacturers did not answer the question. In the course of telephone follow-ups to complete the set of data most of them felt that the lack of a strong innovation activity made this indicator not particularly useful in their case.

As to a possible explanation for the observed trend, the same factors highlighted above for order-to-delivery time and cycle-time can play a role. Firms changing and upgrading their offer, or diversifying into more sophisticated segments of the industry, incur increased complexity in all areas, from research and development to manufacturing. Increased complexity slows down the pace of activity in these areas, and measures of both innovation and efficiency focused on time capture this effect.

Number of new products developed in the past 12 months - 65% of respondents (14 installers and 13 manufacturers) report at least one new product in the past 12 months. The mean for the sample is 24 new products, with a range between 1 and 319. Two firms (both manufacturers, representing 7% of the firms actively innovating) are responsible for this, having respectively developed 180 and 319 new products. The remaining 93% are firms with 10 or fewer new products developed in the last 12 months.

Number of new products developed in the past 5 years - 68% of respondents (15 installers and 13 manufacturers) report at least one new product developed in the past five years. The mean for the sample is 87 new products, with a range between 2 and 1,200. 86% of the firms actively innovating in the past five years developed 30 or fewer new products each, while the remaining 14% developed more than 60. Only one installer falls into this category.

Contribution of new products to overall company sales - The analysis distinguishes three different categories of products developed in the past five years, corresponding to three different degrees of newness incorporated in the products

- Products that are totally new
- Products that are significant upgrading over previous generations
- Products that are minor improvements over previous generations

Table 8.1 summarises the survey data.

Table 8.1 Percentage of sales for different categories of new products (percentage of respondents)

	Totally new	Significant upgrading	Minor improvement
< 25% of company sales	66%	61%	67%
25-50% of company sales	10%	32%	18%
50-75% of company sales	12%	7%	15%
>75% of company sales	12%	-	-

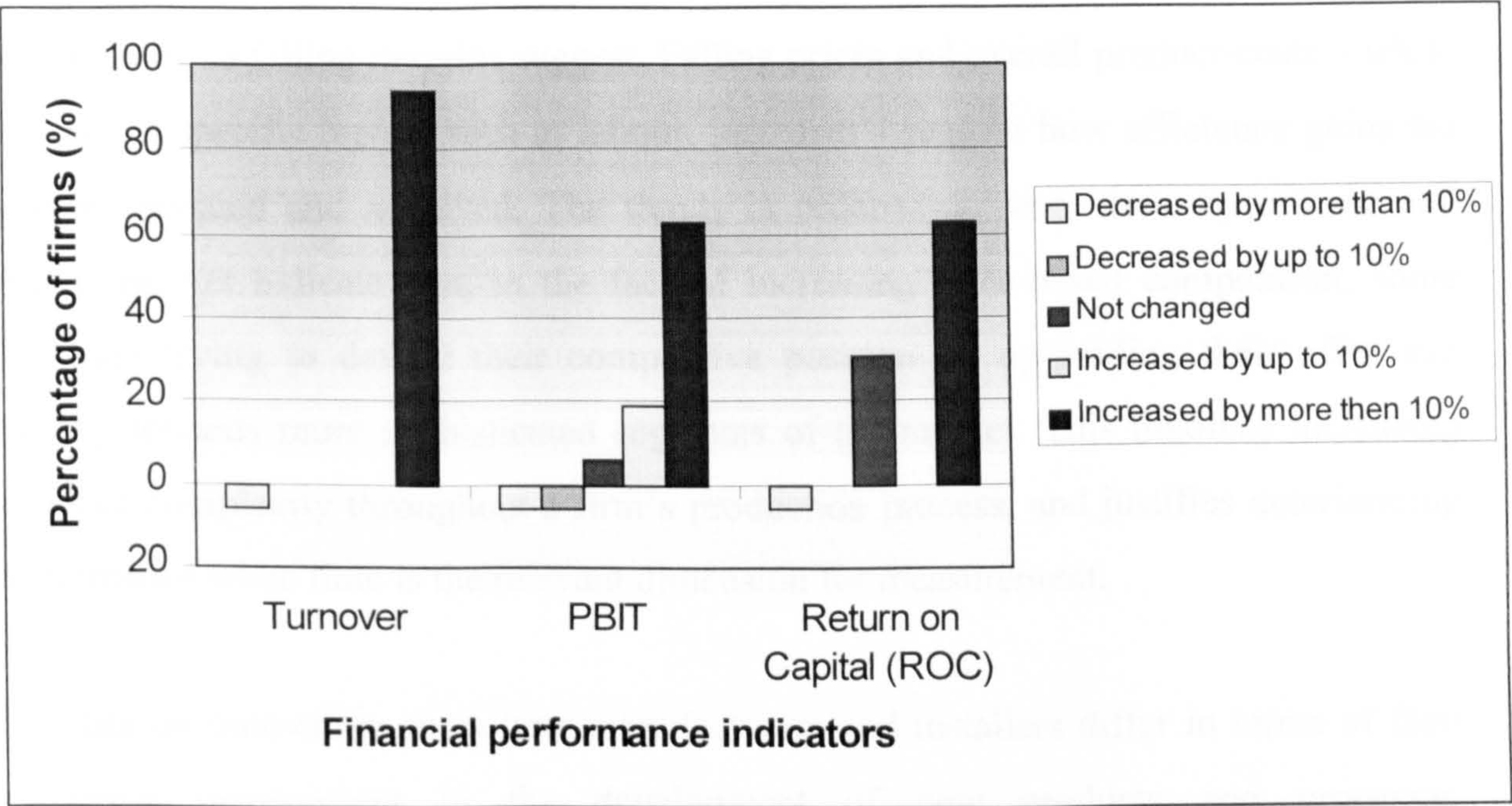
The number of firms, both manufacturers and installers, with a high percentage of sales coming from totally new products developed in the past 5 years is quite small. For a minority of firms and only in the case of totally new products, however, this percentage is over 75%. For installers, products that are upgrading or minor improvement over previous versions never account for more than 50% of overall company sales. For manufacturers, they account for up to 50% of company sales in 16% of cases, and for up to 75% of company sales in 32%.

Apart from a strong emphasis on innovation, other factors can influence the percentage of overall company sales derived from new products. One is age. Firms that are relatively new, with young and growing ranges of products, tend to have a higher percentage of sales based on innovation. A second factor is diversification. Firms entering new segments of the fibre-optics market - maybe switching from mature segments to growing ones - could be in the process of substantially renovating their product ranges.

8.1.3 General financial performance

Ten firms (24% of respondents, equally distributed between installers and manufacturers) preferred not to disclose any data. Figure 8.4 shows the data for the remaining 31 (76% of respondents).

Figure 8.4 **General financial performance**



The data show significant improvement in firms' performance, with a very small percentage reporting deteriorating financial performance in an environment characterised by falling profit margins and increasing competition. Manufacturers seem to have fared better than installers. None of the manufacturers reports a reduction in either 'Turnover' or 'Return on Capital' in the past five years, while 12% of installers do in both areas. Moreover, only 7% of manufacturers report a reduction in 'PBIT' in the past five years against 29% of installers.

These differences must, however, be treated with caution. Some of the firms that did not disclose any financial data might have done so because they had poor results in the past five years. Because the amount of data available is quite small and not completely reliable, due to the possibility of bias highlighted above, it seems better to exclude financial indicators of performance from the correlation analysis.

8.1.4 Summary

This section has spelt out the performance measures used in the study, and presented some overall findings that highlight trends in the industry.

The UK optical communications industry is characterised by increasing price-based competition, as falling margins suggest. Falling prices and overall product-costs – while the cost of specific inputs, such as labour, increases - suggest how efficiency gains are actively pursued and achieved. The trends in order-to-delivery time, cycle-time and time-to-market indicate that, in the face of increasing price-based competition, some firms are trying to defend their competitive position by up-grading their offer and moving towards more sophisticated segments of the market. This involves increasing levels of complexity throughout a firm's production process, and justifies deteriorating performance when time is the relevant dimension for measurement.

The data on innovation show how manufacturers and installers differ in terms of their respective involvement in the development of new products and processes. Manufacturers - with research and design and manufacturing as their core activities - are more directly involved in innovation than installers, whose primary role is to pass the outcome of the innovation efforts of the industry chain on to the end-customers. These different roles, and their impact on supply-chain management, are more directly investigated in the follow-up interviews.

Finally, financial performance does not seem to constitute an immediate problem even in the face of toughening competition. The low response rate in this area, however, invites caution in interpreting the data.

8.2 The correlation analysis

The aim of the correlation analysis is to establish the sign and strength of association between co-operation in supply-chain and organisational performance, and to explore the role of technology in shaping the outcomes of co-operative supply relationships. The underlying assumption, supported by interview data, was that the adoption of co-operation as the fundamental principle to regulate supply relationships should lead to improved efficiency and innovation.

Table 8.2 illustrates the variables included in the analysis.

Table 8.2 Correlation analysis: independent and dependent variables

	Variable
Co-operation in supply relationships	
Teamwork across boundaries	Degree of teamwork (from research to installation) across boundaries
Supplier selection	Span of competencies in selection criteria
Commitment to supplier	Degree of commitment to supplier
Supplier's performance evaluation	Span of performance evaluation criteria
Role of the contract	Degree of specification of contract
Conflict resolution	Degree of 'voice'
Organisational performance	
<i>Efficiency</i>	
- Global	A1. Overall product-cost (trend) A2. Order-to-delivery time (trend)
- Partial	B1. Labour productivity (trend) B2. Material productivity (trend) B3. Equipment utilisation (trend) B4. Cycle-time (trend)
<i>Innovation</i>	
- Process	C1. Time-to-market (trend)
- Output	D1. New products developed in the last 12 months D2. New products developed in the last 5 years D3. % of sales of products developed in the last 5 years that are totally New D4. % of sales of products developed in the last 5 years that are up-grading over previous generations D5. % of sales of products developed in the last 5 years that are minor Improvement

The data collected in the questionnaire have been partially transformed for the analysis. In most cases, this required re-coding and the creation of composite variables to measure the level assumed by the operational indicator used in the correlation. For example, one of the operational measures for the process of inter-organisational co-ordination is the 'degree of teamwork' between the firm and its suppliers. The questionnaire asked the firm to grade its degree of collaboration with suppliers in a five level qualitative scale ('very low' to 'very high') for three macro-activities – research and concept design, design and engineering, and installation and distribution. The first step in data processing was to transform the qualitative scale into a quantitative one by re-coding the labels - thus, 'very low = 1', 'low = 2', 'medium = 3', 'high = 4', and 'very high = 5'. The second step was to create a new composite variable, called 'degree of teamwork'. This was achieved by adding the values for the three activities (research and concept design, design and engineering, and installation and distribution) so that each firm could be associated with a number – an index – expressing its overall degree of collaboration with suppliers. The higher this number, the more the process of inter-organisational co-ordination is of the co-operative type.

Similar transformations have been used to derive each of the other process variables and their measurement levels. Table 8.3 summarises the transformation for all the variables included in the analysis.

Table 8.3 Composite variables: an overview

Composite Variable	Questionnaire data	Re-coding	Transformation
Degree of teamwork	Five level qualitative scale ('very low' to 'very high') for three activities - research and concept design, design and engineering, and installation and distribution	From qualitative to quantitative scale (1 = 'very low' to 5 = 'very high')	The sum of the individual scores for the three activities for each firm gives its position in terms of degree of teamwork
Span of competencies in selection criteria	Classification of 13 selection criteria according to intensity of use with potential suppliers ('always', 'in special cases', 'not at all')	From qualitative classification to quantitative: Not at all = 1 In special cases = 2 Always = 3	The sum of the individual scores of the thirteen criteria for each firm gives its position in terms of span of competencies in selection criteria
Degree of commitment to supplier	Classification of 5 transparency practices according to intensity of use with suppliers ('with all', 'with the majority', 'with a minority', 'with none')	From qualitative to quantitative: With none = 1 With the minority = 2 With the majority = 3 With all = 4	The sum of the individual scores of the five transparency practices for each firm gives its position in terms of the degree of reciprocity in information exchange and knowledge transmission
Span of performance evaluation criteria	Classification of 4 evaluation criteria in terms of their growing importance for the firm on a five level scale ('significantly more important' to 'significantly less important')	From qualitative to quantitative scale (1 = 'significantly less important' to 5 = 'significantly more important')	The sum of the individual scores of the four evaluation criteria for each firm gives its position in terms of the span of performance evaluation criteria used
Degree of specification of the contract	Three mutually exclusive options, expressing decreasing levels of specification of the contract ('exhaustive', 'relatively detailed', 'not very precise')	From qualitative to quantitative: Not very precise = 1 Relatively detailed = 2 Exhaustive = 3	No transformation required

Degree of voice in conflict resolution	Three mutually exclusive options, expressing increasing levels of voice ('use lawyers', 're-negotiate the contract', 'sort things out')	From qualitative to quantitative: Use lawyers = 1 Re-negotiate the contract = 2 Sort things out = 3	No transformation required
Overall product-cost	Five level qualitative scale ('significantly increased' to 'significantly decreased') expressing the performance trend	From qualitative to quantitative scale ('significantly decreased' = 1 to 'significantly increased' = 5)	No transformation required
Order-to-delivery time	Five level qualitative scale ('significantly increased' to 'significantly decreased') expressing the performance trend	From qualitative to quantitative scale ('significantly decreased' = 5 to 'significantly increased' = 1)	No transformation required
Labour productivity	Five level qualitative scale ('significantly increased' to 'significantly decreased') expressing the performance trend	From qualitative to quantitative scale ('significantly decreased' = 1 to 'significantly increased' = 5)	No transformation required
Material productivity	Five level qualitative scale ('significantly increased' to 'significantly decreased') expressing the performance trend	From qualitative to quantitative scale ('significantly decreased' = 1 to 'significantly increased' = 5)	No transformation required
Equipment/Plant utilisation	Five level qualitative scale ('significantly increased' to 'significantly decreased') expressing the performance trend	From qualitative to quantitative scale ('significantly decreased' = 1 to 'significantly increased' = 5)	No transformation required
Cycle-time	Five level qualitative scale ('significantly increased' to 'significantly decreased') expressing the performance trend	From qualitative to quantitative scale ('significantly decreased' = 5 to 'significantly increased' = 1)	No transformation required
Time-to-market	Five level qualitative scale ('significantly increased' to 'significantly decreased') expressing the performance trend	From qualitative to quantitative scale ('significantly decreased' = 5 to 'significantly increased' = 1)	No transformation required
New products developed in the last 12 months	Actual number		No transformation required
New products developed in the last 5 years	Actual number		No transformation required

% of sales from products developed in the last 5 years that are totally new	Classification according to four intervals: below 25% of sales 25% to 50% of sales 50% to 75% of sales More than 75% of sales	From interval to rank: below 25% of sales = 1 25% to 50% of sales = 2 50% to 75% of sales = 3 More than 75% of sales = 4	No transformation required
% of sales from products developed in the last 5 years that are up-grading over previous generations	Classification according to four intervals: below 25% of sales 25% to 50% of sales 50% to 75% of sales More than 75% of sales	From interval to rank: below 25% of sales = 1 25% to 50% of sales = 2 50% to 75% of sales = 3 More than 75% of sales = 4	No transformation required
% of sales from products developed in the last 5 years that are minor improvement	Classification according to four intervals: below 25% of sales 25% to 50% of sales 50% to 75% of sales More than 75% of sales	From interval to rank: below 25% of sales = 1 25% to 50% of sales = 2 50% to 75% of sales = 3 More than 75% of sales = 4	No transformation required

The level of measurement of the variables is predominantly ordinal. A high score for an independent variable for a firm corresponds to a strong presence of the ‘network element’ in supply relationships for that firm. The exception is the ‘degree of specification of the contract’, with a high score associated with the predominance of market-oriented mechanisms. In other words, a high degree of specification of the contract is a ‘contra-indicator’ of co-operation between buyer and supplier.

The strength of association between independent and performance variables is expressed by correlation coefficients, with significance measured at both the ‘5’ and the ‘1’ percent levels. In particular, correlation is measured by Spearman’s correlation coefficients, which are consistent with the ordinal level of measurement predominant in the analysis. The sign of the correlation coefficient is consistent with the sign of the association between the variables.

Each independent variable is individually correlated to each performance variable. The analysis is carried out for the whole sample (41 firms) first, and then repeated by discriminating firms on the basis of (a) primary activity (Manufacturers versus Installers) and, (b) size (Small versus Large).

No attempt is made at summarising the independent variables in a single indicator of the overall degree of ‘networking’ for the firm. Similarly, no attempt is made at summarising a firm’s performance by means of a single indicator. The main reason for keeping the analysis at a disaggregated level is that both inter-organisational co-operation and performance are complex multi-dimensional concepts.

As to the independent variables, different aspects of co-operation might be associated with different dimensions of performance. Equally, different performance variables might be more (less) relevant for specific categories of firm. Combining independent and performance variables in single indicators of, respectively, ‘networking’ and performance might hide these differences and a great amount of information would be lost. A fairly disaggregated level of analysis, though less elegant from a formal point of view, seems more appropriate given the richness and complexity of inter-organisational relations.

Another element that works in favour of keeping the analysis as simple and straightforward as possible is the small size of the sample and the need to preserve the reliability of the data, given the level of measurement adopted. More sophisticated types of analysis would have required a larger data set and a more precise level of measurement of the variables to produce meaningful results.

8.2.1 The correlation coefficients

This Section presents in great detail the results from the correlation analysis between co-operation in supply relationships – measured by focusing on firm’s behaviours in the six crucial areas of teamwork across boundaries, supplier selection, commitment to suppliers, supplier’s performance evaluation, role of the contract and conflict resolution – and organisational performance. The key findings are summarised in Section 8.3.

Teamwork across organisational boundaries - Table 8.4 shows the correlation coefficients for teamwork across organisational boundaries and performance.

Table 8.4 Teamwork across organisational boundaries and performance: whole sample

	Degree of Teamwork
<i>Efficiency</i>	
Overall product-cost	-.153
Order-to-delivery time	-.018
Labour productivity	.319
Material productivity	.240
Plant/Equipment productivity	.378*
Cycle-time	.398*
<i>Innovation</i>	
Time-to-market	.028
New products (12 months)	.000
New products (5 years)	-.050
% of sales from totally new products	.003
% of sales from products that are upgrading	.081
% of sales from products that are minor improvement	.240

There is evidence of significant, positive association between the ‘degree of teamwork’ and efficiency measured by cycle-time and plant/equipment productivity. Significant, here and throughout the analysis, means ‘statistically significant’. The significance levels, when appropriate, are indicated in the tables as, respectively, (*) for significance at the five percent level and (**) for significance at the one percent level. The correlation is also positive for labour productivity and material productivity. This suggests that the involvement of suppliers at early stages of a firm’s production process is associated with improved performance in manufacturing, in terms of both time-based efficiency gains and a more efficient use of production inputs.

Table 8.5 shows the same correlation coefficients when primary activity and size are introduced in the analysis

Table 8.5 Teamwork across boundaries and performance: primary activity and size

	Degree of Teamwork			
	Installers	Manufacturers	Small	Large
<i>Efficiency</i>				
Overall product-cost	-.372	.691**	-.414	.620**
Order-to-delivery time	-.126	.165	-.114	.398
Labour productivity	.828**	-.312	.675**	-.129
Material productivity	.114	-.021	.462	-.183
Plant/Equipment productivity	.509*	-.423	.730**	-.354
Cycle-time	.131	.542*	.916**	-.100
<i>Innovation</i>				
Time-to-market	-.804**	.616*	-.260	.497*
New products (12 months)	-.671**	-.213	-.557*	.372
New products (5 years)	-.560*	-.423	-.423	.180
% of sales from totally new products	.010	-.217	.073	-.311
% of sales from products that are upgrading	.174	-.272	.315	-.388
% of sales from products that are minor improvement	.138	.050	.467	-.067

There is still evidence of positive correlation between the degree of teamwork and efficiency, but with significant differences between Installers and Manufactures. For Installers, teamwork across organisational boundaries is significantly and positively associated with partial efficiency gains (labour and equipment productivity). For Manufacturers the degree of teamwork is negatively associated with input-based measures of efficiency but positively and significantly associated with global ones.

A possible explanation is the different organisation of the production process. Given that every installation project is unique and there are few opportunities for standardisation of the production process, installers’ major interest in seeking increasing degrees of teamwork is limited to the efficient use of individual resources. Time is relevant, but not in the sense that a constant and uninterrupted flow of activities - and output - must be guaranteed for efficiency purposes. On the contrary, Manufacturers tend to adopt standardisation and the principles of mass-production as the basis for manufacturing organisation. A smooth, constant and finely tuned flow of activity – from the acquisition of inputs to the delivery of the output – is essential to guarantee increasing levels of efficiency, and co-operation with suppliers is instrumental in

achieving a high degree of control over the production environment. Global and time-based measures of efficiency become more relevant than simple input-based ones.

A major difference with the data in Table 8.4 is the presence of significant correlation between teamwork across organisational boundaries and innovation. Again, there are differences between Installers and Manufacturers. For Installers, the degree of teamwork is negatively and significantly associated with time-to-market and with the number of new products developed in the past 12 months and 5 years. The association with time-to-market is positive and significant for Manufacturers.

In interpreting these data, it is important to remember that Installers are not the key actors in the overall industry innovation process and this may influence the significance of the results. The negative association between the early involvement of suppliers and innovation might be explained in terms of this structural, industry-based, division of tasks between Manufacturers and Installers when it comes to innovation.

When discriminating according to size, differences emerge between the two groups. For Small firms, the degree of teamwork across boundaries is positively and significantly associated with input-based measures of efficiency and with cycle-time. Large firms show very low - if not negative - association between teamwork across boundaries and input-based efficiency indicators. The correlation is positive and significant with overall product-cost (a global measure of efficiency).

As to innovation, for Small firms teamwork across organisational boundaries is negatively correlated to measures such as time-to-market, new products developed in the past 12 months (significantly), and new products developed in the past 5 years, which all relate to a direct involvement of the firm in research and development. The correlation is positive, though not significant, for measures expressing innovation in terms of the contribution of new products to the overall company sales. For Large firms, the degree of teamwork is positively correlated to innovation measures that indicate a direct involvement of the firm in research and development. The correlation is significant in the case of time-to-market.

In trying to interpret the data on Small and Large firms, it is important to remember how this distinction partially overlaps with that between Installers and Manufactures (see Figure 7.2 and Table 7.2 in Chapter 7). In other words, the explanations offered in analysing the data for Installers and Manufacturers may also apply to similar patterns of behaviours shown, respectively, by Small and Large firms. The two discriminating variables – size and nature of activity – are not, however, perfectly correlated. This means that the observed differences between Small and Large firms are not entirely explained by the nature of activity. These other factors remain, at this stage, obscure and will constitute an object for further enquiry in the follow-up interviews in Chapter 8.

Supplier selection – Table 8.6 shows the correlation coefficients for the span of competencies in selection criteria and performance.

Table 8.6 Span of competencies in selection criteria and performance: whole sample

	Span of competencies in selection criteria
<i>Efficiency</i>	
Overall product-cost	.052
Order-to-delivery time	.325*
Labour productivity	-.059
Material productivity	.148
Plant/Equipment productivity	.169
Cycle-time	.452**
<i>Innovation</i>	
Time-to-market	.339
New products (12 months)	.138
New products (5 years)	.227
% of sales from totally new products	-.144
% of sales from products that are upgrading	.005
% of sales from products that are minor improvement	.147

There evidence of significant, positive association between the span of competencies in selection criteria and order-to-delivery time and cycle-time. The use of selection criteria based on both past and potential performance seems connected to opportunities for time-based efficiency improvements throughout a firm’s production process. In other words, the chain of activities that contributes to a firm’s output appears to run more smoothly and in tune.

The correlation with innovation is always very low. The only exception is with time-to-market – which is, however, not significant. The link between the adoption of a forward-looking approach in selecting suppliers and time-based performance gains is, nonetheless, reinforced.

Table 8.7 shows the same correlation coefficients when primary activity and size are taken into account.

Table 8.7 Span of competencies in selection criteria and performance: primary activity and size

	Span of competencies in selection criteria			
	Installers	Manufacturers	Small	Large
<i>Efficiency</i>				
Overall product-cost	.213	-.065	.191	-.064
Order-to-delivery time	.124	.537*	-.025	.545*
Labour productivity	.099	-.180	.175	-.229
Material productivity	.483*	-.129	.490*	-.080
Plant/Equipment productivity	-.037	.294	.055	.252
Cycle-time	-.059	.715**	.359	.464*
<i>Innovation</i>				
Time-to-market	-.012	.659**	.270	.344
New products (12 months)	.279	-.329	-.231	.184
New products (5 years)	.579	-.453	.156	.140
% of sales from totally new products	-.309	.009	-.036	-.363
% of sales from products that are upgrading	-.042	.053	.059	-.127
% of sales from products that are minor improvement	-.106	.319	-.496*	.584**

There is evidence of positive correlation between the span of competencies in selection criteria and efficiency, but with significant differences between Installers and Manufactures. For Manufacturers, the span of competencies in selection criteria is positively and significantly associated with global and partial measures of efficiency and also with innovation (process). For Installers, the association is positive and significant only with partial efficiency.

When discriminating according to size, differences emerge between the two groups. For Small firms, the span of competencies in selection criteria is positively and significantly associated with partial measures of efficiency whereas for Large firms the association is

positive and significant with both order-to-delivery time (global) and cycle-time (partial).

As to innovation, the correlation for Small firms is generally very low, if not negative (significantly so for the % of sales from products that are minor improvement). For Large firms, the correlation is positive and significant for the % of sales from products that are minor improvement (innovation output).

Commitment to the supplier - Table 8.8 shows the correlation coefficients for the degree of commitment to suppliers and performance for the whole sample.

Table 8.8 Commitment to the suppliers and performance: whole sample

	Degree of commitment to suppliers
<i>Efficiency</i>	
Overall product-cost	.338*
Order-to-delivery time	.087
Labour productivity	.199
Material productivity	.242
Plant/Equipment productivity	.018
Cycle-time	-.289
<i>Innovation</i>	
Time-to-market	.068
New products (12 months)	.285
New products (5 years)	.282
% of sales from totally new products	-.002
% of sales from products that are upgrading	.135
% of sales from products that are minor improvement	-.118

The degree of commitment to suppliers is positively and significantly correlated only with overall product-cost, an indicator of global efficiency. With all the other efficiency measures, the association is positive (except for cycle-time) but very weak. As for innovation, the degree of degree of commitment to suppliers is positively correlated to indicators that suggest an active involvement in research and development (such as the number of new products in the past 12 months and in the past 5 years), but the association is weak. With other indicators, the correlation is either very weak or negative.

Table 8.9 shows the same correlation coefficients when primary activity and size are taken into account.

Table 8.9 Commitment to suppliers and performance: primary activity and size

	Degree of commitment to suppliers			
	Installers	Manufacturers	Small	Large
<i>Efficiency</i>				
Overall product-cost	.382	.339	.485*	.239
Order-to-delivery time	-.157	.069	.225	-.102
Labour productivity	.001	.401	.184	.202
Material productivity	.328	.243	.099	.315
Plant/Equipment productivity	-.035	.026	-.149	.060
Cycle-time	-.087	-.443	-.378	-.222
<i>Innovation</i>				
Time-to-market	-.091	.086	.674*	-.156
New products (12 months)	.313	.340	.286	.392
New products (5 years)	.437	.018	.189	.262
% of sales from totally new products	.085	-.114	.004	.018
% of sales from products that are upgrading	.245	.056	.124	.122
% of sales from products that are minor improvement	-.110	-.074	-.300	.032

The data do not reveal any major difference between Installers and Manufacturers, and with the overall sample. The degree of commitment to suppliers is still positively correlated with overall product-cost for the two groups. However, the individual coefficients are not statistically significant. There is also evidence of positive association (though not significant) with labour productivity for Manufacturers and with material productivity for both categories.

As for innovation, the data are consistent with that observed for the whole sample. The degree of commitment to suppliers is positively correlated to indicators that suggest an active involvement in research and development (such as the number of new products in the past 12 months and in the past 5 years), but the association is weak. With the other indicators, the correlation is either very weak or negative.

When size is taken into account, the degree of commitment to suppliers is still positively correlated with overall product-cost, and significantly so for Small firms. The general positive - if weak - association with input-based efficiency is confirmed, the only exception being plant/equipment productivity for Small firms. Time-based measures of

efficiency are negatively correlated with the degree of commitment to suppliers, the only exception being order-to-delivery time for Small firms (positive though not significant).

As for innovation, there is a positive and significant association between the degree of commitment to suppliers and time-to-market for Small firms, while the association is negative for Large ones. This is the only major difference between the two groups, with all the other innovation indicators showing a positive but weak correlation. The correlation is, however, always stronger with measures indicating the presence of active research and development such as the number of new products.

Supplier’s performance evaluation - Table 8.10 shows the correlation coefficients for the span of performance evaluation criteria and performance for the whole sample.

Table 8.10 Supplier’s performance evaluation and performance: whole sample

	Span of performance evaluation criteria
<i>Efficiency</i>	
Overall product-cost	-.310
Order-to-delivery time	.238
Labour productivity	-.106
Material productivity	.153
Plant/Equipment productivity	.281
Cycle-time	.615**
<i>Innovation</i>	
Time-to-market	.310
New products (12 months)	.108
New products (5 years)	.103
% of sales from totally new products	.083
% of sales from products that are upgrading	.243
% of sales from products that are minor improvement	.355*

The span of performance evaluation criteria is positively correlated to time-based measures of efficiency, and the association is significant for cycle-time. The results for the other efficiency indicators are inconclusive, the only notable one being a negative (though not significant) correlation with overall product-cost. The span of performance evaluation criteria is also always positively correlated to innovation indicators, with a

significant association for the percentage of sales from products that are minor improvement and a relatively strong one with time-to-market.

Table 8.11 shows the same correlation coefficients when primary activity and size are taken into account.

Table 8.11 Supplier's performance evaluation and performance: primary activity and size

	Span of performance evaluation criteria			
	Installers	Manufacturers	Small	Large
<i>Efficiency</i>				
Overall product-cost	-.271	-.268	-.477*	-.328
Order-to-delivery time	.133	.309	-.130	.513*
Labour productivity	-.001	-.177	.213	-.173
Material productivity	.065	-.013	.410	.001
Plant/Equipment productivity	.191	.209	.442	.392
Cycle-time	.042	.718**	.755**	.574**
<i>Innovation</i>				
Time-to-market	-.528*	.507*	-.089	.267
New products (12 months)	-.047	.580*	-.295	.242
New products (5 years)	-.018	.513	-.135	.268
% of sales from totally new products	-.034	.219	.128	-.037
% of sales from products that are upgrading	-.488*	.190	.306	.156
% of sales from products that are minor improvement	-.353	.249	-.013	.690**

When discriminating on primary activity, differences emerge between Installers and Manufacturers. The span of performance evaluation criteria is still positively correlated with time-based measures of efficiency for both groups, but the association is significant and very strong for Manufacturers. The negative correlation with overall product-cost found for the whole sample is also confirmed for both Installers and Manufacturers.

As for innovation, the span of performance evaluation criteria is almost always negatively correlated with innovation for Installers, while the opposite is true for Manufacturers, with significant levels for time-to-market and new products developed in the past 12 months.

When discriminating on size, differences emerge between Small and Large firms. The span of performance evaluation criteria is positively and significantly correlated with time-based measures of efficiency for both groups, the only exception being order-to-

delivery time for Small firms. The negative correlation with overall product-cost found for the whole sample is also confirmed for both Small and Large firms, and it is significant for the former.

As for innovation, the span of performance evaluation criteria is almost always negatively correlated with innovation for Small firms, the only exceptions being the percentage of sales from totally new products and the percentage of sales from products that are upgrading. The opposite is true for Large firms, with significant levels for the percentage of sales from products that are minor improvements.

Role of the contract - Table 8.12 shows the correlation coefficients for the role of the contract and performance for the whole sample.

Table 8.12 Role of the contract and performance: whole sample

	Degree of specification of the contract
<i>Efficiency</i>	
Overall product-cost	-.356*
Order-to-delivery time	-.305
Labour productivity	.515**
Material productivity	.567**
Plant/Equipment productivity	.458**
Cycle-time	.066
<i>Innovation</i>	
Time-to-market	-.587**
New products (12 months)	.182
New products (5 years)	.053
% of sales from totally new products	.184
% of sales from products that are upgrading	.448**
% of sales from products that are minor improvement	.244

The degree of specification of the contract shows very strong positive correlation with input-based measures of efficiency and negative correlation with the two global efficiency indicators, overall product-cost (significant) and order-to-delivery time. It is also negatively and significantly correlated with time-to-market, the measure of innovation that focuses on the process and incorporates time as a relevant dimension. With all the other innovation indicators, the correlation is positive, though significant only for the percentage of sales from products that are upgrading. As previously mentioned in this Chapter, the higher the degree of specification of the contract, the

more market-oriented the relationship between the firm and its suppliers. These data seem to suggest that market-oriented forms of governance in supply relationships are negatively associated with performance – either efficiency or innovation - when this is measured globally and when time is a relevant dimension, but the opposite is true when partial measures are adopted.

Table 8.13 shows the same correlation coefficients when primary activity and size are taken into account.

Table 8.13 Role of the contract and performance: primary activity and size

	Degree of specification of the contract			
	Installers	Manufacturers	Small	Large
<i>Efficiency</i>				
Overall product-cost	-.148	-.510*	-.168	-.455*
Order-to-delivery time	-.230	-.382	.038	-.374
Labour productivity	.280	.837**	.427	.492*
Material productivity	.337	.688**	.260	.667**
Plant/Equipment productivity	.345	.434	.363	.485*
Cycle-time	-.012	-.045	.532*	.003
<i>Innovation</i>				
Time-to-market	-.678*	-.673**	-.370	-.663**
New products (12 months)	-.618**	.219	-.521	.292
New products (5 years)	-.591*	.440	-.610*	.436
% of sales from totally new products	-.503*	.627**	-.324	.706**
% of sales from products that are upgrading	-.171	.773**	-.215	.791**
% of sales from products that are minor improvement	.224	-.052	.255	.167

The patterns for Installers and Manufacturers are similar, and consistent with the general findings. The degree of specification of the contract is positively correlated with input-based measures of efficiency, and significantly so for Manufacturers. It is also negatively correlated with order-to-delivery time, cycle-time and overall product-cost (significantly for Manufacturers). This confirms the idea that market-oriented mechanisms are negatively associated with global measures of efficiency and with measures that incorporate time, but there is evidence of positive association at a more ‘localised’ level.

The relationship between the degree of specification of the contract and innovation is consistently negative for Installers and significantly so for time-to-market, new products

in the past 12 months, new products in the past 5 years and percentage of sales from totally new products.

The evidence is more mixed for Manufacturers. The degree of specification of the contract is negatively associated with time-to-market (significantly), but it is positively correlated with most of the other measures. The positive correlation is significant for the percentage of sales from totally new products and for the percentage of sales from products that are upgrading.

Conflict resolution – Table 8.14 shows the correlation coefficients for conflict resolution and performance for the whole sample.

Table 8.14 Conflict resolution and performance: whole sample

	Degree of 'voice' in conflict resolution
<i>Efficiency</i>	
Overall product-cost	.205
Order-to-delivery time	-.168
Labour productivity	.211
Material productivity	-.103
Plant/Equipment productivity	-.079
Cycle-time	-.477**
<i>Innovation</i>	
Time-to-market	.009
New products (12 months)	.353
New products (5 years)	.275
% of sales from totally new products	.015
% of sales from products that are upgrading	.022
% of sales from products that are minor improvement	-.152

The degree of voice in conflict resolution is negatively associated with time-based efficiency measures, and the correlation is significant with cycle-time. The other data are inconclusive. As for innovation, the association is generally positive (the only exception being the percentage of sales from products that are minor improvement) but weak. Two indicators – new products in the past 12 months and new products in the past 5 years - show comparatively high coefficient, though not significant ones.

Table 8.15 shows the same correlation coefficients when primary activity and size are taken into account.

Table 8.15 Conflict resolution and performance: primary activity and size

	Degree of 'voice' in conflict resolution			
	Installers	Manufacturers	Small	Large
<i>Efficiency</i>				
Overall product-cost	-.101	.592**	.183	.633**
Order-to-delivery time	-.532*	.089	-.050	-.121
Labour productivity	.490*	-.055	-.054	.069
Material productivity	.222	-.436	-.621**	-.009
Plant/Equipment productivity	-.235	.000	.198	-.644**
Cycle-time	-.611**	-.503*	-.578*	-.532*
<i>Innovation</i>				
Time-to-market	-.222	.131	-.188	.303
New products (12 months)	.401	.404	.453	.231
New products (5 years)	.341	.126	.186	.056
% of sales from totally new products	.290	-.274	.332	-.260
% of sales from products that are upgrading	.408	-.298	.307	-.121
% of sales from products that are minor improvement	-.369	-.079	-.121	-.423

The degree of voice in conflict resolution is negatively and significantly associated with time-based efficiency measures for both Installers and Manufacturers. The only exception is order-to-delivery time for Manufacturers, with a positive – though weak – association. The degree of voice in conflict resolution is also positively correlated with labour productivity for Installers, while all the input-based measures of efficiency show negative correlation in the case of Manufacturers. Another difference between the two groups is that Manufacturers show a positive and significant association between the degree of voice in conflict resolution and overall product-cost, while the correlation is negative for Installers.

The data on innovation show a positive association – though a not significant one – for new products in the past 12 months and new products in the past 5 years in both groups. Installers also show positive (not significant) association with the percentage of sales form totally new products and with the percentage of sales from products that are upgrading, while the correlation is negative for Manufacturers.

When size is taken into account, the degree of voice in conflict resolution is negatively associated with time-based efficiency measures for both Small and Large firms. The correlation is significant for cycle-time in both cases. The degree of voice in conflict resolution is also negatively correlated with input-based measures of efficiency. The correlation is significant for material productivity for Small firms and plant/equipment productivity for Large ones. However there is evidence of positive correlation between the degree of ‘voice’ in conflict resolution and overall product-cost, and the association is statistically significant for Large firms.

The data on innovation show a positive association – though a not significant one – for new products in the past 12 months and new products in the past 5 years in both groups. Small firms also show positive (not significant) association with the percentages of sales from totally new products and with the percentage of sales from products that are upgrading, while the correlation is negative for Large ones.

8.3 Network supply relationships and organisational performance in the UK optical communications systems industry

The major objective of the research is to test the linkage between governance forms in the supply-chain – and co-operation in particular – and organisational performance. The basic assumption is that co-operative supply-relationships boost both efficiency and innovation. The study also investigates the role of technology as environmental variable affecting both governance and performance. Does technology have an impact?

The UK optical communications systems industry offers interesting insights into these issues. In our sample, the two groups of manufacturers and installers can be associated with different technological environments. Manufacturers represent the mature technological environment, whereas installers represent the dynamic one. By discriminating between these two groups, the impact of the degree of maturity of the technology on the relationship between governance and performance can be investigated.

Table 8.16 presents the key findings from the correlation analysis between co-operation in supply relationships – measured by focusing on firm’s behaviours in the six crucial areas of teamwork across boundaries, supplier selection, commitment to suppliers, supplier’s performance evaluation, role of the contract and conflict resolution – and organisational performance. Table 8.16 shows the signs of the correlation coefficients for the two groups of manufacturers – the mature technological context - and installers – the dynamic technological context - when the association between co-operation in the supply-chain and performance is statistically significant.

Table 8.16 Correlation analysis: key findings

		CO-OPERATION IN SUPPLY RELATIONSHIPS							
		Teamwork across boundaries		Span of selection criteria		Span of performance evaluation criteria		Degree of specification of the contract	
		Manufact	Installers	Manufact.	Installers	Manufact	Installers	Manufact	Installers
P E R F O R M A N C E	Efficiency (global)	(+)		(+)		(+)			
	Efficiency (partial)		(+)	(+)	(+)			(+)	
	Innovation output					(+)	(-)	(+)	(-)
	Innovation process	(+)	(-)	(+)		(+)	(-)		

On the basis of the differences between manufacturers and installers, we maintain that at a general level the following relationship exists between co-operative governance in the supply-chain and organisational performance:

The network supply-chain has a positive impact on efficiency (both global and partial) and innovation when the core technology of the firm is established and mature. When a radically new technology is still emerging, the network supply-chain has a limited positive impact on efficiency (partial only) and a negative one on

innovation. In emergent industries, the network supply-chain can hamper and delay technological development.

Technology, and in particular the degree of maturity of the core technology of the firm, is a fundamental variable affecting not only governance mechanisms (as Shown in Chapter 7), but also performance outcomes. One question, however, emerges from the combined analysis of the results from the survey and the correlation analysis. If it is true that ‘technology matters’ and the adoption of the network supply-chain translates into significant efficiency and innovation gains only in technologically mature contexts, why are firms in technologically dynamic contexts – such as many installers in the UK optical communications systems industry – moving from market-oriented to co-operative forms to govern supply relationships? What benefits are they pursuing?

The answer to these questions comes from a closer analysis of firms’ behaviours in the UK optical communications systems industry, supported by an in-depth study of six exemplary cases representative of various positions within the industry. This analysis is the focus of Chapter 9.

CHAPTER 9 – THE FOLLOW-UP INTERVIEWS

So far, our study of the UK optical communications systems industry has highlighted that the degree of maturity of the technology has an impact on the relationship between co-operation in supply relationships and organisational performance. In particular, Chapter 7 shows how manufacturers – the representatives of a mature technological environment – and installers – the representatives of a more dynamic technological environment – differ in their approach to co-operation in the supply-chain. In other words, the degree of maturity of the core technology of the firm affects the form of governance – in this case of co-operation – used in supply relationships.

Chapter 8 reinforces the idea that ‘technology matters’ and shows how the adoption of the network supply-chain to govern supply relationships translates into significant efficiency and innovation gains only in technologically mature contexts. If this is true, why are firms in technologically dynamic contexts – such as many installers in the UK optical communications systems industry – moving from market-oriented to co-operative forms to govern supply relationships as shown in Chapter 7? What benefits are they pursuing?

The answer to these questions comes from a closer analysis of firms’ behaviours in the UK optical communications systems industry, supported by an in-depth study of six exemplary cases representative of various positions within the industry. The six cases are introduced by a brief description of the sample and interview methodology, with information about the interviewees, the interview structure and the nature of the questions.

9.1 Case sample and interview structure

Access to firms was first sought during the survey by means of a specific question. All the respondents who agreed in principle to follow-up interviews (13 firms) were contacted by telephone. Out of this round of preliminary contacts, a sample of six firms was selected.

The composition of the sample is influenced by the nature of the issues under investigation, and offers a **comprehensive and balanced mix of different perspectives**. All the relevant positions – manufacturers, installers, and large and small firms - are represented and this contributes to the validity of the final analysis and discussion.

The sample includes two manufacturers of components – a general provider and a specialist one - and four systems installers. While the difference between general and specialist providers emerged quite clearly as potentially meaningful to discriminate among manufacturers, no clear discriminating factor could be inferred for installers. As a consequence, the guideline in determining the number and types of firms included in this group was to try and capture as much variety as possible. This was achieved by doubling the number of installers relative to manufacturers and by selecting firms with obvious different attributes in terms of size and location. Table 9.1 shows the final composition of the sample, with some key data for each firm.

Table 9.1 Key characteristics of the firms included in the sample

Name ¹	Location	Size (employees and turnover)	N. of employees in purchasing	Change in strategy	Independ ent or Group	Type of strategy
Company A	Hampshire	203 £ 20 m	5	Introduction of supplier quality rating Early involvement in design process	Group	General manufacturer
Company B	Hampshire	135 £ 16.5 m	2	Reorganisation Change in reporting structure	Group	Specialist manufacturer
Company C	Buckinghamshire	50 £ 2.4 m	3	NO	Independe nt	Approved installer
Company D	West Midlands	79 £ 4.1 m	2	NO	Independe nt	Approved installer
Company E	Dorset	22 £ .97 m	3	Introduction of quality system Segmentation	Independe nt	Approved installer
Company F	Surrey	30 £ 1.3m	3	NO	Independe nt	Approved installer

The interviews were semi-structured, with questions focusing on a few specific issues:

- The general strategy of the firm and its impact on purchasing strategy
- The firm’s attitude towards co-operation in supply-chain management and its key supply practices – including the role of the contract
- Innovation and its potential sources

¹Fictitious names are used to conceal the real identity of the firms. The interviewees proved, in general, quite open and willing to provide detailed information, provided that confidentiality is guaranteed in public presentation of the data.

Two interviews were carried out in each firm, one with the person in charge of purchasing and one with a senior manager². This reflected our need to access both general information about the strategy and competitive position of the firm, and specific details about its purchasing arrangements and supply relationships. With a few exceptions, the same questions were asked to both interviewees, in order to capture meaningful differences. Each interview lasted on average 50 minutes. When possible³ a tape-recorder was used to integrate and complement interview notes.

9.2 The mini-case studies

The frame of the case studies replicates the structure of the interview, so that the general strategy of the firm and its impact on the firm's approach to purchasing provide a background for its supply-chain management practices and its position on innovation. The presentation makes extensive use of direct quotations from interview notes and transcripts in order to preserve the richness of the original data.

The case studies are divided into two groups, contrasting the case of manufacturers with that of installers. This distinction reflects their different approach to co-operation as emerged in the survey (see Chapter 7), and constitutes a key element in the interpretation of the data. Each case is also labelled in a way that evokes the firm's general attitude to co-operation in supply-chain management. These labels derive from the theoretical interpretation of the data, and should facilitate comparisons between cases.

9.2.1 The case of manufacturers

Two firms represent the group of manufacturers of fibre-optic components. Company A is a general manufacturer while Company B is a specialist provider. This distinction offers a key to interpret differences in behaviours between the two, and highlights

² Given the small size of the firms, in all but one case the senior manager interviewed was the Managing Director.

³ Subject to the consent of the interviewee and the circumstances of the interview.

factors that may influence a firm's approach to supply relations. The two manufacturers share a few characteristics, such as being part of bigger organisations.

COMPANY A: THE PARTNERSHIP INSTIGATOR

General and purchasing strategy - Company A underwent a major strategic change following its acquisition in 1996 by a multinational group, and the incorporation of five managerial figures at the top level - including finance, operations, and quality. After six months, the position of purchasing manager was created for the first time in the company history. The strategy pursued by the firm is "expanding volume wherever we can". To increase their appeal, all the products come with a long-term warranty. Apart from direct sales to OEM and a proprietary distribution system, the company relies heavily on a network of registered installers. This network is a critical area for growth in the future, and the firm's approach is to support its certified installers with "training and pricing".

Supply-chain management – The appointment of a purchasing manager, who replaced a senior buyer, was given a blank-paper mandate to "bring the people up to speed with what was required in purchasing in the long term". The driver driving for reorganising the purchasing function was "lowest cost of acquisition, which incorporates quality and service". A list of preferred suppliers was created by means of a quality rating system and this led to a reduction in the number of suppliers. The best five suppliers (45% of the company's purchasing expenditure) are integrated in a "partnering agreement", which means that they are regularly communicated the firm's aims and are constantly in touch with its marketing and quality functions. The normal contract with the partnering suppliers is two years compared to the average six months for the industry. With all the other firms included in the list of preferred suppliers the company uses "purchasing agreements" instead of traditional contracts⁴ to set a few ground rules and detail the working practices. Different mechanisms are used to monitor supply relationships. Each supplier receives its relevant statistics on performance on a monthly basis. This report is followed by a quarterly review which takes place alternately at the company's premises and at the supplier's "to let them know we are interested". The real check is, however, the annual review when two sets of selection criteria are respectively applied to update the list of preferred suppliers and to select the five "partners". The selection is always based on both past performance and potential for future performance. Location is not relevant.

⁴ The purchasing manager of the company said: "I call them purchasing agreements. I do not like to call them contracts because that's not what they are".

The selection process for the five best suppliers is very tough and based on the criteria listed in Table 9.2.

Table 9.2 Company A: selection criteria for “partnering suppliers”

Supply chain profile
Financially stable and profitable
Commitment to reinvest for future trends
Responsive and accurate info for manufacturing needs
Competitive and market leader in their product group
High quality control performance
Lower the total cost of acquisition
Openness and risk manager/sharer
Design and engineering support
Time to market reduction
Reduction in design & prototype turnaround
Manufacturing led design concepts
Formalisation of agreed working practices
Profit improvement suggestions

The company considers the development of a partnership approach with its suppliers as a fundamental element to secure future success in the face of growing competition. There are, however, external and internal barriers to change. Internal ones are perceived as more demanding to overcome. In the words of the purchasing manager

“There was very much of a reliance upon historical usage and relationships built in 14 or 15 years and that had to be broken. Getting rid of the senior buyer was a necessary step to speed up change.”

Innovation and co-operation with suppliers – The parent company demands that 35% of the firm’s revenues come from new products, so there is strong emphasis on innovation. Suppliers are considered a fundamental element in providing the company with a regular stream of new ideas. They are involved from the early stages of product design, because in

“The market place we cannot always keep abreast of new technologies and new techniques. We do not have all the knowledge. Other manufacturing

companies that use the same suppliers can have good ideas that can be passed on.”

There are still considerable internal barriers because of the involvement of suppliers at the early stages of product design. The purchasing manager said:

“It is my great barrier, I have not been able to break it down completely so far. The suppliers are more than ready to be involved, because if they are involved in design inevitably they are going to get the production. The barriers are from design engineers who feel threatened and see their roles overtaken. They are not prepared to see it as being assisted.”

COMPANY B: THE INDEPENDENT

General and purchasing strategy - Company B underwent a major process of reorganisation in 1997, following a general organisational re-design of the group. In the wave of internal changes, the line of reporting of the purchasing function changed, but there were no discontinuities in the company's purchasing strategy. The company's general strategy is “promoting the case of fibre optics against traditional cables”. Being a specialist provider, the only possibility for growth – given growing competition from general providers – is to develop and support the long-term applications of fibre-optics in the fastest growing niches of the market.

“Our customers continue telling us that lowering system-installation costs is a priority and we have focused our fibre development programs to address their concerns”

Supply-chain management - Even if there has been no clear-cut change in the company's formal strategy towards its suppliers, there is growing recognition of the importance of “maintaining good working relationships with them”. The company has always used lists of preferred suppliers, so that the number of suppliers has been stable in time. Most of the current supply relationships have been in place for the past 5-10 years. Different selection criteria are used according to the importance and nature of the items purchased. Technological potential and innovation capabilities are taken into account selectively. Location is not considered

important. The relationship with a supplier is always based on a written contract, but this is never very detailed and never constitutes the basis for conflict resolution. Performance evaluation gives importance to innovation and new ideas generated by suppliers, but selectively. Supply relationships are monitored regularly with meetings on a quarterly basis followed by an extensive annual review. The development of a highly structured and carefully designed partnership approach is not a priority. A certain degree of co-operation is already in place, and

“Even if there is always scope for improvement, we are quite happy with the way things are. Which is also the way things have always been for us.”

The key driver for future success lies in technical and market developments, and in particular on the viability of fibre-to-the-desk.

Innovation and co-operation with suppliers – A few key suppliers are involved from the early stages of product design, because

“We can learn from them, and it speeds things up at later stages. Suppliers can cut down on what we need to do.”

A positive role for suppliers in bringing about innovation is therefore recognised, but its limitations are also explicitly recognised delineated:

“Suppliers can help, but it is not realistic to think that the kind of radical innovations the industry needs to change gear might come from them.”

9.2.2 The manufacturers: a comparison

Both Company A and B face intense competition, but the pressure is clearly higher for the general manufacturer. The imperative of “selling volume” affects the overall strategy, which revolves around ways of increasing market share and expanding market penetration. Specialist manufacturers face the same pressure on standard products, but find respite in non-standard specialist applications, where competition is based on the technological characteristics and innovation content of the product more than on price. General manufacturers, moreover, disperse their energies over copper and fibre-optic

component, while specialists concentrate on fibre-optics and are more competitive in this area. As a consequence, the big manufacturers tend to develop more aggressive marketing tactics to secure a share of the market.

This difference in competitive pressure partially explains different attitudes towards co-operation with suppliers. It is a vital matter for companies that – like Company A - compete exclusively on cost and need to exploit every available source of competitive advantage. Companies that – like Company B – concentrate on the long-term objective of imposing fibre-optics as the dominant technology in the marketplace are less preoccupied with close co-operation in the supply-chain. Collaboration is welcome, but it is not a matter of survival.

9.2.3 The case of installers

Four firms represent the group of installers.

COMPANY C: THE INFORMAL COLLABORATOR

General and purchasing strategy – Company C is a small company founded 10 years ago by the owner-manager to provide complete LAN and WAN solutions. Its strategy is summarised in the owner's favourite motto: "large enough to cope, small enough to care". Success depends on the ability to strike a balance between growth opportunities in the market and the company's ability to maintain the high standard of quality and service that has allowed it to survive without "becoming the arm of one of the big guys". The competitive frame is one where

"The market is growing, and the problem is not for us, but at the root of the supply-chain because their prices are coming down and they need to do more volume. With our prices it is different. Most of the cost of installation is labour cost, so as far as the customer goes he will not see any reduction in prices. But the big manufacturers are trying to make their customers - the installers - become partners because they would like to tie them in and get their business to secure volumes."

A strategy used by the manufacturers to create a special bond with the installers is by offering a long-term guarantee on their products. In the owner's description:

“Most of the components come from the manufacturers with a guarantee, that is 15-20 years for copper and 2 years for fibre. But to be honest, the guarantee is just a peace of mind, and is there for marketing. It does nothing, given also the speed of technological development in the industry. The first year, the first few days are critical. If it is going to be a problem, it will show up then. It is only a way to gain access to the end market by locking-in the installers in a long-term relationship. We do not want to give away our independence to the manufacturers, and as a small company the only way to do so is to have a strong position in the market and avoid the big guys as much as possible.”

Supply-chain management – Most of the suppliers are specialist providers and this reflects the company's attempt to retain its autonomy:

“A fundamental criterion is good technical support, and in any case we prefer to deal with small and medium sized firms.”

All the suppliers are local, and this is very important to reduce the cost of keeping stocks. The number of suppliers has moderately increased in recent years due to the strong expansion of the business. The contract is not very important, and potential problems are solved amicably.

“In the end – says the MD - it is down to the people. Our key buyer is very good at dealing with people. He does not need to put things down on paper because he knows whom he is dealing with, and they do the same. They know him and things get sorted because of that.”

The senior buyer reinforces this view:

“We have a formal procedure to deal with our suppliers which is part of ISO9000, but whether we stick to it is another matter. We use a list of selected suppliers, and there is a formal quarterly assessment, but things normally happen more effectively out of the formal procedure.”

The company takes a sceptical view on the partnership approach as implemented by general providers of components, which is seen as a threat to its own independence. But it remains, however

“Very keen on co-operation with our suppliers when co-operation is left to the people and not formalised in procedures. People can make things more official, but our way is an efficient way and gives us an edge.”

Innovation and co-operation with suppliers – Co-operation with suppliers is not particular relevant given the special role the company sees for itself in the overall industry innovation process.

“Our fundamental role is to sort out the good from the bad. A lot of people come up with ideas and it is a big melting pot. We just take the best of it and stick to it. We tend to use the same good technologies rather than any fancy novelty that we know is not going to work. There is a lot of scope for great innovation at the component level, but our innovations are small things, low tech, close to the customer’s end.”

The company believes that its fundamental role is to act as “filter” of innovations, and to provide a service to the end customers by helping them to define the characteristics of the system they need. Co-operation with customers is probably more important than co-operation with suppliers, and the company puts great emphasis on its ability to establish good relationships with its customers. The MD summarises the company’s strategy as follows:

“The decision as to what to install is always the installer’s. The customer is at the mercy of the people deciding the specifications. We know before the customer, so we can tell the customer what they need for what they want in terms of functionality of the overall system. We do not use strict contracts. We give a quotation and a time to complete the work. They give us the order, and with no formal contract we carry out the order in our own terms. The decision between fibre and copper comes out of discussion. We know what is available; they know what they want to do with it. We give them the options and their relative costs. Fibre-to-the-desk is normally out of the question because it is so very expensive, and even if fibre companies try to convince us to tell customers

to use fibre, we simply cannot justify the cost. So most of the systems are a mixture, copper within the building and fibre between them.”

COMPANY D: THE WILLING PARTNER

General and purchasing strategy – Company D was founded seven years ago by two ex-BT engineers. Its strategy has always been to get access to the end-market by operating as sub-contractor for bigger firms. A key marketing tool in securing contracts is the close partnership with a few well-known manufacturers, which has in time lead to the development of “an impressive portfolio of approvals”. The company’s registration and certification as approved installer of warranty products is regarded as an important strategic asset. Once a contract is secured, the priority becomes to comply with the specifications and deliver the service required to the best possible standards.

Supply-chain management – Right from the start, the company has developed a close partnership with very few suppliers. This policy has been maintained in time, so that the number of suppliers has not varied much. The suppliers are predominantly big manufacturers of components, typically general providers⁵. Location is not important. Because of the emphasis posed on certification as the building block of the company’s strategy, the terms of the supply relationships are laid down more by the suppliers than by the company in its own right. In other words, this strategy has driven the company into

“Being chosen as a reliable installer in a game decided elsewhere” more often than “being master of our own destiny and having to navigate the turbulent waters of tough competition.”

The conditions of a normal buyer-supplier relationship, with the buyer selecting the supplier, are reversed. In this case, it’s the supplier who “selects” the buyer by granting it the certification of approved installer. The relationship between the company and its suppliers resembles quite closely that between franchisee and franchiser.

“We may be perceived as an appendix of our most powerful suppliers, but it’s working for us and we have no problems with it as long as the business is

successful. We know what our role is, and what is required of us, and we try to be the most professional and reliable of partners. If that means that our future is closely connected to the future of our key suppliers, that is it. When you choose matrimony because of its advantages, you have to take the risks. The alternative is to be on our own in direct competition with a lot of small firms like us, struggling to survive in an environment that is certainly going to become more and more competitive. I do not know whether I would prefer it that way."

Innovation and co-operation with suppliers – Innovation is not a priority, and the company does not even act as "filter" of what works and what does not. Its ability to choose is limited by the close relationship with its suppliers, who often impose the products they want to push on to the market by offering very favourable conditions. This strong dependency puts severe constraints on the company's offer and service, with activities such as system design and technical advisory ruled out from the start.

COMPANY E: THE SCEPTICAL PARTNER

General and purchasing strategy - Company E is a small firm founded by the owner-manager in 1983. The company started as equipment supplier and moved into installation in 1987. Since then, it has been involved in both design and installation of complete systems. Its ability to offer a wide solution, spanning from the definition of the technical characteristics of the system to the solution of the practical problems of installation, is recognised as the primary strategic success factor.

"A lot of people in this industry do not bother and ask the customer. In fact we find that a lot of customers do not want to know, they just say do it. We have always made sure that even if the work does not show anywhere, it is always done technically well, effectively, efficiently and it is clean. (...) Whether we recommend copper or fibre it is horses for courses. If the customer has any ideas of what he wants and where he is going we can guide him. But they do not often do. The average customer is not really interested in the technology

⁵ One of them is Company A.

details. 'Do not blind me with science, give me the system' is the typical attitude."

Because of its remote location, the company has developed a strong local market and deals primarily with medium sized firms. Co-operation with customers is a strategic priority.

Supply-chain management - In 1996 the company revised its purchasing strategy following the introduction of a quality system. Its total purchase was divided into the two classes of standard and specialist supplies, put under separate management. The number of suppliers has slightly decreased since. The composition of the supply base is mixed, with general providers co-existing alongside specialist ones. The reason for this is the growing importance of product range - "the kit we can buy" – relatively to more traditional criteria, such as price, supply regularity, working relationships and service. The impact on purchasing strategy is that:

"We have selected a few big providers for the key components and stick to them. The flip side of the coin is that, because of the warranty system imposed by the big manufacturers, we had to become approved installers and we are now locked in. This is partly balanced by the fact that it mainly applies to copper. For most of the fibre components, the big manufacturers can't really compete on price with the specialists, so we have selected some specialists as well."

Location is not fundamental element. Written contracts are used as a basis for re-negotiation in case of problems. The degree of structuring and formalisation of the mechanisms used to monitor supply relationships depends on the type of suppliers. It is quite high with general providers, while things are managed in a more informal way with specialist ones. The company's philosophy in this area is:

"We need to be close to our suppliers but we do not need a terrible amount of integration. When thinking of other industries, such as the automotive, it's probably an in-between level we are after."

Innovation and co-operation with suppliers – The company feels that its fundamental role in the industry innovation process is to keep up-dated on the technological developments introduced by manufacturers and to test them in the field so that "only the best solutions reach

the market”. This function is naturally connected to the company’s strategy of offering a very wide service to its customers, and acting as the customer’s adviser in defining the technical characteristics of the system. Co-operation with suppliers is:

“Necessary in the sense that we act as intermediaries between the market and the fundamental sources of innovation, so that research efforts point in the right direction. We are the transmission-chain between the customers and the manufacturers, and to do our job properly we should be able to keep our independence of judgement. The problem is that more often than not manufacturers are not really interested. They have a standard product and they want to squeeze it to the limit. All they seem to want from us is to convince the customers that it is the right thing for them as well, which might not always be the case.”

COMPANY F: THE HOSTILE PARTNER

General and purchasing strategy – Company F was founded by the owner-manager 10 years ago and offers a complete service of design and installation of optical communications systems. The company did not follow a precise market strategy, but because soon became deeply involved in a few niches of the market⁶. A distinctive expertise in these areas is now a recognised strategic strength. Customers are divided into two categories, depending on their relative knowledge of the technology.

“On the one hand there are people who are very technically aware of what is available in terms of solutions and have already done a lot of the design work. With these customers, the possibilities to influence the specification of the work are quite limited. At the other extreme, we have customers who are totally ignorant. There is no correlation between the size of a company and its knowledge of the technology, but in the second group the biggest tend also to be very conservative and to retreat in their comfortable areas. Dealing with them requires very specific skills.”

⁶ These are communications systems for the pharmaceutical and banking industries and security systems for the military.

Supply-chain management – The company procurement strategy reflects the particular nature of the projects in its area of expertise. Some of the projects are fairly standard, but others – especially the security systems for the military – require a considerable amount of specialist equipment. The company relies on two main sources of supply. A few key suppliers provide mainstream products for standard installation projects. Price is an important factor, but product range is far more so. Because of the extensive use of long-term warranty, the company became a certified installer for some of its biggest suppliers of standard components. For non-standard applications, the company relies on a number of specialist suppliers - many located in the US. Location is never an issue. The mechanisms used to monitor supply relationships vary depending on the type of supplier. They are quite formalised and structured with general providers, and tend to be very informal with specialists. Access to US specialist providers was firstly secured through personal connections of the owner and has proved a key factor in shaping the company's offer. The possibility to get specialist equipment that is not commonly available in the UK lead to a strong market position in specialist areas. The relationship between the firm and the US suppliers is informally and personally managed by the owner, who regards it as:

“Our best chance to retain our independence from the aggression of the big manufacturers. If we did not have the possibility to offer something rare in the UK, we would probably end up as a powerless pawn in the hands of one of the big players.”

The company takes a very negative view of partnership in supply relations involving general providers of standard components. The purchasing manager, who is in charge of mainstream supplies, shares with the owner the view that:

“The big suppliers - such as X, Y and Z⁷ - are desperately trying to lock-in the installers. We are their revenue generators, but the respect is not there and this is not partnership. This also means that what should be at the core of the business - the technical performance of the system and the fact that it is easy to use - has degenerated into a sale issue where cost and commercial viability dominate.”

⁷ The names of these companies are kept secret for confidentiality reasons, but it is interesting to note that one of them is Company A.

Innovation and co-operation with suppliers – The company is

“In love with the technology. Our mission is to be at the front edge all the time, and to help the diffusion of optical applications by educating the customers and informing them of the huge possibilities it offers. (Co-operation with suppliers is) important to keep informed, even if we do not take active part in the actual innovation process. Because of the close contact with the end-customers, we can help the diffusion of innovation, but we might as well prevent it. It all boils down to one’s own business ethics.”

9.2.4 The installers: a comparison

Companies C and D are examples of extreme approaches to supply-chain management. Company C is a small firm dealing in a very informal way with similarly small suppliers. People and personal relationships are the basis for co-operation. Company D is a small firm dealing in a very formal way with a few big suppliers. The emphasis on approvals and certification leads to a situation where the traditional roles of buyer and supplier are reversed. The supplier carefully monitors the buyer, and the relationship closely resembles that between franchiser and franchisee. The relationship is also very structured and formalised.

Both Company C and D are very happy with their approach, while this is not the case for the other two installers. Company E and F are satisfied with their relationship with specialist suppliers – which is relatively informal and definitely not close to the ‘partnership model’ – and very critical of big manufacturers. Two major complaints are laid at the door of the general manufacturers of standard components. The first is that they are trying to develop a partnership approach with installers only to secure market share, but “behind the nice word – partnership – there is exploitation and dependency”. The second is that, by imposing their own conditions, the big manufacturers are undermining the successful strategy of those installers whose core business is to provide the customers with the “system they need, not the system the manufacturers want us to give them”.

Company F fears that the technological knowledge and expertise that allows it to offer a high quality service to its customers will be ultimately compromised by the pressure on sales sweeping the industry. Tailor-made solutions, individually crafted on the basis of a deep understanding of the customers' specific needs, might be replaced by standardised ones, good for the manufacturers but degrading for the installers, and ultimately unsatisfactory for the users.

9.3 Integrating survey and interviews: a discussion of the case studies

In the light of the information offered by the case studies, it is now possible to address the questions raised by the survey and introduced at the beginning of the Chapter. The major finding from the case studies is that our distinction between manufacturers and installers as representatives of, respectively, a mature and a dynamic technological environment is valid for our sample but is only partially representative of the reality.

The degree of maturity of the technology is, in fact, a variable that cuts across these two groups, so that the real distinction is between *manufacturers and installers operating within a predominantly mature environment* (copper) and *manufacturers and installers operating within a predominantly dynamic environment* (fibre-optics). The remaining part of this Section is devoted to the analysis of inter and intra group differences.

9.3.1 Differences between manufacturers and installers

The survey indicates the firms primarily involved in manufacturing differ from firms primarily involved in installation in their approach to co-operation in the supply-chain. The case studies reinforce the idea that **manufacturers and installers operate in segments of the opto-electronic industry characterised by different levels of competitive pressure.**

Manufacturers of components operate – with the exception of the specialists – in an environment characterised by mass production and standard products and compete on high volumes and low prices. Installers face an expanding market and offer a product –

the design and installation of communications systems – that is never standardised even when based on standard components. Every installation project is inherently different and poses problems of its own, depending on factors such as the technical requirements and overall functionality of the system; the degree of technological knowledge of the customer and its ability to define the specifications of the system; the nature of the installation project in terms of environmental conditions, type of premises, and amount of building work.

Because of the different nature of competition in their industry segment, installers can rely on a wider variety of strategies than manufacturers. They can more easily concentrate on protected niches of the market and pursue successful differentiation strategies. The four case studies offer contrasting examples. Company C concentrates on quality and on its ability to advise small and medium sized customers; Company D focuses on being the ideal sub-contractor and relies heavily on close partnership with a few big suppliers; Company E is similar to company C, but it also exploits a remote geographical location to develop a strong local market; Company F bases its strategy on advanced technological knowledge for specialist applications and on unique connections in the USA.

Fundamental differences in the nature of competition at the level of industry or industry segment can explain differences in purchasing strategies between groups of firms. When competition in the industry segment is based on price, efficiency and cost reduction are paramount for a firm's survival. All available sources of efficiency and cost effectiveness are exploited to the full, and close supply relationships play a fundamental role in securing this objective. Incremental innovation – another source of efficiency gains – can be promoted by integrating the 'best' suppliers in the firm's product development process. **Manufacturers and installers operate in two substantially different competitive environments, and this explains the different approach to the development of network-oriented supply relations observed in the two groups.**

9.3.2 Differences among installers

The case studies indicate that installers differ from manufacturers, but they also differ among themselves in the development of co-operative supply relationships. Qualitative data show that **installers' purchasing approaches vary significantly in terms of supply base composition**. Company C and Company D exclusively deal with a single type of supplier - specialist and general manufacturers respectively. Company E and Company F deal with a combination of both types. **The relative importance of specialist versus general providers seems to be related to differences in approach to co-operation in supply relations.**

The proportion of specialist versus general providers depends, ultimately, on a **company's business strategy** and on the specific driver chosen to compete in the marketplace. **Three types of strategies** emerge from the analysis of case studies. Some installers confine themselves to the role of sub-contractors and are not involved in systems design. This is the case of Company D – the 'Willing Partner' - whose competitive driver is certified quality and reliability as sub-contractor. This strategy has led the company to develop a very close partnership with a few general providers. Company D does not complain about the limitations imposed by the close relationship with its suppliers because its overall strategy is intrinsically consistent and is also successful.

Other installers operate exclusively in a 'small world' of small and medium-sized customers and specialist suppliers. This is the case of Company C - the 'Informal Collaborator' - whose competitive driver is attention to the customers' need and the provision of a very comprehensive service to well-identified types of customers. By confining itself to specialist providers the company avoids the pressures of maintaining a relationship with big manufacturers without being locked-into their competitive game. The price to pay is to keep growth under control - that is, to stick very carefully to the specific and protected niche of the market that is consistent with the strategy.

Finally, some installers find themselves in a more uncertain position. These firms have so far operated in relatively protected areas of the market, but their competitive

advantage is being endangered, if not positively eroded, under the impact of stronger forces. This is the case of Company E and F - who also happen to be the smallest in the sample. Remote location and a very strong position in the local market characterise the success of Company E – the ‘Sceptical Partner’ - and this monopolist advantage does not appear to be immediately threatened. This might explain why, even if the company criticises the manufacturers’ attempt to impose their rules of “ill disguised partnership”, this criticism is not tinged with resentment. The situation changes dramatically for Company F – the ‘Hostile Partner’ - who openly and strongly resents the actions of the big manufacturers. This strong feeling is very likely fuelled by fears that the company’s strategy of tailor-made specialist solutions will not resist the aggression of the ‘volume sellers’, now that they have “a foot in”.

On the whole, this analysis confirms the idea that the degree of maturity of the technology is a variable that cuts across our simplistic distinction between manufacturers and installers. The real difference is between *manufacturers and installers operating within a predominantly mature environment* (copper) and *manufacturers and installers operating within a predominantly dynamic environment* (fibre-optics). Factors such as the level of competitive pressure, the composition of the supply-base and the type of strategy can all be connected to the nature of the core technology of the firm and its degree of maturity.

The general conclusion is that firms in emergent industries – many installers and specialist manufacturers in our study – move from market-oriented to co-operation-oriented governance forms *that are different* from those developed by firms in mature industries and pursue *different objectives*. In other words, there are different types of co-operative supply relationships and they produce different outcomes. The question is what types and what outcomes?

An answer to this question will be suggested in Chapter 10.

9.4 The role of the contract

The survey raises the issue of the role played by written contracts in co-operative supply relationships. The case studies reinforce the impression that **contracts can be used in different ways** and the discriminating factor is not necessarily the adoption of co-operative approaches in supply-chain management.

The case studies highlight a general dislike in the opto-electronic industry for the word ‘contract’, always associated with antagonistic relationships and aggressive behaviours. The majority of the firms interviewed use a written document to detail the rules of supply relations, and often these documents are identified as partnership or purchasing ‘agreements’.

There are, however, notable exceptions. A few firms - such as Companies C and F in some cases - do not put things in writing. There are no written documents to seal deals between these firms and their suppliers, and supply relationships are entirely regulated by means of personal contacts and negotiations. Two common traits characterise these cases. The first one is that they are both small firms dealing with similarly small suppliers; the second is that supply relationships closely resemble a dialogue between experts, given that both the firms and their suppliers are specialist companies. This suggests that in a ‘small world of specialists’ individuals and personalities play a key role. Size and the specialist content of the activity emerge as discriminating factors.

CHAPTER 10 – CONCLUSIONS

This study focuses on the emergence of a new governance form, the network supply-chain, in the UK optical communications systems industry, and concentrates, in particular, on the shift from market-oriented to co-operation-oriented forms governing supply relations in the industry. In doing so, it has two objectives.

The first is to investigate the extent of this change and its contingencies and, in particular, the impact of technology. Optical communications systems is an industry characterised by the co-existence of, and on-going race between, two technologies - ‘established’ copper and ‘emergent’ fibre-optics - and therefore it offers an ideal context to test the role of technology in the development of co-operative forms of governance.

The second objective of the research is to test the linkage between governance forms in the supply-chain and organisational performance. Is it possible to correlate the adoption of co-operation as the fundamental principle governing supply relationships with improvements in efficiency and innovation? Does technology have a significant impact on the relationship between governance forms and performance?

The primary outcome of the study is the identification of two models of co-operative supply relationships, respectively named the exploitative and the explorative model, that take into account the connection between technology, governance mechanisms, and organisational performance. The terms exploitative and explorative are derived from March (1991) and have no intrinsic connotations, negative or positive. The two models presented here are ideal-types that can be found in more or less pure form in real contexts. The exploitative model is consistent with environments where the technology is well established; ‘exploitation’ is the main strategic driver; and efficiency and incremental innovation the predominant objectives.

The explorative model is consistent with environments where a specific technology has not yet established itself as the dominant one; ‘exploration’ is still a strategic priority; and the search for opportunities to diffuse the emergent technology is the fundamental

objective. Both the exploitative and the explorative models need a 'trigger' to develop in contexts previously dominated by market-oriented mechanisms. In other words, the change in governance forms in the supply-chain only occurs in response to an external event or condition.

This Chapter summarises our key findings on the relationship between governance forms in the supply-chain, performance and technology in the UK optical communications systems industry. We also present two ideal-types of co-operative supply relations – namely, the exploitative and the explorative model - and highlight the conditions under which they develop. The degree of maturity of the technology, combined with the firm's technology orientation, plays a crucial role. Finally a few implications of the study for academic research and for practitioners are presented.

10.1 Industry characteristics and the sample

Due to its particular technological dynamics, the optical communications systems industry is a stimulating, if complex, environment for our study. Two interrelated aspects deserve attention. First, firms in opto-electronics have to manage complex technological interdependencies between different technological levels, and in particular between key components – such as lasers, cables and optical assemblies – and generic technologies and materials – such as glass and fibre. Some of these 'participating' technologies are mature – for example, cables - but in other areas there is great scope for radical innovation – for example, in routing and splicing. The logic of interdependencies and the rapid expansion in the range of applications for the technology dictate that, beyond the different degrees of maturity of the participating technologies, optical communications as a whole is an emergent technology. The common view is for opto-electronics to replace traditional copper-based technology sometime in the future. The real issue is one of timing. How quickly is this process going to take?

This leads to our second consideration. Contrary to early expectations, the race between established copper-based technology and emergent fibre-optics in communications systems is far from over. Copper is proving very resilient and is reacting vigorously and

effectively to the substitution threat. This means that, at present, the end-user systems are mostly based on a combination of the two technologies, and the prevalence of one or the other depends ultimately on the degree of sophistication required for a specific application as well as on the discretionary choice of the system designer.

The main implication for our study is that the industry is heterogeneous, that is, populated by firms that differ in significant ways. Apart from the traditional distinction between manufacturers and installers - which is based on the core activity of the firm and corresponds to different levels in the traditional industry supply-chain - firms also differ in terms of their relative involvement with the two competing technologies. Manufacturers split clearly into the two groups of general manufacturers – that is, firms involved in manufacturing activities based on both copper and optical technologies – and specialist ones – that is, firms exclusively involved with optical technology. As for installers, the distinction is less clear cut, because installers need to operate within the realm of both copper and optical technologies to offer complete systems solutions. It is, however, possible to distinguish between installers more or less actively orientated towards the development of the new technology.

Beside the heterogeneity of the firms in terms of primary activity and predominant technological focus (copper versus optical technology), the rapid growth of the market and the expansion in the range of applications makes it difficult to clearly identify the boundaries of the industry. All these factors are taken into account and reflected in our choice of the target population for the study as described in Chapter 6. We defined our target population as all UK firms involved in manufacturing and installation of optical communications systems, with the exclusion of firms involved in activities such as distribution, systems maintenance and equipment testing which are normally included in publicly available data on the industry. The sampling frame was derived by combining two existing lists - the members of the Fibre-optics Industry Association (167 corporate members) and the Fibre-optics, Lasers and Opto-Electronics Directory (126 companies). The total sample consisted of 132 firms.

Alongside secondary data, new empirical data were collected by means of a survey and follow-up interviews. We received 53 questionnaires, of which 41 were usable for the analysis giving a 31% response rate. A preliminary analysis of respondents indicated no major bias in favour of specific categories in terms of size or activity. Size was measured by means of two indicators - annual revenue and employees. According to both indicators, all respondents can be classified as SMEs and this confirms previous industry studies (Brown and Hendry, 1998) which show how the industry is still fragmented, particularly at the top end of the supply-chain.

10.2 Research findings: the relationship between governance forms in the supply-chain, technology and organisational performance

The research has dealt with various aspects relating to the use of co-operation as the fundamental principle for governing supply relationships in the UK optical communications systems industry. These are fully developed in Chapters 7, 8 and 9. The issues that, however, stand out among all others is the association between co-operation in the supply-chain and organisational performance, and the role of technology in shaping the form and the outcomes of co-operative supply relationships.

What is the relationship between governance forms in the supply-chain, organisational performance and technology? To answer this question we studied the correlation – that is, the strength and sign of the association - between the use of co-operation in supply relationships and organisational performance. The underlying assumption, supported by interview data, was that the adoption of co-operation as the fundamental principle to govern supply relationships should lead to improvements in both efficiency and innovation.

The variables used in the analysis to measure co-operation in supply relationships were initially derived from existing literature and subsequently validated by means of interview and other qualitative data collected in the preliminary stages of the research (see Table 10.1). These concerned processes of co-ordination, information transfer, control, and conflict resolution. For performance, the analysis includes two dimensions

of efficiency, cost and time - that is, speed – with measures at both global and partial level. Global efficiency (A1 and A2 in Table 10.1) refers to the whole organisation, whereas partial efficiency (B1 to B4 in Table 10.1) is a measure of the firm’s ability to make the best use of critical resources. Innovation is measured in terms of the output of the overall innovation process (D1 to D5 in Table 10.1) as well as in terms of the speed of the process itself (C1 in Table 10.1). Time-based measures of performance are included in the study because time is a fundamental competitive dimension throughout the industry.

Table 10.1 Independent and dependent variables in the correlation analysis

	Variable
Co-operation in supply relationships	
Teamwork across boundaries	Degree of teamwork across the overall production process (from research to installation)
Supplier selection	Span of competencies in selection criteria
Commitment to supplier	Degree of commitment to suppliers
Supplier’s performance evaluation	Span of performance evaluation criteria
Role of the contract	Degree of specification of contract
Conflict resolution	Degree of ‘voice’ in conflict resolution
Organisational performance	
<i>Efficiency</i>	
- Global	A1. Overall product cost (trend) A2. Order-to-delivery time (trend)
- Partial	B1. Labour productivity (trend) B2. Material productivity (trend) B3. Equipment utilisation (trend) B4. Cycle time (trend)
<i>Innovation</i>	
- Process	C1. Time-to-market (trend)
- Output	D1. New products developed in the last 12 months D2. New products developed in the last 5 years D3. % of sales of products developed in the last 5 years that are totally new D4. % of sales of products developed in the last 5 years that are up-grading over previous generations D5. % of sales of products developed in the last 5 years that are minor Improvement

To take the impact of technology into account, the analysis discriminates between manufacturers and installers. The group of manufacturers represents the technologically

mature context, being predominantly composed of firms whose technological core is copper-based technology and who have diversified into optical technology in response to the threat of substitution¹. The association between the group of installers and the context of a radical emerging technology is less rigorous. An analysis of the characteristics of the firms in the sample, however, offers a few justifications for our choice. First, installers are young firms compared to manufacturers - about 10 years old on average - with little if any history in an exclusively copper-dominated environment. Second, a significant proportion operates – if not exclusively - in sophisticated niches of the market, where being at the forefront of the new technology is a necessary requisite to meet customer needs. Third, information about the strategic mission of the firm and the circumstances connected to its birth – such as, for example, the background of the founder – support our assumption. The interpretation of the results, however, must take into account the imperfect correlation between the group of installers and the context of a radical emerging technology.

The key findings are summarised in Table 10.2. This shows the signs of the correlation coefficients for the two groups of manufacturers (the mature technological context) and installers (the dynamic technological context), where the association between co-operation in the supply-chain and performance is statistically significant.

¹ The specialist manufacturers are excluded from this analysis.

Table 10.2 Correlation analysis: key findings

		CO-OPERATION IN SUPPLY RELATIONSHIPS							
		Teamwork across boundaries		Span of selection criteria		Span of performance evaluation criteria		Degree of specification of the contract	
		Manufact	Installers	Manufact.	Installers	Manufact	Installers	Manufact	Installers
P E R F O R M A N C E	Efficiency (global)	(+)		(+)		(+)			
	Efficiency (partial)		(+)	(+)	(+)			(+)	
	Innovation output					(+)	(-)	(+)	(-)
	Innovation process	(+)	(-)	(+)		(+)	(-)		

On the basis of these results, we maintain that at a general level the following relationship exists between co-operative governance in the supply-chain and organisational performance:

- 1. The network supply-chain – that is, co-operative supply relationships of all types - has a positive impact on efficiency (both global and partial) and innovation when the core technology of the firm is mature.*
- 2. When a radically new technology is still emerging, the network supply-chain has a limited positive impact on efficiency (partial only) and a negative one on innovation.*
- 3. In emergent industries, the network supply-chain can hamper and delay technological development.*

Technology, and in particular the degree of maturity of the core technology of the firm, is a fundamental variable affecting not only governance mechanisms, but also performance outcomes.

The results from the correlation analysis, combined with qualitative data from interviews and case studies, led to the identification of six organisational areas that are critical in the analysis of co-operative supply relationships (teamwork across boundaries, supplier selection, commitment to the supplier, supplier's performance evaluation, role of the contract, and conflict resolution). These are described below, with relevant evidence from the UK optical communications systems industry:

1. *Teamwork across organisational boundaries.* This relates to the existing division of labour between buyer and supplier. The more suppliers are involved and actively participate in the early stages of the overall production process, the more co-operative the nature of the mechanism governing the relationship. Our data on the UK optical communications systems industry show that a significant percentage of firms heavily involve their suppliers in activities such as research and concept design (45%), and in design and engineering (38%). These percentages change when primary activity is taken into account, and become 74% and 59% for manufacturers respectively, and 22% and 19% for installers.
2. *Supplier selection.* This relates to the span of criteria used to select suppliers - the wider the span, including criteria that go beyond past performance to encompass factors such as potential for innovation and technological capabilities, the more co-operative the relationship. Our data show that in the UK optical communications systems industry this span is wide, with time, delivery, quality and price as the building blocks of a multi-dimensional system of selection. These basic criteria are, in fact, complemented by others that express a supplier's potential contribution in areas such as innovation and technological development (34% use this type of criteria regularly and 57% selectively), or reflect its R&D capabilities - 22% (regularly), 54% (selectively). A significant proportion of respondents also use criteria that capture 'soft' dimensions of a supplier's profile, such as its managerial culture and practices - 37% (regularly), and 49% (selectively) - and ease of communication - 62% (regularly), and 32% (selectively).

3. *Commitment to the supplier.* This relates to the level of commitment of the firm towards its suppliers, which is expected to be higher in co-operative relationships, where there is a shared sense of inter-dependence between the two firms. The use of 'transparency practices' constitutes a measure of the level of commitment of a firm to its suppliers. These include open books, exchange of strategically sensitive data, exchange of key personnel, and idiosyncratic investments – that is, supplier-specific investments of both a tangible (for example, shared facilities) and intangible (for example, training) nature. Our data show that 49% of respondents use at least one of these transparency practices, the percentages being 53% and 42% respectively for installers and manufacturers. Also, the most frequently adopted practice is supplier-specific investments for manufacturers and exchange of key personnel for installers.
4. *Supplier's performance evaluation.* This relates to the span of criteria used to evaluate suppliers' performance: the wider the span (beyond cost-reduction, timeliness and compliance to specifications), the more co-operative the relationship. Our data show that in the UK optical communications systems industry new dimensions are taken into account in evaluating suppliers' performance. For example, the contribution offered by suppliers in terms of new ideas for improved efficiency and innovation has become more important in the past five years for 50% of the respondents.
5. *Role of the contract.* This relates to the value given to the contract, either written down in law or in oral form, as a means to specify the expectations of the negotiating parties. Thanks to the protection and enforcement offered by the legal system, the contract is a form of safeguard. Our data show that firms in the UK optical communications systems industry tend to recognise the value of the contract as a mechanism that allows for the rules of the relationship with their supplier to be made explicit. Contracts are, consequently, as detailed as the negotiating circumstances allow.
6. *Conflict resolution.* This relates to the use of legal enforcement - as guaranteed by the contract versus trust-based mechanisms - in case of conflict between buyer and

supplier. The more conflict resolution is based on trust, the more co-operative the relationship. The degree of 'voice' in conflict resolution is our measure of the firm's reliance on trust. Our data show that firms in the UK optical communications systems industry very rarely rely on the legal protection of the contract as the exclusive basis for conflict resolution. Moreover, 50% of respondents 'put the contract aside' in case of conflict with their suppliers and opt for methods exclusively based on trust.

On the whole, our data show that a significant proportion of firms in the UK optical communications systems industry uses co-operation as the fundamental principle to govern supply relationships. This corroborates and reinforces findings from previous studies (Lamming, 1989; Lorenzoni, 1992; Normann and Ramirez, 1993), and confirms that the diffusion of the network supply-chain is not confined to traditional industries with established technologies, such as automotive, but affects high-tech industries and industries where the technology is still at a developmental stage.

The data, however, also show that this pattern is not homogeneous across the industry. Firms differ in terms of the areas most affected by the shift from market-oriented to co-operation-oriented forms of governance and the element that discriminates between groups of firms characterised by different approaches to co-operation is the *degree of maturity of the core-technology of the firm*. Whether a firm is operating within the context of an established technology or of an emergent, dynamic one has an impact on the form of governance used to regulate supply relationships.

10.3 Exploring the relationship between governance, performance and technology: the exploitative and explorative models of network supply relationships

It is not unusual to start a research with a hypothesis to test and end up with a more exploratory piece of work. In our case, we started with the assumption that co-operative governance in the supply-chain should lead to efficiency and innovation improvements

and we set out to test this assumption in a new context, the UK optical communications systems industry. Our analysis, however, moves beyond our initial intent and adds an exploratory edge to the research.

The main result so far is that ‘technology matters’, and the adoption of the network supply-chain to govern supply relationships translates into significant efficiency and innovation gains only in technologically mature contexts. If that is true, why are firms in technologically dynamic contexts – such as many installers and specialist manufacturers in the UK optical communications systems industry – moving from market-oriented to more co-operative forms of governing supply relationships? What benefits are they pursuing?

The answer to these questions comes from a closer analysis of firms’ behaviours, supported by an in-depth study of six exemplary cases representative of various positions within the industry. Firms in emergent industries – which includes many installers and specialist manufacturers in our study – move from market-oriented to co-operation-oriented governance forms that are different from those developed by firms in mature industries and pursue different objectives. In other words, there is more than one kind of co-operative supply relationship and these produce different outcomes. The question is what types and what outcomes?

The UK optical communications systems industry offers an insight into this issue. The follow-up interviews and the case studies offered the opportunity to get a great amount of qualitative data on the actual behaviours and underlying motivations of the different types of firms operating in the industry. Firms in the UK optical communications systems industry fall into one of four categories:

- *General manufacturers:* These are the incumbents, firms originally involved in copper that have diversified into opto-electronics. Copper remains, however, the core technology. The incumbents’ main interest is to maintain their market position by exploiting their investment in copper and, at the same time, keep the development of opto-electronics under control.

- *Specialist manufacturers*: These are the new entrants, firms that have never been involved in traditional copper technology. Their core technology is opto-electronics and their main interest is to promote its development as the future dominant technology.
- *'Technology-neutral' installers*: These are installers that mainly follow market opportunities for growth with no special allegiance to a specific technology. They are, in other words, technology-neutral and tend to operate in the less sophisticated segments of the market. Because copper still is a competitive technology in these market segments, these firms are quite substantially involved with copper technology.
- *'Technology-driven' installers*: These are installers that take an active interest in the development of opto-electronics and consider themselves the ideal promoters for this revolutionary technology. The diffusion and success of opto-electronics is at the centre of their strategy, and their focus on this technology leads them to operate mainly in specialist market niches with sophisticated applications.

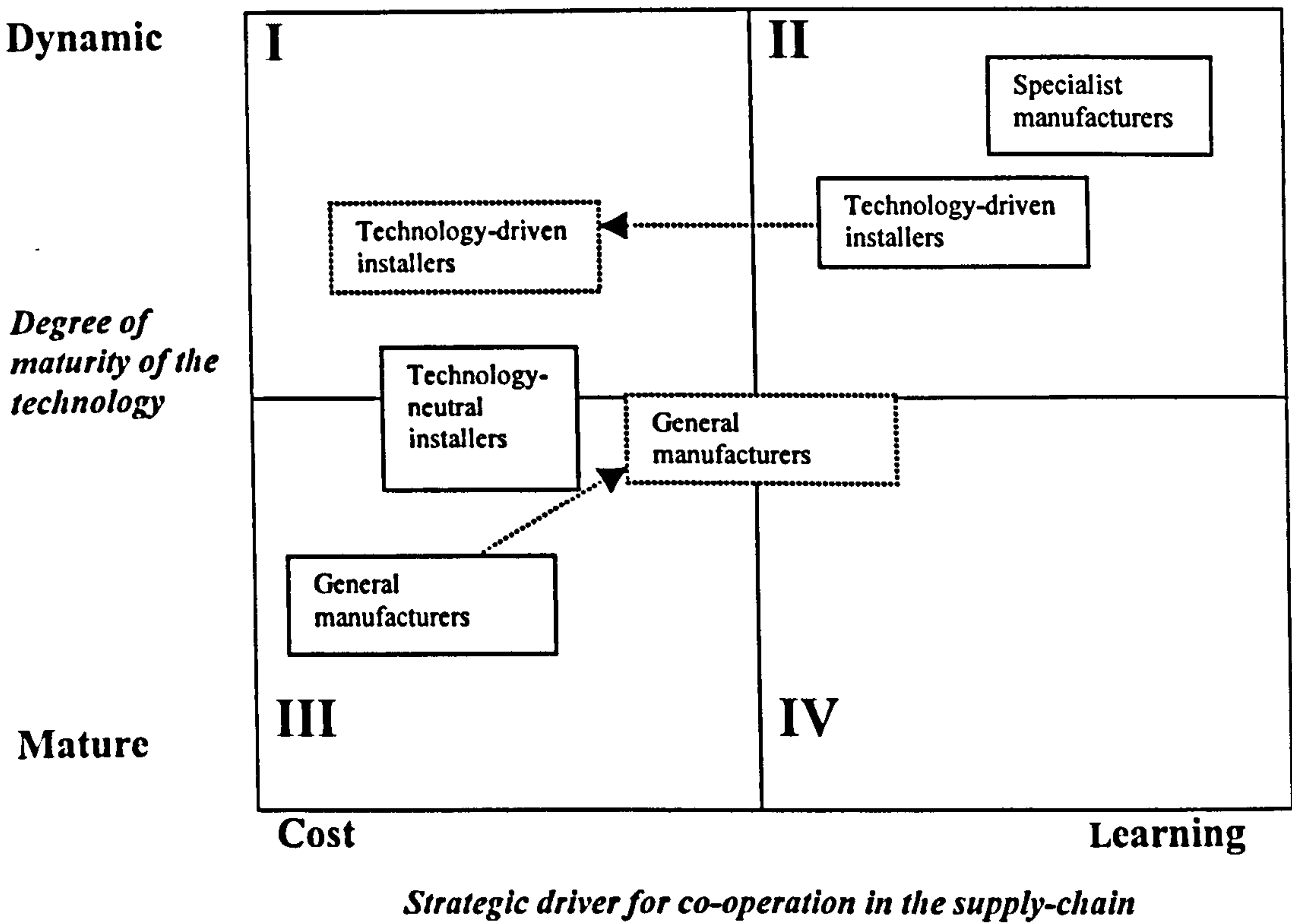
Firms in these four categories show different patterns of behaviour in their approach to co-operation in the supply-chain. More specifically, general manufacturers and technology-neutral installers show similar characteristics from specialist manufacturers and technology-driven installers. Table 10.3 highlights the main differences between these two groups in the six critical areas for co-operation in the supply-chain.

Table 10.3 Behavioural patterns of co-operation in supply relationships among four types of firm

	A General manufacturers & Technology-neutral installers	B Specialist manufacturers & Technology-driven installers
Key areas for co-operation in supply relationships		
<i>Teamwork across organisational boundaries</i>	Suppliers are heavily involved at the early stages of the overall production process and co-ordination is mainly achieved by means of system integration	Suppliers are involved but the relationship is not formalised in structures. Their involvement is based on social interactions at the individual level that lead to high relational capital
<i>Supplier selection</i>	Selection is fundamental in order to secure a high degree of organisational fit and, consequently, promote efficiency and reduce control and conflict resolution costs	Selection is important but organisational fit is not the priority. A certain amount of diversity and non-complementarity is required to generate new knowledge
<i>Commitment to supplier</i>	High degree of commitment at the organisational level, that leads to high relation specific investments and the creation of idiosyncratic relationship knowledge	Low degree of commitment at the organisational level but high at the individual level, which leads to high relational capital
<i>Supplier's performance evaluation</i>	Predominantly formal and structured	Mainly informal and unstructured
<i>Role of the contract</i>	The relationship is between 'organisations'. The contract plays a fundamental role in defining the operational rules and making the expectations of the parties explicit. It is used as a safeguard	The relationship is between 'people'. The contract is relatively unimportant, whereas trust-based personal relationships
<i>Conflict resolution</i>	Heavily engineered integrative conflict management	Informal integrative conflict management. Relational capital is the fundamental mechanism

Besides showing different approaches to co-operation in the supply-chain, firms in the UK optical communications systems industry can also be classified in terms of two dimensions. The first (industry-specific) is the degree of maturity of the technology. The second (firm-related) is the firm's strategic driver for co-operation in the supply-chain. By combining these two dimensions we obtain a positioning matrix in terms of 'mature versus dynamic' and 'cost versus learning'. Fig. 10.1 shows firms' current positions as well as potential movements across these four quadrants.

Fig. 10.1 A positioning matrix



From the analysis of behavioural patterns and positions, we derive the general conclusion that firms in mature technological contexts develop co-operative supply relationships that are different from those developed by firms in dynamic technological contexts, and that they also pursue different objectives. For analytical purposes, we describe these different approaches in terms of two ideal-types - *exploitative* and *explorative* co-operative supply relationships. These terms are derived from March (1991), and refer to the fact that firms that pursue co-operative supply relationships aim to exploit existing technological opportunities, whereas the explorative kind is concerned with learning and innovation in an emerging technological environment. General manufacturers and technology-neutral installers tend to adopt the exploitative model, whereas specialist manufacturers and technology-driven installers tend to adopt the explorative one. Table 10.4 compares the two.

Table 10.4 Two models of co-operation in supply relationships

	EXPLOITATIVE MODEL	EXPLORATIVE MODEL
General market strategy	Cost-leadership and standardisation	Differentiation and/or focus in the sophisticated niches of the market
Strategic orientation	Exploitation – cost-related	Exploration – learning-related
	Protecting existing market position and investments. Defensive attitude	Development of a new market position. Aggressive attitude
Strategic rationale for co-operation	Secure the stability of external environment and control over it	Encourage the development and success of the new technology
Approach to co-operation in the supply-chain	Highly formalised and structured. Requires stability to function smoothly and is intrinsically rigid	Highly informal and unstructured. Thrives in diversity and is intrinsically flexible
Focus of co-operative efforts	Processes matter. Shared identity is fundamental to lower the cost of communication and control, to facilitate co-ordination and to build idiosyncratic knowledge. Procedures and processes are engineered to help develop shared identity	People matter. Shared identity is not encouraged because it suffocates diversity and limits opportunities for new knowledge by denying access to non-complementary or compatible ideas

The two models are similar in that both use vertical-co-operation as a source of competitive advantage (Dyer and Singh, 1998), but the rationale for this is profoundly different. Firms adopting the exploitative model are predominantly engaged in exploitation-oriented strategies and use vertical co-operation mainly to achieve cost-related types of benefits (Hagedoorn, 1993; Kale, Singh and Perlmutter, 2000). Their fundamental objective is to enhance their competitive position through market power and efficiency, to preserve the existing and build on it. Firms adopting the explorative model are predominantly engaged in exploration-oriented strategies and mainly use vertical co-operation to pursue learning opportunities and to access external knowledge (Cohen and Levinthal, 1990). Their fundamental objective is to develop an entirely new

position, not to maintain and preserve an old one. These firms want to be at the forefront of knowledge in their core technological domain and use all available sources to do so.

The need for inter-organisational co-ordination - that is principles that support 'co-ordination among specialised firms' (Kogut, 2000) - is high in both models, but the processes that fulfil this need are different. The exploitative model primarily uses integration of systems to achieve co-ordination. This means that firms put in place formal mechanisms and procedures to regulate their activities and those of their suppliers, and inevitably incur high levels of relation-specific investment. These resources cannot easily be re-deployed without huge costs, and therefore stability and continuity in the relationships are valued. The development of a 'shared identity', the shared sense of purpose between firms engaged in co-operation (Kogut and Zander, 1996; Dyer and Nobeoka, 2000), is also fundamental and actively encouraged. Shared identity reduces the costs of communication and control, facilitates co-ordination and sustains the development of idiosyncratic partnership knowledge.

The explorative model achieves inter-organisational co-ordination by means of spontaneous interactions between people. Firms are close without being integrated, thanks to the on-going dialogue and conversation at the individual level. Formal mechanisms and structures are kept at a minimum, if not completely avoided as a potential obstacle to flexibility and mutual adjustment. People's knowledge of each other and personal trust, both based on past history, are the key mechanisms. Relational capital, defined as the level of mutual trust, respect, and friendship that arises out of close interaction at the individual level between partners (Kale, Singh and Perlmutter, 2000), is the fundamental organisational mechanism for control and conflict resolution. The development of a shared sense of identity is not actively encouraged because shared identity comes at a cost (Kogut, 2000; Gulati and Lawrence, 1999). It, in fact, reduces diversity and limits the opportunities to generate new knowledge.

The two ideal-types can exist in pure forms. More often, however, firms tend to mix elements from the two, or develop only a few aspects of the complex systems of organisational and social processes required to implement the models fully. Some firms

in our sample fall in this category. These are mainly installers that began as technology-driven firms and have moved beyond the boundaries of their original focus, losing their strategic cohesiveness. These firms find themselves in the hands of stronger competitive forces with no clear direction. They are, in Porter's words, "stuck in the middle" (Porter, 1985). This unresolved strategic situation is mirrored by a mixed strategy in the supply-chain, with a combination of elements from the exploitative and the explorative models. It is as if two firms co-existed within the same organisational boundary, one in pursuit of growth and volume expansion, and the other in pursuit of knowledge and focus. Co-operation with suppliers is a major source of tension.

We can now answer the initial question, what types of co-operative supply relationships and what outcomes?

- 1. In mature industries, firms move from market-oriented to co-operative-oriented supply relationships of the exploitative type in pursuit of strategic and cost-related objectives. Exploitation is their predominant strategy.*
- 2. With radical emergent technologies, firms move from market-oriented to co-operative oriented supply-relationship of the explorative type in pursuit of learning-related objectives. Exploration is their predominant strategy.*

In situations where an established technology and an emergent one co-exists, and the technological race is still in place, different models and strategies develop in parallel within the same industry. Technology-driven new entrants (such as the specialist manufacturers and the technology-driven installers in the optical communications systems industry) develop explorative types of co-operation. Incumbents and technology-neutral new entrants (such as those installers in the optical communications systems industry that do not favour one technology over the other but limit themselves to exploit market opportunities) develop the exploitative type.

10. 4 A few research implications

In maintaining the importance of the degree of maturity of the technology in shaping the form of vertical co-operation, we share Hagedoorn's (1993) claim that industry factors are fundamental for the establishment and diffusion of co-operative inter-firm relationships both horizontally and vertically. We also find evidence that different co-operative solutions are enacted to achieve different types of competitive advantage (Hagedoorn, 1993).

Our study in the UK optical communications systems industry has led us to the general conclusion that in mature industries co-operative supply relationships of the exploitative type are developed in pursuit of strategic and cost-related objectives. In emergent industries, co-operative supply relationships of the explorative type are developed in pursuit of learning-related objectives. Our research also shows that the development of co-operation oriented governance forms in supply relationships does not occur spontaneously, but is more likely triggered by an external factor. In the UK optical communications systems industry, the exploitative model is triggered by the substitution threat posed by fibre-optics to copper-based technology, whereas the development of the explorative model is stimulated by the material difficulties of fibre-optics to win the technological race once and for all. Fibre-optics needs powerful champions in the market, and any form of co-operation that promotes its diffusion is critical at this stage.

These results have important implications. First, market-oriented governance forms still play a significant role in governing supply relations in both mature and emergent industries, and the move towards co-operation based ones is not inevitable. Co-operation in the supply-chain is a useful answer under specific circumstances, but it is not *the* ultimate recipe for a firm's success. Also, co-operation in the supply-chain complements but cannot be a substitute for a sound and coherent strategy in the marketplace. Firms stuck in the middle of contrasting business strategies are unlikely to benefit from any type of co-operative supply relationship. Firms also run the risk of choosing the 'wrong' type of co-operative model and therefore of nurturing unrealistic expectations of performance. If a firm adopts the explorative model in the hope to

obtain massive efficiency gains, it should come as no surprise if the results are disappointing. The same applies to any firm that wanted to pursue learning opportunities by means of highly engineered, exploitative types of vertical co-operation. The expected outcome is more likely to be a failure. This risk is even worse for firms that have lost clarity in their strategic vision and, perhaps, do not even know for sure what objectives are worth pursuing in the first place.

The research implications for academics and practitioners become, consequently, clear. In terms of future directions for research, academics are encouraged to adopt a contingency approach to the study of vertical co-operation and recognise explicitly the role of environmental factors – such as the degree of maturity of the technology - on the emergence, diffusion and outcomes of co-operative forms. But there is another, probably better, way to carry this research forward.

Our research takes a limited view on organisational networks (see Chapter 3) to concentrate on dyadic relationships (buyer-supplier relationships) and governance issues (market versus co-operation-oriented mechanisms). The wider network, which is the focus of important theoretical contributions in the fields of Organisational Sociology and Network Analysis, is not our central concern. The ‘supply-chain’ *per se* – that is the entire set of relationships that connect different actors at different levels of the same value chain - is not the focus of our efforts.

This does not mean, however, that the general perspective on organisational networks should not be a matter of concern for future research. In fact, the opposite is true. With our improved understanding of the variables affecting relationships and outcomes at the dyadic level (the micro-level) we can now go back and refine the general model of co-operative behaviours and structures (the macro-level).

More research is needed to validate and refine the two ideal-types of exploitative and explorative co-operation. Other typologies of vertical co-operation might be developed on the basis of a growing body of empirical knowledge. But it is not only about ‘new organisational forms’. It is also a matter of connecting micro and macro levels, dyadic

relationships and wider network structures. Moreover, the idea that network-oriented forms, management and the environment interact and co-develop should be given proper attention. Research should, consequently, proceed in different directions. At the organisational level, the actual processes and competencies required to implement the various forms of vertical co-operation need careful consideration. When the environment is taken into account, other factors besides the degree of maturity of the technology may affect the form of vertical co-operation and its outcome. These factors need to be clearly identified. Finally, new organisational forms and their outcomes generate environmental changes that, in turn, feed new adaptation processes. The dynamic relation between organisation and environment is at present inadequately explored.

Apart from setting a future research agenda on forms of co-operation in vertical relationships, their antecedents and their outcomes, our study also contributes to a particularly controversial area of debate. We refer to the on-going discussion on the complexities of replicating the 'partnership' approach (Lamming, 1993; Dyer, Sung Cho and Chu, 1998), developed with great success in the automotive industry by firms such as Toyota and Honda and applying this in a variety of contexts, involving different kinds of firm, industries and countries. We agree with those who maintain that, although the 'partnership' model – in our view very similar to the exploitative type of vertical co-operation - is well known in its more superficial aspects, the details of the 'how to' implement it and make it work are not (Dyer and Nobeoka, 2000). We also agree that sometimes it is a question of time, of allowing enough time for the complex organisational and social processes that constitute it to develop fully. We also recognise the validity of the arguments that focus on cultural and institutional factors as potential obstacles (Casson, 1991; Dore, 1983; Korczynski, 1998). Our original contribution to this debate is, however, to highlight the possibility that firms might choose a model of vertical co-operation that is not consistent with their technological environment and their pursued strategy, and therefore nurture false expectations of performance.

The implications of the study for practitioners are also very clear. Practitioners are encouraged to develop a deeper understanding of the complexities underlying the choice

of vertical co-operation. It is not only an issue of implementation – no matter how important that might be – but also of choosing the appropriate form of vertical co-operation, in the full knowledge that co-operation in the supply chain does not substitute a sound and coherent business strategy.

REFERENCES

- Abernathy, W.J. and Utterback, J. (1978). "Patterns of Industrial Innovation", *Technology Review*, June-July, pp. 40-47.
- Aldrich, H.E. (1972). "An Organization-environment Perspective on Co-operation and Conflict between Organizations in The Manpower Training System", *Quarterly Journal of Management Development*, 3, pp.11-37.
- Aldrich, H.E. (1976). "Resource Dependence and Inter-organizational Relations: Local Employment Service and Social Services Sector Organizations", *Administration and Society*, 7, pp. 419-454.
- Aldrich, H.E. and Pfeffer, J. (1976). "Environments and Organizations", in Inkeles, A. (ed.) *Annual Review of Sociology*, Vol. 2, pp. 79-105. Palo Alto, CA: Annual Reviews.
- Aldrich, H.E. and Whetten, D.A. (1981). "Organization-sets, Actions-sets, and Networks: Making the Most of Simplicity", in Nystrom, P.C. and Starbuck, W.H. (eds.), *Handbook of Organizational Design*, Vol. 1, pp. 385-408. London: Oxford University Press.
- Alter, C. and Hage, J. (1993). *Organizations Working Together*. Newbury Park, CA: Sage.
- Anderson, J., Håkansson, H. and Johanson, J. (1994). "Dyadic Business Relationships within A Business Network Context", *Journal of Marketing*, 15, pp. 1-15.
- Anderson, P. and Tushman, M.L. (1990). "Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change", *Administrative Science Quarterly*, 35, pp. 604-633.
- Aoki, M., Gustafsson, B. and Williamson, O.E. (eds.), (1990). *The Firm as A Nexus of Treaties*. London: Sage Publications.
- Araujo, L. and Easton, G. (1996). "Networks in Socio-Economic Systems: A Critical Review", Draft Chapter in Iacobucci, D. (ed.), *Business Networks*, Kellogg School of Management, Northwestern University.
- Baden-Fuller, C. and Lorenzoni, G. (1995). "Creating a Strategic Center to Manage A Web of Partners", *California Management Review*, 37, pp. 146-163.
- Barnard, C. (1938). *The Functions of The Executive*. Harvard University Press.
- Barney, J.B. (1990). "The Debate between Traditional Management Theory and Organizational Economics", *Academy of Management Review*, 15, pp. 382-393.
- Barney, J.B. (1991). "Firms Resources and Sustained Competitive Advantage", *Journal of Management*, 17, pp. 99-120.

References

- Barney, J.B. and Hansen, M.H. (1994). "Trustworthiness as A Source of Competitive Advantage", *Strategic Management Journal*, 15, pp. 175-190.
- Barney, J.B. and Ouchi, W.G. (1986). *Organizational Economics*. San Francisco, CA: Jossey-Bass.
- Baxter, L. and Clutterbuck, D. (1989). "Management Control in Supply-Chain JIT", in Voss, C. and Clutterbuck, D. (eds.), *Just-in-Time. A Global Status Report*. London: IFS Publications.
- Benson, J.K. (1975). "The Inter-organizational Network as A Political Economy", *Administrative Science Quarterly*, 20, pp. 229-249.
- Best, M.H. (1990). *The New Competition: Institution of Industrial Restructuring*. Cambridge, UK: Polity Press.
- Bidault, F. and Jarillo, J.C. (1995). "Trust in Economic Transactions". Working Paper for The European Science Foundation Conference on "Industry Structure and Inter-organizational Networks", University of Geneva.
- Blackburn, J.D. (1991). *Time-Based Competition*. Homewood, IL: Business One Irwin.
- Blau, P. (1964). *Exchange and Power in Social Life*. New York: Wiley.
- Boisot, M. and Child, J. (1988). "The Iron Law of Fiefs: Bureaucratic Failure and The Problem of Governance in Chinese Economic Reforms", *Administrative Science Quarterly*, 33, pp. 507-527.
- Bolwijn, P.T. and Kumpe, T. (1990). "Manufacturing in The 1990s - Productivity, Flexibility and Innovation", *Long Range Planning*, 23 (4), pp. 44-57.
- Boudreaux, D.J. and Holcombe, R.G. (1989). "The Coasian and Knightian Theories of the Firm", *Managerial and Decision Economics*, 10, pp.147-154.
- Boje, D.M. and Whetten, D.A. (1981). "Effects of Organizational Strategies and Contextual Constraints on Centrality and Attributions of Influence in Inter-organizational Networks", *Administrative Science Quarterly*, 26, pp. 378-395.
- Bradach, J. and Eccles, R. (1989). "Price, Authority, and Trust", *American Review of Sociology*, 15, pp. 97-118.
- Brown, J. and Hendry, C. (1998). "Industrial Districts and Supply-Chains as Vehicles for Managerial and Organizational Learning", *International Studies of Management and Organisation*, 27 (4), pp.127-157.
- Buchanan, A. (1985). *Ethics, Efficiency, and The Market*. Oxford, England: Clarendon Press.

References

- Buckley, P.J. and Casson, M. (1988). "A Theory of Co-operation in International Business", in Contractor, F.J. and Lorange, P. (eds.), *Co-operative Strategies in International Business*. Lexington Books.
- Burns, T. and Stalker, G.M. (1961). *The Management of Innovation*. London: Tavistock.
- Burt, R.S. (1977a). "Positions in Multiple Network Systems", *Social Forces*, 56, pp. 106-131.
- Burt, R.S. (1977b). "Power as A Social Topology", *Social Science Research*, 6, pp. 1-83.
- Burt, R.S. (1982). *Toward A Structural Theory of Action*. New York: Academic Press.
- Burt, R.S. (1992). *Structural Holes: The Social Structure of Competition*. Cambridge, MA: Harvard University Press.
- Cameron, K.S. and Whetten, D.A. (1983). *Organizational Effectiveness: A Comparison of Multiple Models*. New York: Academic Press.
- Capecchi, V. (1989). "A History of Flexible Specialisation and Industrial Districts in Emilia-Romagna", in Pyke, F., Becattini, G. and Sengenberger, W. (eds.), *Industrial Districts and Inter-firm Co-operation in Italy*. International Institute for Labour Studies, Geneva.
- Casson, M. (1991). *The Economics of Business Culture*. Oxford, England: Clarendon Press.
- Chaffee, C.D. (1988). *The Rewiring of America. The Fiber Optics Revolution*. Academic Press, Inc.
- Charin, A.H. (1983). *Introduction to Optical Fibers*. New York: McGraw Hill.
- Clark, K.B. (1989). "Project Scope and Project Performance: The Effect of Parts Strategy and Supplier Involvement on Product Development", *Management Science*, pp. 1247-1263.
- Clark, K.B. and Fujimoto, T. (1991). *Product Development Performance*. Boston, MA: Harvard School Press.
- Coase, R.H. (1937). "The Nature of the Firm", *Econometrica* N.S., pp. 386-405.
- Coase, R.H. (1988). *The Firm, The Market, and The Law*. Chicago: University of Chicago Press.
- Cohen, W.M. and Levinthal, D.A. (1990). "Absorptive Capacity: A New Perspective on Learning and Innovation", *Administrative Science Quarterly*, 35, (1), pp. 128-153.

References

- Commons, J.R. (1934). *Institutional Economics*. Madison, WI: University of Wisconsin Press.
- Contractor, F.J. and Lorange, P. (eds.) (1988). *Co-operative Strategies in International Business*. Lexington Books.
- Cook, K.S. (1977). "Exchange and Power in Inter-organizational Networks", *The Sociological Quarterly*, 18, pp. 62-82.
- Cooper, A.C. and Schendel, D. (1976). "Strategic Response to Technological Threats", *Business Horizons*, 19, pp. 61-69.
- Cox, A. (1996). *Innovations in Procurement Management*. Boston: Earlsgate Press
- Cusumano, M.A. and Takeishi, A. (1991). "Supplier Relations and Management: A Survey of Japanese, Japanese-Transplant, and U.S. Auto Plants", *Strategic Management Journal*, 12, pp. 563-588.
- Daft, R.L. (1982). "Bureaucratic versus Non-bureaucratic Structure and The Process of Innovation and Change", in Bacharach, S. (ed.) *Research in the Sociology of Organizations*, 1, pp. 129-166. Greenwich, CT: JAI Press.
- Demsetz, H. (1993). "The Theory of The Firm Revisited", in Williamson, O.E. and Winter, S.G. (eds.) pp. 159-178. *The Nature of The Firm. Origins, Evolution, and Development*. New York: Oxford University Press.
- Dess, G.G. and Beard, D. (1984). "Dimensions of Organizational Task Environments", *Administrative Science Quarterly*, 29, pp. 52-73.
- Dewar, R.D. and Dutton, J.E. (1986). "The Adoption of Radical and Incremental Innovations: An Empirical Analysis", *Management Science*, 32, pp. 1422-1433.
- Dore, R. (1983). "Goodwill and The Spirit of Capitalism", *British Journal of Sociology*, 34, pp. 459-482.
- Dosi, G. (1984). *Technical Change and Industrial Transformation*. New York: St. Martin's.
- Dosi, G. et al. (eds.) (1988). *Technical Change and Economic Theory*. London: Pinter.
- Doz, I. and Prahalad, C.K. (1991). "Managing DMNCs: A Search for A New Paradigm", *Strategic Management Journal*, 12, Special Issue, pp. 145-164.
- Durkheim, E. (1933). *The Division of Labor in Society*. G. Simpson trans. New York: Free Press.

References

- Dyer, J.H. (1996). "Specialized Supplier Networks as A Source of Competitive Advantage: Evidence from the Auto Industry", *Strategic Management Journal*, 17, pp. 271-291.
- Dyer, J.H. (1997). "Effective Inter-firm Collaboration: How Firms Minimise Transaction Costs and Maximise Transaction Value", *Strategic Management Journal*, 18 (7), pp. 535-556.
- Dyer, J. and Ouchi, W.G. (1993). "Japanese-style Partnerships: Giving Companies A Competitive Edge", *Sloan Management Review*, 35 (1), pp. 51-63.
- Dyer, J.H., Sung Cho, D. and Chu, W. (1998). "Strategic Supplier Segmentation: The Next 'Best Practice' in Supply-Chain Management", *California Management Review*, 40 (2), pp. 57-75.
- Dyer, J.H and Singh, H. (1998). "The Relational View: Co-operative Strategy and Sources of Interorganizational Competitive Advantage", *Administrative Science Quarterly*, 23, (4), pp.660-679.
- Dyer, J.H. and Nobeoka, K. (2000). "Creating and Managing a High-performance Knowledge Sharing Network", *Strategic Management Journal*, 21, (3), p. 345.
- Easton, G. (1992). "Industrial Networks: A Review", in Axelsson, B. and Easton, G. (eds.), *Industrial Networks: A New View of Reality*. London: Routledge.
- Ebers, M. (ed.) (1997). *The Formation of Inter-organization Networks*. Oxford: Oxford University Press.
- Eccles, R. and Crane, D. (1988). "Managing through Networks in Investment Banking", *California Management Review*, 27, pp.176-195.
- Eisenhardt, K.M., (1995). "Building Theories From Case Study Research", in Huber, G.P. and Van de Ven, A.H. (eds.). *Longitudinal Field Research Methods. Studying Processes of Organizational Change*. London: Sage Publications.
- Emerson, R.E. (1962). "Power-dependence Relations", *American Sociological Review*, 27, pp. 31-41.
- Emirbayer, M. (1997). "Manifesto for A Relational Sociology", *American Journal of Sociology*, 103, pp. 281-317.
- Ettlie, J.E., Bridges, W.P. and O'Keefe, R. (1984). "Organizational Strategy and Structural Differences for Radical vs. Incremental Innovation", *Management Science*, 30, pp. 682-695.
- European Fibre-Optics Directory and Report*. (1992). Materials Technology Publications.

References

- Evan, W.M. (1966). "The Organization-set: Toward A Theory of Inter-organizational Relations", in Thompson, J.D. (ed.). *Approaches to Organizational Design*, pp. 173-191. Pittsburgh: University of Pittsburgh Press.
- Ferdows, K., Miller, J., Nakane, J. and Vollmann, T. (1986). "Evolving Global Manufacturing Strategies: Projections into The 1990s", *International Journal of Operation and Production Management*, 4.
- Ferdows, K. and De Meyer, A. (1989). "Lasting Improvement in Manufacturing Performance: In Search of A New Theory", Insead, Working Paper n. 89/4.
- Ferlie, E. and Pettigrew, A. (1996). "Managing Through Networks: Some Issues and Implications for The NHS", *British Journal of Management*, Special Issue, 7, pp. 81-99.
- Fombrun, C.J. (1982). "Strategies for Network Research in Organisations", *Academy of Management Review*, 7 (2), pp.280-291.
- Foss, N. J. (1993). "More on Knight and The Theory of The Firm", *Managerial Decision and Economics*, 14, pp. 269-276.
- Freeman, C. (1982). *The Economics of Industrial Innovation*. London: Penguin.
- Freeman, C. (1991). "Networks of Innovators - A Synthesis of Research Issues", *Research Policy*, 20 (5), pp. 499-514.
- Friedlander and Gurney (1981). *Handbook of Successful Franchising*. New York: Van Nostrand Reinhold.
- The European Market for Fibre-Optic Communications Components*. (1992) Frost and Sullivan Inc. Publishers.
- Galaskiewicz, J. (1979). *Exchange Networks and Community Politics*. Beverly Hills, CA: Sage.
- Galaskiewicz, J. (1985). "Inter-organizational Relations", *Annual Review of Sociology*, 11, pp. 281-304.
- Galbraith, J. (1973). *Designing Complex Organizations*. Reading, MA: Addison-Wesley.
- Goodman P.S. and Pennings, J.M. (1997). *New Perspectives on Organizational Effectiveness*. San Francisco: Jossey Bass.
- Goshal, S. and Moran, P. (1996). "Bad for Practice: A Critique of The Transaction Cost Theory", *Academy of Management Review*, 21 (1), pp.13-47.
- Granovetter, M. (1985). "Economic Action and Social Structure: The Problem of Embeddedness", *American Journal of Sociology*, 91, pp. 481-501.

References

- Granovetter, M. (1992). "Problems of Explanation in Economic Sociology", in Nohria, N. and Eccles, R.G. (eds.), pp. 25-56. *Networks and Organisations: Structure, Form, and Action*. Boston: Harvard Business Press.
- Grant, R. and Baden-Fuller, C. (1995). "A Knowledge-Based Theory of Inter-firm Collaboration", Working Paper for The Academy of Management Conference.
- Gray, B. (1990). "Building Inter-organizational Alliances: Planned Change in A Global Environment", *Research in Organizational Change and Development*, 4, pp. 101-140.
- Griffin, A. (1993). "Metrics for Measuring Product Development Cycle Time", *Journal of Production and Innovation Management*, 10, pp.112-125.
- Grossman, S.J. and Hart, O.D. (1986). "The Cost and Benefits of Ownership: A Theory of Vertical and Lateral Integration", *Journal of Political Economy*, 94, pp. 691-719.
- Gulati, R (1995). "Does Familiarity Breed Trust? The Implications of Repeated Ties for Contractual Choice of Alliances", *Academy of Management Journal*, 38 (1), pp. 85-112.
- Gulati, R., Khanna, T. and Nohria, N. (1994). "Unilateral Commitments and The Importance of Process in Alliances", *Sloan Management Review*, Spring, pp. 61-69.
- Gulati, R., Nohria, N. and A. Zaheer (2000). "Strategic Networks", *Strategic Management Journal*, 21, (3), pp. 203-215.
- Gundlach, G.T. and Murphy, P.E. (1993). "Ethical and Legal Foundations of Relational Marketing Exchanges", *Journal of Marketing*, 57, pp. 35-46.
- Hagedoorn, J. (1993). "Understanding The Rationale of Strategic Technology Partnering: Interorganizational Modes of Co-operation and Sectoral Differences", *Strategic Management Journal*, 14, pp. 371-385.
- Håkansson, H. (1982) (ed.). *International Marketing and Purchasing of Industrial Goods*. John Wiley and Sons.
- Håkansson, H. (1989). *Corporate Technological Behavior: Co-operation and Networks*. London: Routledge.
- Håkansson, H. and Snehota, I. (1995) (eds.). *Developing Relationships in Business Networks*. London: Routledge.
- Hall, R. (1972). *Organizations*. Englewood Cliffs, NJ: Prentice-Hall.
- Hall, R., Clark, J.P., Giordano, P.C., Johnson, P.V. and Van Roekel, M. (1977). "Patterns of Inter-organizational Relationships", *Administrative Science Quarterly*, 22, pp.457-474.

References

- Hamel, G. and Prahalad, C.K. (1989). "Strategic Intent", *Harvard Business Review*, 67, pp. 63-76.
- Harland, C.M. (1995). "Supply-Chain Management: Relationships, Chains and Networks", Paper for the British Academy of Management.
- Harrison, B. (1994). *Lean and Mean: The Changing Landscape of Corporate Power in The Age of Flexibility*. Basic Books.
- Hedlund, G. (1994). "A Model of Knowledge Management and The N-form Corporation", *Strategic Management Journal*, 15, Special Issue, pp. 73-90.
- Hedlund, G. and Rolander, D. (1987). "The Strategy-Structure Paradigm in International Business Research and Practice". Research Paper 87/4, Institute of International Business at the Stocholm School of Economics, Stockholm.
- Hedlund, G. and Rolander, D. (1990). "Action in Heterachies: New Approaches to Managing the MNC", in Bartlett, C.A., Doz, Y.L. and Hedlund, G. (eds.), pp. 15-46. *Managing The Global Firm*. London and New York: Routledge.
- Heide, J.B. and John, G. (1990). "Alliances in Industrial Purchasing: The Determinants of Joint Action in Buyer-Supplier Relationships", *Journal of Marketing Research*, 27, pp. 24-36.
- Helper, S. (1991a). "An Exit-Voice Analysis of Supplier Relations - The Case of the United States Automobile Industry", in Grabher, G. (ed.), pp. 141-160. *The Embedded Firm. On The Socioeconomics of Industrial Networks*. London and New York: Routledge.
- Helper, S. (1991b). "How Much Has Really Changed Between U.S. Automakers and their Suppliers", *Sloan Management Review*, Summer, pp. 15-28.
- Henderson, R. and Clark, K.B. (1990). "Architectural Innovation: The Reconfiguration of Existing Product Technologies and The Failure of Established Firms", *Administrative Science Quarterly*, Special Issue, 35, pp. 9-30.
- Hendry, C. and Brown, J. (1996). "The Development and Performance of Opto-electronics in the UK, Germany and the USA", Working Paper for the British Academy of Management.
- Hendry, C. and Brown, J. (1999). "Industry Clusters as Commercial, Knowledge and Institutional Networks: Opto-electronics in Six Regions in The UK, USA and Germany", in Grandori, A. (ed.) *Interim Networks: Negotiated Order and Industrial Competitiveness*. London: Routledge.
- Hinings, C.R., Hickson, D.J., Pennings J.M. and Schneck, R.E. (1974). "Structural Conditions of Intra-organizational Power", *Administrative Science Quarterly*, 19, pp. 22-44.

References

- Hinterhuber, H.H. and Levin, B.M. (1994). "Strategic Networks - The Organization of the Future", *Long Range Planning*, 27 (3), pp.43-53.
- Hirschmann, A.O. (1970). *Exit, Voice and Loyalty: Responses to Decline in Firms, Organisations and States*. Cambridge MA: Harvard University Press.
- Hirst, P. and Zeitling, J (eds.) (1989). *Reversing Industrial Decline? Industrial Structure and Policy in Britain and Her Competitors*. Oxford: Berg.
- Hofstede, G.H. (1991). *Cultures and Organizations: Software of The Mind*. Maydenhead: McGraw Hill.
- Homans, G.C. (1950). *The Human Group*. New York: Harcourt, Brace.
- Ho Park, S. (1996). "Managing an Inter-organizational Network: A Framework of The Institutional Mechanism for Network Control", *Organisation Studies*, 17 (5), pp. 795-824.
- Huber, G.P. and Van de Ven, A.H. (eds.). (1995). *Longitudinal Field Research Methods. Studying Processes of Organizational Change*. London: Sage Publications.
- Ingham, G. (1996). "Some Recent Changes in The Relationship Between Economics and Sociology", *Cambridge Journal of Economics*, 20, pp. 243-275.
- Imai, K. (1985). *Kaizen: The Key to Japan's Competitive Success*. The Kaizen Institute.
- Imai, K., Nonaka, I, and Takeuchi, B. (1985). "Managing The New Product Development Process: How Japanese Companies Learn and Unlearn", in Clark, K.B., Hayes, R.H. and Lorenz, C. (eds.). *The Uneasy Alliance*. New York: Harvard Business School Press.
- Imrie R. and Morris, J. (1992). "A Review of Recent Changes in Buyer-Supplier Relations", *International Journal of Management Science*, 20.
- Itami, H. (with Rohel, T.) (ed.) (1987). *Mobilizing Invisible Assets*. New York: Harvard University Press.
- James, B.G. (1985). "Alliance, The New Strategic Focus", *Long Range Planning*, 18, pp.76-81.
- Jarillo, C. (1988). "On Strategic Networks", *Strategic Management Journal*, 9, pp. 31-41.
- Jarillo, C. (1993). *Strategic Networks. Creating The Borderless Organization*. Oxford: Butterworth-Heinemann.

References

- Johanson, J.K. and Nonaka, I. (1987). "Market Research: The Japanese Way", *Harvard Business Review*, May-June.
- Johanson, J.K. and Mattsson, L.G. (1987). "Interorganizational Relations in Industrial Systems: A Network Approach Compared with The Transaction Cost Approach", *International Studies of Management and Organization*, 17, pp. 34-48.
- Johanson, J.K. and Mattsson, L.G. (1994). "The Markets-as-Networks Tradition in Sweden", in Laurent, G., Lilien, G.L. and Pras, B. (eds.). *Research Traditions in Marketing*. Kluwer Academic Publishers.
- Jones, B. (1985). "Controlling Production on The Shopfloor", in Tolliday, S. and Zeitlin, J. (eds.). *Shopfloor Bargaining and The State*. Cambridge: Cambridge University Press.
- Jones, C., Hesterly, W.S. and Borgatti S.P. (1997). "A General Theory of Network Governance: Exchange Conditions and Social Mechanisms", *Academy of Management Review*, 22 (4), pp. 911-945.
- Kale, P., Singh, H. and Perlmutter, H. (2000). "Learning and Protection of Proprietary Assets in Strategic Alliances: Building Relational Capital", *Strategic Management Journal*, 21, (3), pp. 217-237.
- Kaneko, I. and Imai, K. (1987). "A Network View of The Firm", Working Paper, Hitotsubashi University.
- Kanter, R.M. (1972). *Commitment and Community*. Cambridge, MA: Harvard.
- Kas, C. (1982). *Optical Fiber Systems: Technology, Design, and Applications*. New York: McGraw Hill.
- Katz, D. and Kahn, R.L. (1978). *The Social Psychology of Organizations* (2nd ed.). New York: Wiley.
- Kenis, P. and Knoke, D. (1998). "A Network Theory of Inter-organizational Relations", Working Paper for The 14th EGOS Colloquium.
- Kenis, P. and Schneider, V. (1991). "Policy Networks and Policy Analysis: Scrutinising A New Analytical Toolbox", in Marin, B. and Maynz, R. (eds.), pp. 25-59. *Policy Networks. Empirical Evidence and Theoretical Considerations*. Frankfurt, Main and Boulder, CO: Campus and Westview.
- Klein, B., Crawford, R.G., and Alchian, A.A. (1978). "Vertical Integration, Appropriable Rents and The Competitive Contracting Process", *Journal of Law, Economics and Organizations*, 21, pp. 297-326.
- Knight, F.H. (1921). *Risk, Uncertainty, and Profit*. 1964 edition, New York: Augustus M. Kelley.

References

- Knoke, D. and Guilarte, M. (1994). "Networks in Organizational Structures and Strategies", *Current Perspectives in Social Theory*, Supplement, 1, pp. 77-115.
- Kogut, B. (1985). "Designing Global Strategies: Comparative and Competitive Value Added Chains", *Sloan Management Review*, Summer, pp. 15-28.
- Kogut, B. (2000). "The Network as Knowledge: Generative Rules and The Emergence of Structure", *Strategic Management Journal*, 21, (3), pp. 405-425.
- Kogut, B. and U. Zander (1996). "What Firms Do? Coordination, Identity and Learning", *Organization Science*, 7, (5), pp. 502-518.
- Korczynski, (1998). "The Low Trust Route to Economic Development: Inter-Firm Relations in The UK Engineering Construction Industry in The 1980s and 1990s", *Journal of Management Studies*, 33 (6), pp. 787-808.
- Lamming, R.C. (1989). "The Causes and Effects of Structural Change in The European Automotive Component Industry", Working Paper of The International Motor Vehicle Program. MIT, Cambridge, MA: USA.
- Lamming, R.C. (1993). *Beyond Partnership: Strategies for Innovation and Lean Supply*. Hemel Hempstead, UK: Prentice-Hall.
- Lamming, R.C. and Cox, A. (eds.) (1995). *Strategic Procurement Management in The 1990s: Concepts and Cases*. Boston: Earlsgate Press.
- Langfield-Smith, K. and Greenwood, M.R. (1998). "Developing Co-operative Buyer-Supplier Relationships: A Case Study of Toyota", *Journal of Management Studies*, 35 (3), pp. 331-353.
- Langlois, R.N. (1988). "Technological Change and The Boundaries of The Firm", *Journal of Institutional and Theoretical Economics*, 144, pp. 635-657.
- Langlois, R.N. (1991). "Transaction Cost Economics in Real Time", *Industrial and Corporate Change*, 1, pp. 99-127.
- Larson, A. (1992). "Network dyads in Entrepreneurial Settings: a Study of Governance of Exchange Relationships", *Administrative Science Quarterly*, 1, (37), pp. 76-104.
- Laumann, E.O., Galaskiewicz, J., and Marsden, P. (1978). "Community Structure as Inter-organizational Linkages", *Annual Review of Sociology*, 4, pp. 455-484.
- Laumann, E.O. and Pappi, F. (1976). *Networks of Collective Action: A Perspective on Community Influence Systems*. New York: Academic Press.
- Levin, R., Klevorick, A., Nelson, R.R. and Winter, S. (1987). "Appropriating the Returns from Industrial R&D", *Brookings Papers on Economic Activity*.

References

- Lincoln, J.R. (1990). "Japanese Organization and Organization Theory", in Cumming L.L. and Staw, B. (eds.). *Research in Organizational Behavior*, 12, pp. 255-294.
- Lincoln, J.R. and Gerlach, M.L. (1992). "Keiretsu Networks in The Japanese Economy - A Dyad Analysis of Inter-corporate Ties", *American Sociological Review*, 9 (2), pp. 125-140.
- Littler, C.R. (1990). "The Labour Process Debate: A Theoretical Review 1974-1988", in Knights, D. and Willmott, H. (eds.). *Labour Process Theory*. London: Mcmillan.
- Lomi, A. (1992). "L'Organizzazione a Rete nella Teoria Organizzativa", in Lorenzoni, G. (ed.). *Accordi, Reti e Vantaggio Competitivo. Le Innovazioni nell'Economia d'Impresa e negli Assetti Organizzativi*. ETASLibri.
- Lorenzoni, G. (1982). "From Vertical Integration to Vertical Disintegration", Working Paper for the Strategic Management Society Conference, Montreal.
- Lorenzoni, G. (1990). *L'Architettura di Sviluppo delle Imprese Minori*. Bologna: Il Mulino.
- Lorenzoni, G. (ed.) (1992). *Accordi, Reti e Vantaggio Competitivo. Le Innovazioni nell'Economia d'Impresa e negli Assetti Organizzativi*. ETASLibri.
- Lusch, R.F. and Brown, J.R. (1996). "Interdependency, Contracting, and Relational Behavior in Marketing Channels", *Journal of Marketing*, 60, pp. 19-38.
- Lyons, T.F., Krachenberg, A.R., and Henke, J.W. (1990). "Mixed Motive Marriages: What's Next for Buyer-Supplier Relations?", *Sloan Management Review*, 31 (3), pp. 29-36.
- Mahoney, J.T. (1992). "The Choice of Organizational Form: Vertical Financial Ownership Versus Other Methods of Vertical Integration", *Strategic Management Journal*, 13 (8), pp. 559-584.
- Mansfield, E. (1968). *Industrial Research and Technological Innovation*. New York: Norton.
- March, J.G. (1991). "Exploration and Exploitation in Organizational Learning", *Organisation Science*, 2, pp. 71-87.
- March, J.G. and Simon, H.A. (1958). *Organizations*. New York: Wiley.
- Marshall, A. (1920) *Principles of Economics: an Introductory Volume*. New York: Mcmillan.
- Matthyssen, P. and Van den Bulte, C. (1994). "Getting Closer and Nicer: Partnership in The Supply Chain", *Long Range Planning*, 27 (1), pp.72-83.

References

- McMillan, J. (1990). "Managing Suppliers: Incentive Systems in Japanese and United States Industry", *California Management Review*, Summer, pp. 38-55.
- Mcneil, I.R. (1978). "Contracts Adjustments of Long Term Economic Relationships Under Classical, Neoclassical and Relational Contract Law", *Northwestern University Law Review*, 72, pp. 854-902.
- Macneil, I.R. (1980). *The New Social Contract*. New Haven, CT: Yale University Press.
- Miles, R.E. and Snow, C.C. (1992). "Causes of Failure in Network Organizations", *California Management Review*, 34, pp. 53-72.
- Mintzberg, H. (1979). *The Structuring of Organizations*. Englewood Cliffs, NJ: Prentice-Hall.
- Miyazaki, K. (1995). *Building Competencies in the Firm*. St. Martin's Press.
- Moch, M. and Morse, E.V. (1977). "Size, Centralization and Organizational Adoption of Innovations", *American Sociological Review*, 42, pp. 716-725.
- Mohr, J. and Spekman, R. (1994). "Characteristics of Partnership Success: Partnership Attributes, Communication Behavior, and Conflict Resolution Techniques", *Strategic Management Journal*, 15, pp. 135-152.
- Morris, J. and Imrie, R. (1993). *Transforming Buyer-Supplier Relations*. London: Mcmillan.
- Murray, R. (1985). "Benetton Britain", *Marxism Today*, November.
- Nelson, R.R. and Winter, S.G. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press.
- Nelson, R.R. and Rosenberg, N. (1993). "Technical Innovation and National Systems", in Nelson, R. (ed.). *National Innovation Systems*, Oxford University Press.
- Nishiguchi, T. (1994). *Strategic Industrial Sourcing*. New York: Oxford University Press.
- Nohria, N. and Eccles, R.G. (eds.) (1992). *Networks and Organizations*. Boston: Harvard Business School Press.
- Nooteboom, B. (1996). "A Dynamic Theory of Network Efficiency", Working Paper for EMOT, Modena.
- Normann, R. and Ramirez, R. (1993). "From Value Chain to Value Constellation: Designing Interactive Strategy", *Harvard Business Review*, 71 (4), pp. 65-77.

References

- Oliver, C. (1990). "Determinants of Inter-organizational Relationships: Integration and Future Directions", *Academy of Management Review*, **15** (2), pp. 241-265.
- Oliver, N. and Wilkinson, B. (1988). *The Japanization of British Industry*. Oxford, UK: Basil Blackwell.
- Oliver, N., Delbridge, R. and Lowe, J. (1996). "Lean Production Practices: International Comparisons in The Auto Components Industry", *British Journal of Management*, **7**, Special Issue, pp. 29-44.
- Ohmae, K. (1982). *The Mind of The Strategist*. McGraw-Hill.
- Ouchi, W.G. (1979). "A Conceptual Framework for The Design of Organizational Control Mechanisms", *Management Science*, **25**, pp. 833-848.
- Ouchi, W.G. (1980). "Markets, Bureaucracies, and Clans", *Administrative Science Quarterly*, **25**, pp. 121-141.
- Ouchi, W.G. and Kremen-Bolton, M. (1988). "The Logic of Joint Research and Development", *California Management Review*, **16**, pp. 9-33.
- Pavitt, K. (1984). "Sectoral Patterns of Technical Change: Towards A Taxonomy and A Theory", *Research Policy*, **13**, 343-373.
- Pavitt, K. (1990). "What We Know about The Strategic Management of Technology", *California Management Review*, **32** (3), pp. 17-26.
- Pennings, J.M. (1981). "Strategically Inter-dependent Organisations", in Nystrom, P.C. and Starbuck, W.H. (eds.), pp. 433-455. *Handbook of Organizational Design*. London: Oxford University Press.
- Perlmutter, H.V. and Heenan, D. (1986). "Thinking Ahead", *Harvard Business Review*, **86** (2), pp. 136-152.
- Perrow, C. (1979). *Complex Organisations: A Critical Essay*. (2nd ed.). New York: Scott, Foresman.
- Perrow, C. (1986). *Complex Organisations: A Critical Essay*. (3rd ed.). New York: Random House, Inc.
- Pettigrew, A.M. (1979). "On Studying Organizational Cultures", *Administrative Science Quarterly*, **24**, pp. 570-581.
- Pettigrew, A.M. (1995). "Longitudinal Field Research on Change: Theory and Practice", in Huber, G.P. and Van de Ven, A.H. (eds.). *Longitudinal Field Research Methods. Studying Processes of Organizational Change*. London: Sage Publications.

References

- Piore, M.J. and Sabel, C.E. (1984). *The Second Industrial Divide*. New York: Basic Books.
- Pfeffer, J. (1994). *Competitive Advantage through People: Unleashing the Power of The Workforce*. Boston: Harvard Business School Press.
- Pfeffer, J. (1997). *New Direction for Organisation Theory. Problems and Prospects*. Oxford, New York: Oxford University Press.
- Pfeffer, J. and Salancik, G.R. (1978). *The External Control of Organizations*. New York: Harper and Row.
- Porter, M.E. (1980). *Competitive Strategy*. New York: Free Press.
- Porter, M.E. (1985). *The Competitive Advantage*. New York: Macmillan.
- Porter, M.E. (1990). *The Competitive Advantage of Nations*. New York: Free Press.
- Porter, M.E. and Fuller M.B. (1986). "Coalitions and Global Strategies", in Porter, M.E. (ed.), pp. 315-343. *Competition in Global Industries*. Cambridge, MA: Harvard Business School Press.
- Powell, W.W. (1987). "Hybrid Organizational Arrangements", *California Management Review*, 30, pp. 67-87.
- Powell, W.W. (1990). "Neither Market nor Hierarchy: Network Forms of Organisation", in Cummings, L.L. and Staw, B. (eds.), pp. 295-336. *Research in Organizational Behavior*, 12.
- Provan, K.G. and Milward, H.B. (1995). "A Preliminary Theory of Inter-organizational Network Effectiveness: A Comparative Study of 4 Community Mental Health Systems", *Administrative Science Quarterly*, 40 (1), pp. 1-33.
- Pugh, D.S., Hickson, D.J., Hinings, C.R., and Turner, C. (1969). "The Context of Organization Structures", *Administrative Science Quarterly*, 14, pp. 91-114.
- Richardson, J. (1993). "Parallel Sourcing and Supplier Performance in The Japanese Automobile Industry", *Strategic Management Journal*, 14, pp. 339-350.
- Ring, P. (1996a). "Processes as Outcomes of Co-operative Inter-organizational Relationships", Working Paper for *Global Perspectives on Co-operative Strategies*, London, Ontario, Canada.
- Ring, P. (1996b). "The Costs of Networked Organization", Working Paper for The 14th EGOS Colloquium.
- Ring, P. (1996c). "Networked Organisation: A Resource Based Perspective", Acta Universitatis Upsalensis, Uppsala University, Stockholm, Sweden.

References

- Ring, P. and van de Ven, A.H. (1992). "Structuring Co-operative Relationships between Organizations", *Strategic Management Journal*, 13, pp. 483-498.
- Ring, P. and van de Ven, A.H. (1994). "Developmental Processes of Co-operative Inter-organizational Relationships", *Academy of Management Review*, 19, (1), pp. 90-118.
- Rowlinson, M. and Procter, S. (1997). "Efficiency and Power: Organizational Economics Meets Organisation Theory", *British Journal of Management*, 8, Special Issue, pp. 31-42.
- Rumelt, R.P. (1974). *Strategy, Structure, and Economic Performance*. Harvard University Press.
- Rumelt, R.P., Schendel, D., and Teece, D.J. (1991). "Strategic Management and Economics", *Strategic Management Journal*, 12, pp. 5-29.
- Sabel, C. (1992). "Studied Trust: Building New Forms of Co-operation in A Volatile Economy", in Pyke, F. and Sengenberger, W. (eds.). *Industrial Districts and Local Economic Regeneration*. Geneva: International Institute for Labour Studies.
- Sako, M. (1992). *Prices, Quality, and Trust Inter-firm relations in Britain and Japan*. Cambridge, MA: Cambridge University Press.
- Scher, M.J. (1997). "The Limitations of 'Trust-Based' Theories in Japanese Inter-organizational Networks in The Era of Globalization", Working Paper for The 13th EGOS Colloquium.
- Schermerhorn, J.R. Jr. (1975). "Determinants of Inter-organizational Co-operation", *Academy of Management Journal*, 18, pp. 846-856.
- Schonberger, R.J. (1982). *Japanese Manufacturing Techniques*. New York: Free Press.
- Schumpeter, J.A. (1934). *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.
- Schumpeter, J.A. (1942). *Capitalism, Socialism, and Democracy*. New York: Harper.
- Senior, J.M. and Ray, T.E. (1990). "Optical-fibre Communication: The Formation of Technological Strategies in The UK and US", *International Journal of Technology Management*, 5, (1), pp. 71-88.
- Silver, M. (1984). *Enterprise and The Scope of The Firm: The Role of Vertical Integration*, Oxford: Martin Robertson.
- Simon, H.A. (1991). "Organizations and Markets", *Journal of Economic Perspectives*, 5 (2), pp. 25-44.

References

- Simon, H.A. (1947). *Administrative Behavior*. New York: Free Press.
- Spekman, R., Kamauff, J. and Salmond, D. (1994). "At Last Purchasing Is Becoming Strategic", *Long Range Planning*, 27 (2), pp. 76-84.
- Stalk, G. and Hout, T.M. (1990). *Competing Against Time. How Time-based Competition Is Reshaping Global Markets*. London: Collier Mcmillan Publishers.
- Stinchcombe, A.L. (1983). *Economic Sociology*. London: Academic.
- Stinchcombe, A.L. (1990). *Information and Organizations*. Berkeley, CA: University of California Press.
- Teece, D.J. (1986). "Profiting from Technological Innovation", *Research Policy*, 15, pp. 285-305.
- Teece, D.J. (1995). "Firm Organization, Industrial Structure, and Technological Innovation", Working Paper, University of California, Berkeley.
- Teece, D.J. and Pisano, G. (1989). "Collaborative Arrangements and Global Technology Strategy", in Burgelman R.A. and Rosenbloom R.S. (eds.), *Research on Technological Innovation, Management and Policy*, Vol. 4, pp. 227-256, Greenwich, Conn.: JAI Press.
- Telser, L.G. (1980). "A Theory of Self-enforcing Agreements", *Journal of Business*, 53, pp. 27-44.
- Thompson, J.D. (1967). *Organizations in Actions*. New York: McGraw-Hill.
- Thorelli, H.B. (1986). "Networks: Between Markets and Hierarchies", *Strategic Management Journal*, 7, pp. 37-51.
- Tichy, N.M. (1981). "Networks in Organizations", in Nystrom, P.C. and Starbuck, W.H. (eds.). *Handbook of Organizational Design*, Oxford University Press, Vol. 1, pp. 225-249.
- Tichy, N.M., Tushman, M.L., and Fombrun, C. (1979). "Social Network Analysis for Organizations", *Academy of Management Review*, 4, (4).
- Turnbull, P., Oliver, N. and Wilkinson, B. (1992). "Buyer-supplier Relations in The UK Automotive Industry: Strategic Implications of The Japanese Manufacturing Model", *Strategic Management Journal*, 13 (2), pp. 159-168.
- Turnbull, P.W. and Valla, J.P. (eds.) (1985). *Strategies for International Industrial Marketing*. London: Croom Helm.
- Tushman, M.L. and Romanelli, E. (1985). "Organizational Evolution: A Metamorphic Model of Inertia and Reorientation" in Staw, B. and Cummings, L. (eds.) pp. 171-222. *Research in Organization Behavior*. Vol 7, Greenwich, CA: JAI Press.

References

- Tushman, M.L. and Anderson, P. (1986). "Technological Discontinuities and Organizational Environments", *Administrative Science Quarterly*, 31, pp. 439-465.
- Tushman, M.L., Newman, W. and Romanelli, E. (1986). "Convergence and Upheaval: Managing The Unsteady Pace of Organizational Evolution", *California Management Review*, Fall (1).
- Tushman, M.L. and Nelson, R.R. (1990). "Introduction: Technology, Organizations, and Innovation", *Administrative Science Quarterly*, Special Issue, 35 (1), pp. 1-8.
- Utterback, J.M. (1994). *Mastering The Dynamics of Innovation*. Boston, MA: Harvard University Press.
- Uzzi, B. (1997). "Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness", *Administrative Science Quarterly*, 42, pp. 35-67.
- van de Ven, A.H. (1976). "On The Nature, Formation, and Maintenance of Relations among Organizations", *Academy of Management Review*, 1, pp. 24-36.
- von Hippel, E. (1985). *User Innovation: An Analysis of The Functional Sources of Innovation*, Cambridge, MA: Sloan School of management, MIT.
- von Hippel, E. (1986). "Lead Users: A Source of Novel Product Concepts", *Management Science*, 32 (7), pp. 791-805.
- von Hippel, E. (1988). *The Sources of Innovation*. Oxford University Press.
- Voss, C. (1987) (ed.). *Just-in-Time Manufacturing*. London: IFS Publications.
- Weber, M. (1921). *The Theory of Social and Economic Organization*. Translated by Henderson, A.M. and Parsons, T. New York: Oxford University Press.
- Wellman, B. (1997). "Structural Analysis: From Method and Metaphor to Theory and Substance", in Wellman, B. and Berkowitz, S.D. (eds.). *Social Structures: A Network Approach*. Greenwich, CT: JAI Press.
- Wheelwright, S. and Clark, K.B. (1992). *Revolutionizing Product Development. Quantum Leaps in Speed, Efficiency, and Quality*. New York: Free Press.
- Whetten, D.A. (1981). "Inter-organizational Relations: A Review of The Field", *Journal of Higher Education*, 52, pp. 1-28.
- Whetten, D.A. and Aldrich, H.E. (1979). "Organisation Set Size and Diversity: People Processing Organisations and Their Environments", *Administration and Society*, 10:11, pp. 251-281.

References

- Wilkins A.L. and Ouchi, W.G. (1982). "Efficient Cultures: Exploring The Relationship between Culture and Organizational Performance", *Administrative Science Quarterly*, 28, pp. 468-481.
- Williamson, O.E. (1975). *Markets and Hierarchies. Analysis and Antitrust Implications*. New York: Free Press.
- Williamson, O.E. (1985). *The Economic Institutions of Capitalism. Firms, Markets, Relational Contracting*. New York: Free Press.
- Williamson, O.E. (1990). "The Firm as A Nexus of Treaties: an Introduction" in Aoki, M., Gustafsson, B., and Williamson, O.E. (eds.), *The Firm as A Nexus of Treaties*. London: Sage Publications.
- Williamson, O.E. (1991a). "Strategizing, Economizing, and Economic Organization", *Strategic Management Journal*, Special Winter Issue, 12, pp. 75-94.
- Williamson, O.E. (1991b). "Comparative Economic Organization: The Analysis of Discrete Structural Alternatives", *Administrative Science Quarterly*, 36, pp. 269-296.
- Williamson, O.E. (1996). "Economic Organization: The Case for Candor", *Academy of Management Review*, 21 (1), pp. 48-57.
- Williamson O.E. and Ouchi, W. (1981). "The Markets and Hierarchies and Visible Hand Perspectives", in van de Ven, A. and Joyce, W. (eds.), pp. 347-370. *Perspectives on Organizational Design and Behavior*. New York: Wiley.
- Williamson, O.E. and Winter, S.G. (eds.) (1991). *The Nature of The Firm. Origins, Evolution, and Development*. New York: Oxford University Press.
- Willis P. and Arnfield, R. (1995). *European Fibre-Optics Networks: Technology and Multi-Media Opportunities*.
- Winter, S.G. (1988). "On Coase, Competence, and The Corporation", *Journal of Law, Economics and Organization*, 4, pp. 163-180.
- Winter, S.G. (1991). "On Coase, Competence, and The Corporation", in Williamson, O.E. and Winter, S.G. (eds.), pp. 179-195. *The Nature of The Firm. Origins, Evolution, and Development*. New York: Oxford University Press.
- Wissema, J.G., Euser, L. and Wissema-Klok A.W. (1989). *Inkoopmanagement: drie strategieën*. Kluwer, Deventer.
- Womack, J.P., Jones, D.T. and Roos, D. (1990). *The Machine that Changed The World*. New York: Harper Perennial.
- Yin, R.K. (1984). *Case Study Research: Design and Methods*, Beverly Hills, CA: Sage.

APPENDIX A – SURVEY QUESTIONNAIRE

NAME AND ORGANISATIONAL POSITION OF THE PERSON COMPILING THE QUESTIONNAIRE

SECTION I: SUPPLY CHAIN RELATIONSHIPS
This section focuses on the way relationships between the company and its suppliers are organised, as well as on recent developments in the company’s supply strategy.

1. How is the supply/purchasing function currently organised within the company?

- a. Number of people:
- b. Title of the unit:
- c. To which function/position does the supply/purchasing function report?
(Please give title)

2. Have there been any major changes in the company’s strategy for supply chain management and purchasing in the past five years? (Please tick the appropriate box)

YES

[]

NO

[]

If yes,

2.1 In what year(s)?

2.2 What was the main reason for the change(s) ?

2.3 In what did the change(s) consist ?

3. What has been the trend in the number of suppliers during the past five years? (Please tick as appropriate)

- a. Substantially increased (over 30 % more)
- b. Moderately increased (10 to 30 % more)
- c. No big change (between -10 and +10 %)
- d. Moderately decreased (10 to 30% fewer)
- e. Substantially decreased (over 30 % fewer)

4. Please list the six most important materials/parts/components in terms of company purchasing expenditure and indicate the approximate percentage of overall company purchasing expenditure they each represent.

Material/part/component	Percentage of overall company purchasing expenditure	
1.	[%]
2.	[%]
3.	[%]
4.	[%]
5.	[%]
6.	[%]

Appendix A - The survey questionnaire

5. How important are these six materials/parts/components purchased by the company for the functionality of its final products? (Please tick as appropriate)

Materials/parts/components [as listed in Q. 4]	Extremely important	Quite important t	Important	Relatively important	Not important
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]
5. _____	[]	[]	[]	[]	[]
6. _____	[]	[]	[]	[]	[]

6. How many suppliers are potentially available in the market for the provision of these six materials/components/parts? (Please tick as appropriate)

Materials/parts/components	A great many (more than 20)	Not quite so many (5 to 20)	Very few (fewer than 5)
1. _____	[]	[]	[]
2. _____	[]	[]	[]
3. _____	[]	[]	[]
4. _____	[]	[]	[]
5. _____	[]	[]	[]
6. _____	[]	[]	[]

7. Which of the following practices is the company currently adopting for the supply of these six materials/parts/components? (Please tick as appropriate)

Materials/parts/components	Multiple sourcing	List of preferred suppliers	Parallel sourcing of selected suppliers	Single supplier
1. _____	[]	[]	[]	[]
2. _____	[]	[]	[]	[]
3. _____	[]	[]	[]	[]
4. _____	[]	[]	[]	[]
5. _____	[]	[]	[]	[]
6. _____	[]	[]	[]	[]

8. Have any of the following practices become more or less important for the company in the past five years? (Please tick as appropriate)

	Significantly more important	Moderately more important	No change	Moderately less important	Significantly less important
a. Multiple sourcing	[]	[]	[]	[]	[]
b. List of preferred suppliers	[]	[]	[]	[]	[]
c. Parallel sourcing of selected suppliers	[]	[]	[]	[]	[]
d. Single supplier	[]	[]	[]	[]	[]

Appendix A - The survey questionnaire

9. How long has your company had a commercial relationship with your suppliers as a whole? (Please tick as appropriate)

	more than 10 years	5 to 10 years	less than 5 years
a. More than 75%	[]	[]	[]
b. 50% to 75%	[]	[]	[]
c. 25% to 50%	[]	[]	[]
d. Fewer than 25%	[]	[]	[]

10. With what proportion of suppliers is the company currently adopting any of the following practices? (Please tick as appropriate)

	With all	With the majority	With a minority	With none
a. Exchange of personnel and key human resources	[]	[]	[]	[]
b. Shared physical facilities /resources	[]	[]	[]	[]
c. Open books*	[]	[]	[]	[]
d. Supplier-specific investments**	[]	[]	[]	[]
e. Exchange of data on internal processes***	[]	[]	[]	[]

* Open books: transparency in private information related to costs and other accounting data

** Investments in training, or special machinery, or similar for a specific supplier

*** Internal processes, such as technological development and R&D, strategic planning, marketing

11. Which of the following criteria are currently used by the company in selecting a supplier? (Please tick as appropriate)

	Always used	Used only in special cases	Not used at all
a. Financial performance	[]	[]	[]
b. Price	[]	[]	[]
c. Time and delivery	[]	[]	[]
d. Quality	[]	[]	[]
e. R&D design and capability	[]	[]	[]
f. Technical innovation	[]	[]	[]
g. Sound managerial practices	[]	[]	[]
h. Compatible culture	[]	[]	[]
i. Production flexibility	[]	[]	[]
l. Ease of communication	[]	[]	[]
m. Willingness to invest and share risk	[]	[]	[]
n. Good skill base and training	[]	[]	[]
o. Location	[]	[]	[]
p. Other (specify): _____	[]	[]	[]
: _____	[]	[]	[]

Appendix A - The survey questionnaire

12. Have any of the following criteria for selecting a supplier become more or less important for the company in the past five years? (Please tick as appropriate)

	Significantly more important	Moderately more important	No change	Moderately less important	Significantly less important
a. Financial performance	[]	[]	[]	[]	[]
b. Price	[]	[]	[]	[]	[]
c. Time and delivery	[]	[]	[]	[]	[]
d. Quality	[]	[]	[]	[]	[]
e. R&D design and capability	[]	[]	[]	[]	[]
f. Technical innovation	[]	[]	[]	[]	[]
g. Sound managerial practices	[]	[]	[]	[]	[]
h. Compatible culture	[]	[]	[]	[]	[]
i. Production flexibility	[]	[]	[]	[]	[]
l. Ease of communication	[]	[]	[]	[]	[]
m. Willingness to invest and share risk	[]	[]	[]	[]	[]
n. Good skill base and training	[]	[]	[]	[]	[]
o. Location	[]	[]	[]	[]	[]
p. Other (specify): _____	[]	[]	[]	[]	[]
: _____	[]	[]	[]	[]	[]

13. Have any of the following factors for evaluating the performance of a supplier become more or less important for the company in the past five years? (Please tick as appropriate)

	Significantly more important	Moderately more important	No change	Moderately less important	Significantly less important
a. Compliance with technical requirements/specifications	[]	[]	[]	[]	[]
b. Warranty performance	[]	[]	[]	[]	[]
c. Delivery/Service	[]	[]	[]	[]	[]
d. New ideas generated by the supplier	[]	[]	[]	[]	[]
e. Other (specify): _____	[]	[]	[]	[]	[]
: _____	[]	[]	[]	[]	[]

14. What is the average level of detailed specification of the contract with a supplier on non-technical issues (such as penalties, clauses for reassessing prices, provisions for unpredictable events, etc.?) (Please tick as appropriate)

a. The contract is very detailed and exhaustive	[]
b. The contract is relatively detailed, but there is scope for flexibility and adjustments	[]
c. The contract is not very precise and things are specified along the way	[]

15. If something goes wrong during the life of a contract, what is the normal company reaction? (Please tick as appropriate)

a. Stick to the contract and use the lawyers	[]
b. Renegotiate the contract, and listen to the supplier's reasons	[]
c. Put the contract aside, and try to "sort things out"	[]

16. Does the company use any of the following mechanisms for assessing the soundness of the overall relationship with its suppliers? (Please tick all that apply)

- a. Regular meetings for open and informal discussion

[]
- b. Occasional meetings for open and informal discussion

[]
- c. Periodical and formal grading against a check-list of well specified criteria)

[]
- d. Self certification

[]
- e. Other (specify):

[]

:

[]

17. It could help if you could indicate any significant actions or initiatives that have resulted from such reviews in recent years

SECTION II: THE COMPANY’S MAIN PRODUCTS AND ITS GENERAL MANUFACTURING ORGANISATION

This section focuses on the company’s main products and the way it organises its activities concerning both existing and newly developed products

18. Please list the company’s four most important products in terms of overall sales and indicate the approximate percentage of overall company sales they each represent. (If the company has fewer than four products, please indicate accordingly)

Main products	Percentage of overall company sales
1. <div></div>	[%]
2. <div></div>	[%]
3. <div></div>	[%]
4. <div></div>	[%]

19. How important are these products for the company’s future strategy and competitive success? (Please tick as appropriate)

Main products	Extremely important	Quite important	Important	Relatively important	Not important
1. <div></div>	[]	[]	[]	[]	[]
2. <div></div>	[]	[]	[]	[]	[]
3. <div></div>	[]	[]	[]	[]	[]
4. <div></div>	[]	[]	[]	[]	[]

20. What is the current market situation for each of these main products? (Please tick as appropriate)

Main products	New market	Fast growing market	Market close to maturity	Mature market	Declining market
1. <div></div>	[]	[]	[]	[]	[]
2. <div></div>	[]	[]	[]	[]	[]
3. <div></div>	[]	[]	[]	[]	[]
4. <div></div>	[]	[]	[]	[]	[]

Appendix A - The survey questionnaire

21. How much collaboration is there between the company and the following for the *research and concept development* of new products? (Please tick as appropriate)

	very high	high	medium	low	very low
a. Suppliers	[]	[]	[]	[]	[]
b. Customers	[]	[]	[]	[]	[]
c. External research institutes	[]	[]	[]	[]	[]
d. University laboratories	[]	[]	[]	[]	[]
e. Parent company (if relevant)	[]	[]	[]	[]	[]
f. Other companies	[]	[]	[]	[]	[]
g. Other (specify): _____	[]	[]	[]	[]	[]
:	[]	[]	[]	[]	[]

22. Have any of the following become more or less important in the past five years for the *research and concept development* of new products? (Please tick as appropriate)

	more important	no change	less important
a. Suppliers	[]	[]	[]
b. Customers	[]	[]	[]
c. External research institutes	[]	[]	[]
d. University laboratories	[]	[]	[]
e. Parent company (if relevant)	[]	[]	[]
f. Other companies	[]	[]	[]
g. Other (specify): _____	[]	[]	[]
:	[]	[]	[]

23. How much collaboration is there between the company and the following for the *design and engineering* of new products to develop them for production? (Please tick as appropriate)

	very high	high	medium	low	very low
a. Suppliers	[]	[]	[]	[]	[]
b. Customers	[]	[]	[]	[]	[]
c. External research institutes	[]	[]	[]	[]	[]
d. University laboratories	[]	[]	[]	[]	[]
e. Parent company (if relevant)	[]	[]	[]	[]	[]
f. Other companies	[]	[]	[]	[]	[]
g. Other (specify): _____	[]	[]	[]	[]	[]
: _____	[]	[]	[]	[]	[]

Appendix A - The survey questionnaire

24. Have any of the following become more or less important for the *design and engineering* of new products to take them into production in the past five years? (Please tick as appropriate)

	more important	no change	less important
a. Suppliers	[]	[]	[]
b. Customers	[]	[]	[]
c. External research institutes	[]	[]	[]
d. University laboratories	[]	[]	[]
e. Parent company (if relevant)	[]	[]	[]
f. Other companies	[]	[]	[]
g. Other (specify): _____	[]	[]	[]
:	[]	[]	[]

25. What is the relative importance of “*make*” (internal manufacturing) versus “*buy*” (external supply) for the company’s main products as listed in Q. 18? (Please indicate the approximate balance between “*make*” and “*buy*” as a percentage)

Main products [as listed in Q.18]		MAKE	BUY	
1.	_____	[%]	[%]	= 100 %
2.	_____	[%]	[%]	= 100 %
3.	_____	[%]	[%]	= 100 %
4.	_____	[%]	[%]	= 100 %

26. What was the situation in relation to these products five years ago (or when they were introduced, if less than five years ago)? (Please indicate the approximate balance between “make” and “buy” as a percentage)

Main products		MAKE	BUY
1. _____	[%]	[%]	= 100 %
2. _____	[%]	[%]	= 100 %
3. _____	[%]	[%]	= 100 %
4. _____	[%]	[%]	= 100 %

27. How much collaboration is there between the company and the following for the *distribution/installation* of the company's main products? (Please tick as appropriate)

	very high	high	medium	low	very low
a. Suppliers	[]	[]	[]	[]	[]
b. Customers	[]	[]	[]	[]	[]
c. Partners	[]	[]	[]	[]	[]
d. Other (specify): _____	[]	[]	[]	[]	[]
: _____	[]	[]	[]	[]	[]

28. Have any of the following become more or less important for the *distribution/installation* of the company’s main products in the past five years? (Please tick as appropriate)

	more important	no change	less important
a. Suppliers	[]	[]	[]
b. Customers	[]	[]	[]
c. Partners	[]	[]	[]
d. Other (specify): _____	[]	[]	[]
: _____	[]	[]	[]

SECTION III: EFFICIENCY AND INNOVATIVENESS

This section focuses on the company’s recent performance in terms of efficiency and innovativeness, both measured through a variety of indicators.

29. What has been the trend in the *price* of the company’s main products as listed in Q. 18 during the past five years (or since they were introduced, if less than five years)? (Please tick as appropriate)

Main products [as listed in Q. 18]	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]

30. What has been the trend in the *overall product cost* of these four main products during the past five years, or since they were introduced (if less than five years) ? (Please tick as appropriate)

Main products	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]

31. What has been the trend in the *order-to-delivery time* (from the moment an order is received to delivery) for these four main products during the past five years? (Please tick as appropriate)

Main products	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
1. _____	[]	[]	[]	[]	[]
2. _____	[]	[]	[]	[]	[]
3. _____	[]	[]	[]	[]	[]
4. _____	[]	[]	[]	[]	[]

Appendix A - The survey questionnaire

32. What has been the trend in *productivity in manufacturing* for the company during the past five years in terms of the measures indicated? (Please tick as appropriate)

	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
a. Labour efficiency	[]	[]	[]	[]	[]
b. Material efficiency	[]	[]	[]	[]	[]
c. Plant utilisation	[]	[]	[]	[]	[]
d. Product cycle-time	[]	[]	[]	[]	[]

33. Have overall production volumes changed significantly for the company during the past five years? (Please tick as appropriate)

	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
Production volumes	[]	[]	[]	[]	[]

34. What has been the trend in the *time to market* (from research and concept development to first manufacturing for sale) for the company’s new products during the past five years? (Please tick as appropriate)

	Significantly increased	Moderately increased	No change	Moderately decreased	Significantly decreased
Time to market	[]	[]	[]	[]	[]

35. How many new products has the company developed in (a) the last 12 months, and (b) in the past five years? (Please indicate the number of new products)

a. in the last 12 months

b. in the past 5 years

[]

[]

36. What is the relative importance, in terms of overall company sales, of new products developed by the company in the past five years ? (Please tick the box corresponding to the appropriate category)

	Percentage of present company sales			
	more than 75 %	50% to 75%	25% to 50%	below 25%
a. Products that are totally new	[]	[]	[]	[]
b. Products that are significant up-grading over previous generations	[]	[]	[]	[]
c. Products that are minor improvements over previous generations	[]	[]	[]	[]

37. What percentage of current sales derives from products licensed to you by other companies (Please indicate the approximate percentage)

a. Percentage of current sales derived from products licensed to you by other companies

[] %

38. What percentage of current revenue derives from products which the company has licensed to others?

a. Percentage of current revenue derived from products you have licensed to other companies [%]

SECTION IV: GENERAL DATA ABOUT THE COMPANY

This section focuses on general data about the company, such as recent financial performance and size, to complement the information gathered in the previous three sections

If you prefer not to disclose the data of Q. 39, please go directly to question n. 40.

39. What has been the trend in company financial performance during the past five years? (Please tick as appropriate)

	Increased by more than 10%	Increased by up to 10%	No change	Decreased by up to 10%	Decreased by more than 10%
a. Turnover	[]	[]	[]	[]	[]
b. Royalties (if relevant)	[]	[]	[]	[]	[]
b. Profit before interest and tax	[]	[]	[]	[]	[]
c. Return on Capital	[]	[]	[]	[]	[]

40. Number of company's employees at present time: _____

41. Current annual sales revenue: _____

42. What is the approximate percentage of sales in the UK and abroad?

Percentage of overall company sales

a. Sales in the UK	[%]
b. Sales abroad	[%]
	<hr/>
	[100 %]

If you would be interested in receiving a short report of the results from the research, please give your company name and address, or attach a business card.

Company name and address: _____

Could you also indicate, by ticking the box, if you would be willing to contribute to possible follow-up interviews?

YES	[]
NO	[]

THANK YOU!!

APPENDIX B – The components of a fibre-optic communication system

Light emitting components

Light emitting components are of two different kinds, LEDs and lasers. LEDs are used for short-distance communications. Infrared-emitting diodes are used in the range up to 200 Mbit/s and 2 km span. In many cases, a glass or a sapphire sphere on top of the chip is used to focus the emission onto the front face of the fibre, thereby bridging the gap between chip and fibre. Infrared-emitting diodes in the 0.8 μm range are based on Gallium Arsenide (GaAs), while those in the 1.3 μm are based on Indium Gallium Arsenide Phosphide (InGaAsP).

Lasers consist of a medium in which light amplification takes place between a pair of mirrors forming a resonator. They are made from hetero-structures in which a thin active region is formed between passive cladding regions. Elements from the family of III-V semi-conductors are normally used. Changing the thickness, structure and the materials of hetero-structure formation, semi-conductor lasers with different characteristics (in terms of the wavelength emitted, output power, electrical and optical characteristics, and noise).

There are, in fact, two categories of semi-conductor lasers, long wavelength and short wavelength. The long wavelength ones operate in the 1.3-1.5 μm and are used for long-distance trunk-line communications. Materials such as InGaAsP are used.

The short wavelength lasers (0.6-0.8 μm , visible region) are used in other applications, such as optical disks and laser prints.

The combination of fibre characteristics (silica glass) and laser characteristics affect the level of signal regeneration required, and hence the number of repeaters necessary to complete the transmission.

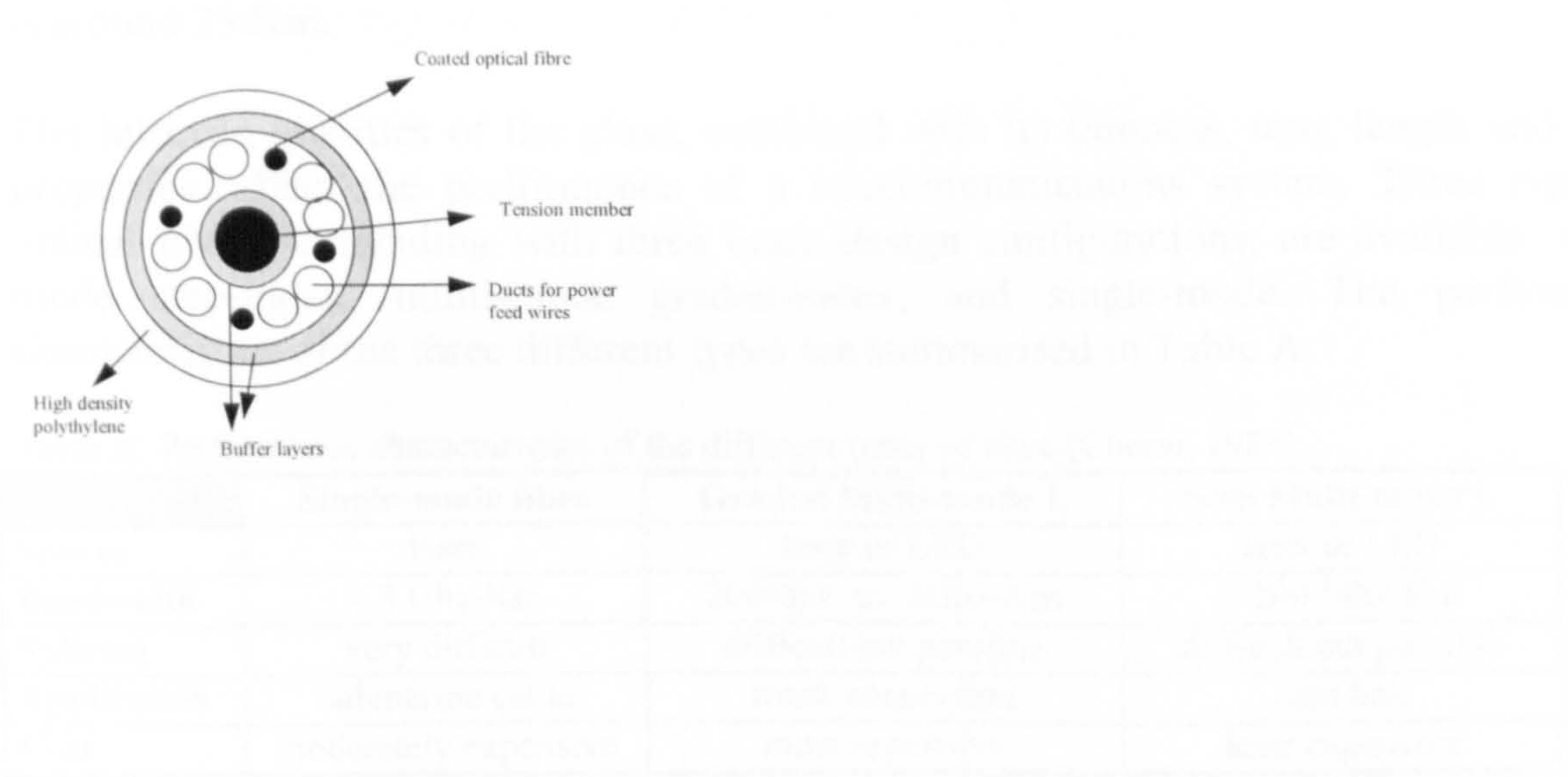
Light transmission components

Optical fibre is made of two types of glass (see Figure A). The core has a higher refractive index¹ than the glass surrounding the core (the 'cladding'). If light is shone into one end of the fibre it will pass along the core of the fibre and most of the rays of light that hit the interface between the core and cladding will be reflected back into the core. In this way light can propagate substantial distances and pass around bends in the fibre. The pure silica glass used for optical fibre has particularly low attenuation at three

¹ The speed of light varies depending on the medium it is passing through. It is fastest in a vacuum. When light passes from one medium to another (e.g. from air to water or from glass to air) its path of travel is bent (refracted) due to the change in velocity. The refractive index of a material is the speed of light in a vacuum divided by the speed of light in the material, and also relates to the amount the light beam is bent as it enters or leaves the material. The refractive index of air is approximately the same as a vacuum, that is 1. When light hits the surface between two media at a sufficiently shallow angle, it is reflected completely rather than passing through. It is this property that is the basis of the operation of optical fibre.

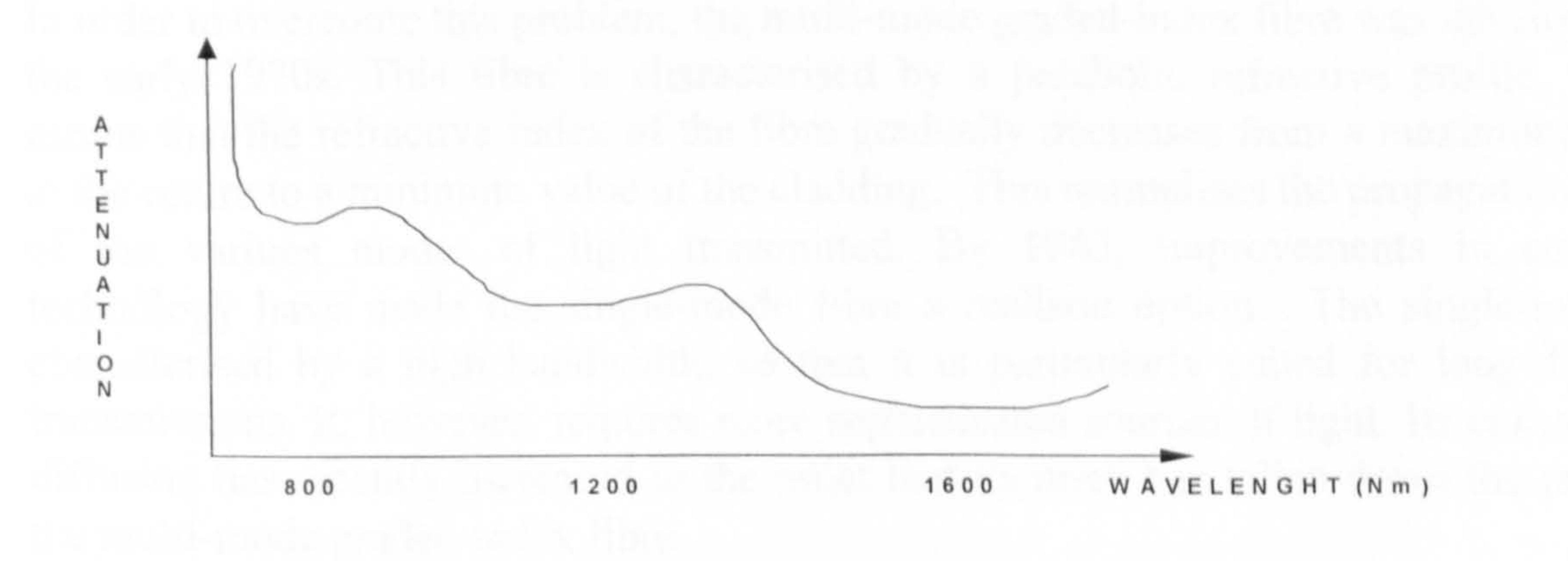
specific wavelengths, often referred to as the first, the second, and the third windows (respectively 0.85, 1.3 and 1.55 μm). The design of transmitters for use with optical fibres has concentrated on these wavelengths.

Figure A. Optical fibre: section



The schematic spectral loss curve for high silica glass is showed in Figure B.

Figure B. The spectral loss curve



The number of fibres in a cable varies between two and 260 in typical applications. The cable's overall thickness is approximately one inch - much less than a typical copper cable of lower carrying capacity. Optical-fibre cables are not subject to interference by

power lines. It is technically feasible to produce optical-fibre cables that are many hundreds of kilometres long from one pre-formed block. Such cables would offer greater performance as there would be less attenuation due to the smaller number of joints required. However they would require huge carrier drums and special heavy lifting gear to be used, as well as a greatly increased hold capacity in cable-laying ships. These factors normally mean that the maximum length of cable fabricated in one piece is around 25 Km.

The intrinsic qualities of the glass, combined with its thinness, long length and other properties, affect the performance of a telecommunications system. Three types of optical fibres, coinciding with three basic design configurations, are available: multi-mode step-index, multi-mode graded-index, and single-mode. The performance characteristics of the three different types are summarised in Table A.

Table A. Performance characteristics of the different types of fibre (Cherin, 1983)

	Single-mode fibre	Graded Multi-mode f.	Step Multi-mode f.
Source	laser	laser or LED	laser or LED
Bandwidth	> 3 Ghz-Km	200Mhz to 3Ghz-Km	< 200 Mhz-Km
Splicing	very difficult	difficult but possible	difficult but possible
Application	submarine cable	trunk connection	data link
Cost	moderately expensive	most expensive	least expensive

The first low-loss fibres produced were of the multi-mode step-index type. This type is characterised by a sharp boundary between the core and the cladding, which has a slightly lower refractive index than the core. The problem with the multi-mode step fibre is that the different modes of light travel at different speed, and therefore do not arrive at destination simultaneously. This phenomenon, known as inter-modal dispersion effect - the light pulse is spread out in time - limits the fibre's transmission bandwidth capability, and consequently its information-carrying capacity.

In order to overcome this problem, the multi-mode graded-index fibre was developed in the early 1970s. This fibre is characterised by a parabolic refractive profile, which means that the refractive index of the fibre gradually decreases from a maximum value at the centre to a minimum value of the cladding. This normalises the propagation times of the variuos modes of light transmitted. By 1983, improvements in coupling technology have made the single-mode fibre a realistic option. The single-mode is characterised by a high bandwidth, so that it is particularly suited for long-distance transmissions. It, however, requires more sophisticated sources of light. Its commercial diffusion has recently increased to the point that its price has fallen down the price of the multi-mode graded-index fibre.

Fibre-connecting components

Since fibres can only be manufactured in lengths of several kilometres, while the minimum distance between the source of light and the first receiving component (see below) is about 30 kilometres, fibres have to be connected together. Fibre-to-fibre connectors fall into two types: permanent splices and demountable connectors.

Permanent splices may be divided into fusion splicing - where connection is accomplished by applying localised heat at the interface between two butted, pre-aligned fibre ends so that they soften and fuse - and mechanical splicing - where the fibre end are hold in alignment by means of a mechanical device. De-mountable connectors are used in special applications (such as military systems or computer networks) where connections have to be changed frequently. Connectors are also used to link cables to optical transmitters and receivers pigtails.

Light receiving components

At the receiving end of a light-wave communication, the optical signal must be converted back into an electrical signal. The fundamental principle is that of photo-detection. Two different types of devices are available in this area, PIN photodiodes and Avalanche photodiodes. They also differ according to the type of material used, silicon, germanium, or III-V semiconductors.

Compared to PINs, Avalanche photodiodes have a more complex structure and achieve greater levels of sensitivity through internal amplification of the detected signal.

Repeaters are electromechanical devices used to amplify the signal when it is attenuated below a threshold level. The number of repeaters necessary to complete the transmission is dependent on a variety of factors, as shown in Table B.

Table B. How the components of an optical fibre network affect the requirements for repeaters. In this table the photo-detectors (which pick up light signals) are either photodiodes (PIN) or Avalanche photodiodes (APD)

	LED				LASER DIODE			
Fibre	Multi-mode Step index		Multi-mode graded index		Multi-mode step index		Multi-mode graded index	Single-mode
Modulation	A		A	D	A/D	D	A/D D	D
Detector	PIN	APD	PIN	APD	PIN	APD	APD	APD
Wavelength (nm)	850	1550	850	1550	850	1550	850 1550	850 1550
Repeater Spacing (Km)	2-3	20-30	8	10	10	20-30	10 20-30	10 20-100

The number of receivers represent a critical factor in an optical communications systems, mainly due to the high cost of these devices when compared to other key elements. At the moment, the cost for repeaters and amplifiers represents almost 40% of the overall cost of a communication system.

In recent times there has been a new technological development, the optical amplifier, that might substantially affect the cost of the overall transmission service. Optical amplifiers are repeaters that do not convert the light signal into an electrical signal to be re-converted into a light signal with increased intensity. There are two types: (a) the Erbium Doped Fibre Amplifier (EDFA), which completely eliminates the need for signal conversion and re-generation. The longest un-repeated span can be increased

from 200 Km (current maximum distance) to 400 Km (submarine systems); and, (b) BT's Optical Amplifier. Instead of carrying 1,900 simultaneous conversations, a single optical-fibre will be able to transmit almost 80,000. Moreover, no repeaters will be needed for a distance of 100Km as compared with the present 30Km limit.

Passive devices

Couplers are passive devices used to combine two or more light beams into one or to split one light beam into two. Wavelength Division Multiplexers allow two or more optical signals at different wavelengths to be coupled into or out of a fibre. This increases the data-carrying capacity of a fibre. The ability to provide this type of multiplexing on any fibre has long been a selling point of fibre optic cabling, as it holds the promise of increasing the usable bandwidth of installed fibres merely by the addition of a new device at each end of a link.

Switching systems

In multiplexed digital transmissions the electrical signals are 'switched' - i.e., separated and redirected - using semiconductor technology. This technology is known as 'software switching' and this process involves taking input from the cable, storing it and then transferring it to an output channel. The whole operation is carried out by a computer and must take place extremely rapidly. Switching equipment currently comprises a very high proportion of the cost of a telecommunications system.

A new technology, which is based on the idea of 'hardware switching', is being developed and is based on optical fibre transmission. ATM, first proposed by AT&T in 1985, is defined as a transfer mode in which information is organised into cells and which is asynchronous in the sense that the recurrence of cells containing information from an individual user is not necessarily periodic. One further advantage is that this type of cells can be switched using hardware rather than software and this leads to further speed benefits.

Reasons why it is sound to believe that ATM will be highly implemented are:

1. ATM is downwardly compatible with the existing telecommunications technology;
2. ATM is upwardly compatible with emerging telecommunications technologies;
3. ATM will have an enormous impact on Local Area Networks (LANs), that is networks of Pcs in a single location;
4. ATM is suitable for multimedia applications that require a large bandwidth: in general for those applications where large bandwidth is required for relatively short periods of time;
5. Existence of ATM Forum: group formed by interested industrial concerns in 1992 (more than 350 members).

CONFERENCE PAPERS AND PUBLICATIONS

S. Spedale (1998). "Explorative and Exploitative Inter-organisational Relationships in the Supply-chain. The Case of the UK Fibre-optics Industry", Paper for the 14th EGOS Colloquium, Maastricht.

S. Spedale (1997). "From Antagonism to Co-operation. Patterns of Evolution in Vertical Inter-Organisational Networks", Paper for the 13th EGOS Colloquium, Budapest.

A. Arcari and S. Spedale (1996). "Outsourcing Staff Activities: the Italian Case", Paper for the 19th Annual Conference of the European Accounting Association, Bergen.

A. Arcari, A. Pistoni and S. Spedale (1995). "The Governance of Network Organisations: Assessing the Role of Traditional Management Control Systems", Paper for the 18th Annual Conference of the European Accounting Association, Birmingham.

S. Spedale (1995) Chapters I, II, and VII (in Italian), in A.Arcari, *Managing co-operation in Network Organisations*, EGEA, Milan.

D. Pierantozzi and S. Spedale (1995). "Activity Based Costing & Value Based Management: Lessons for the SMEs" in *Finanza, Marketing e Produzione*, 2.