FIRM-LEVEL TRANSFER OF TECHNOLOGY: AN EMPIRICAL STUDY OF MODES OF INTERNATIONAL COMMERCIALISATION OF TECHNOLOGY IN BRITISH INDUSTRY

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To

Barbara

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Marcus

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TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Page

Page

LIST OF FIGURES

LIST OF APPENDICES

ACKNOWLEDGEMENTS

Going through a PhD. is a very challenging process. It is a test of resistance when your strength is tried constantly and your mind passes from a state of euphoria to one of depression in seconds and vice-versa. It is a very solitary process of thinking and writing but also a collective act of exchanging ideas. It is, more than anything else, a war against time, against the computer and, sometimes, against yourself, with the objective to reach heaven. It is not possible in this world of mixed feelings and difficulties to survive and overcome the obstacles without the support of a good number of people that cross your path offering a helping hand or staying behind backing up your actions. I will not be able to manifest properly my deep appreciation to all of those people who made my way smoother, helping me in several manners during my trajectory. Nevertheless, some of them, for their close involvement with my work, must be mentioned. Let's start with people in the front-line.

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DECLARATION

No portion of this thesis has been submitted in support of an application for another degree or qualification from this University or any other Institute of Learning.

ABSTRACT

The thesis examines the process of technology transfer in British firms. The literature on modes, causes and effects of technology transfer says little about how British firms transfer their technology abroad. A firm-level study was chosen because most international technology transfer happens not between countries but between firms, even if these firms are in different countries. The present research uses data from British industry, which is still one of the major sources of technology in the world and its firms represent an important example of the role of technology supplier.

The adopted methodology consisted of a pilot study, conducted through interviews with executives related to technology in six different firms, using a semi-structured questionnaire, and a survey, conducted through a structured mail-questionnaire, sent to British firms which transfer technology overseas.

In the light of an extensive literature review and the pilot study, several non-exclusive dimensions of the transfer of technology related to home market, technology, foreign government policy, firm's attribute and foreign market were identified and an analytical framework was developed, aggregating those dimensions, that were tested through the survey.

The findings suggest that two main groups emerged from the sample. One is described as market/investment led. Its firms usually transfer their latest technology, prefer licensing as their main form of going abroad, are more aggressive, impulsive and dynamic and they transfer their technologies independent of their concerns about the consequences that it can bring to them. The other group is described as control/relationship orientated and its firms are more conservative, follow an incremental mode of internationalisation, do not transfer their latest technology and tend to collude with other firms in a foreign market.

The decision of the firms on international operations is generally not influenced by characteristics of the home market or the age of technology. Similarly, attributes of the firms do not appear to have a major influence. Foreign government policy is recognised as very important in defining the process of technology transfer and attributes of foreign markets are important enough to motivate firms to go abroad.

CHAPTER 1

INTRODUCTION

1.1 Background

The present study aims to examine the way British firms transfer technology abroad. The researcher's interest in the subject stems from previous research developed by him, concerning firms which receive foreign technology in a Third World country[1]. That research has led to the present study of the other side of the relationship, the suppliers, in an attempt to understand more fully the overall process of technology transfer.

Technology plays a fundamental role in the world economic system. It can drastically change standards of competition, creating new industries and leaving others without a function, and it can totally remodel forms of production and services. The possession of an unique technological asset might thus ensure a firm of a leading position in the market.

The development of technology has been substantially centralised in large firms of developed countries. Because of this, the transfer of technology is a basic prerequisite for less-developed countries to achieve economic growth; for Teece (1977), the economic growth of every nation is inextricably linked to the successful international transfer of technology.

Firms supply technology abroad for a series of reasons. One reason is factor price when production in another country can generate more profits than production at home. In addition, when legal restrictions mean it is not possible to trade,

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1 See Hemais et al (1986, 1989a)

investing overseas can be a way of overcoming the constraint. Another reason for transferring technology abroad is to take advantage of geographical factors of foreign export platforms, which makes producing in these special locations a better choice if a firm decides to service the world market.

Raising funds to support internal R&D is also an important reason to transfer technology. Investments in R&D are becoming increasingly more costly, and firms need to arrange new sources of funds to maintain these activities. Furthermore, the exploitation of technology in a new market strengthens the competitive advantage of the firm, not only in this external market but also at home, with the incremental support for R&D activities.

Firms are re-examining their policies for the administration of their technological assets and adopting diverse strategies, when they transfer these assets to other countries. This re-examination is caused by various tendencies of the world's economy, including the growing risks caused by fluctuating currencies, inflation, recession, stagflation, substitution of imported merchandise, in addition to the increasing rise of trade barriers and the risks of the political-social instability of many countries. All these risks lead firms to act more cautiously in terms of investment of capital abroad; consequently they are an important factor in determining the way in which technology is transferred.

1.2 Objective of the research

The main goal of the present research is to explain the process of technology transfer in British firms. The literature on modes, causes and effects of technology transfer does not say very much about how British firms transfer abroad the technology they develop. The present research expects to contribute to this understanding, through an examination of diverse sectors, sizes and ownership, observing whether these differences influence the way technology is transferred from the UK to overseas. In addition, the type of production, skills of labour force, orientation of firm, and R&D tendencies are explored.

Several dimensions related to the transfer of technology, such as modes of transfer, characteristics of suppliers and characteristics of receivers, are combined in one model, as an aid to explaining the process.

1.3 Scope of the study

It is necessary to explain the boundaries of the theme of the study. First of all, the level of the transactions with technology which was chosen was that of the micro level. Second, not all forms of transfer of technology are within the target of the present research: only those that are related to a business transaction. Finally, Britain was chosen as the industry to be analysed.

It should be also explained that a series of operational definitions were made, based on the literature and on the study of the process of technology transfer, aiming to limit the range of the research. These definitions are related to technology, ownership of firms, size of firms and sector of activities and constitute Appendix 1.1.

1.3.1 Firm-level transfer

There is a vast literature on the study of technology transfer at macro level. This literature highlights questions such as the economic and social impact of the process of transfer, technological dependency and appropriate technology, trade between countries, national benefits from the export and import of technology, and so on. However, in spite of the importance of the macro study of the international flow of technology, it should be emphasised that, nowadays, most of the international technology transfer happens not between countries but between firms, even if these firms are in different countries. And going one step further, it can be stated that a growing proportion of the technology trade occurs at intra-firm level, i.e., between units of the same firm, located in different countries[2]. This is *per se* a good reason for starting research at the level of firm transfer of technology. Furthermore, an analysis of the modal choices made by firms when they transfer technology abroad can be done more properly at the micro level.

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2 On this subject, see Brooke (1986), Hemais et al (1989b) and Aggarwal & Agmon (1990).

1.3.2 Commercialisation of technology

Technology, as proposed by Jenkins (1987), is an asset derived from past investments in R&D. As not all firms have access to technology, it is necessary to consider the conditions under which technology is diffused and transferred. According to the author, the transfer of technology has all the elements of a business transaction, thus it should be more properly called commercialisation of technology. As stated in a document from the United Nations Centre on Transnational Corporations (UNCTC, 1987), commercialisation of technology implies that the technology is made to constitute a commodity or an asset which is produced, thereby incurring production costs, and from which an income is earned, whether that income is in the form of profits or of revenues from sale, lease or rental. Cooper & Hoffman (1978) emphasize that, once the commodity attributes of technology are recognized, it is natural enough that international trade in technology should come to be looked upon as analogous in some respects to trade in goods.

1.3.3 British industry

Despite the fact that the transfer of technology from one country to another has existed for hundreds of years in a sporadic form, it became more prevalent and structured only after the British industrial revolution, when Britain provided the basis for industrial development first to Western Europe, then to the USA. Britain led the world in technology until the beginning of this century, when American firms gradually replaced UK firms in this leadership[3].

Today, even though the technological performance of the UK is unsatisfactory when compared with other countries such as the USA, Japan or Germany, British industry is still one of the major sources of technology in the world and their firms represent an important example of the role of technology supplier[4].

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3 See Harris (1991) for an historical approach of the movements of technology in Britain in the last two centuries.

4 For discussion of the subject, see Stubbs (1980), Dunning (1983a) and Patel & Pavit (1989).

1.4 Organisation of the thesis

The thesis is organised in eight chapters. The process of technology transfer will be examined and discussed through a review of the literature in Chapter 2. Definitions of technology are summarized and the main modes of technology transfer are analysed together with the environment where the technology is transferred. Finally, the major theories of international production are examined, with attention to the points that are of particular interest to this research.

The development of the research hypotheses, with the construction of a model representing how the process of technology transfer evolves, will be the object of Chapter 3. A description of the pilot study realised is also found in this chapter. Chapter 4 will examine the methodological procedures followed by the research, explaining in detail the reason for the choice of those procedures, as well as the development of the measurement instruments used in the survey.

The operationalisation of the methodological procedures will be explained in Chapter 5. The field work is analysed, exploring the process of application of the questionnaire. Tests for the acceptability of the results are examined, as well the preliminary statistical adjustment of the data. And Chapter 6 will deal with the description of the results obtained by the survey, and with the characteristics of the sample studied.

General findings of the research and tests of the hypotheses will be presented in Chapter 7, when the results are discussed in the light of the literature and of the pilot study. And, finally, Chapter 8 will present the main findings of the research, the implications of these findings, the limitations of the methodology, as well as directions for future research.

Appendices are included, containing operational definitions, characteristics of the firms participating in the pilot study, correspondence related to the research, a copy of the questionnaire, and statistical programs used, to illustrate the procedures adopted, as well as to support the results obtained.

CHAPTER 2

TECHNOLOGY AND ITS INTERNATIONAL TRANSFER: AN OVERVIEW OF THE LITERATURE

2.1 Introduction

The market for technology is highly imperfect. This is the result of a notable concentration of technology in a few countries, which gives them an oligopolistic advantage. At the same time, there are restrictions, originating from the proprietary rights on the transfer of knowledge, which inhibit access to this knowledge. On the other hand, because of these imperfections and restrictions, with the pricing of technology being generally indeterminate, there is vast ground for negotiations, when the suppliers and receivers can use their bargaining power, trying to obtain the best for their business[1].

Krugman (1979) sees the great capacity for exploiting a new technology as the leading advantage of developed countries. Technological leadership, resulting from investments in R&D and its exploitation, is an important factor of the competitiveness of the firm. The transfer of technology can generate high profits, open passages to markets which are hard to enter, reduce the time between development and application, create new markets for other products of the firms, and allow access to foreign technologies through reciprocal grants.

British industry, credited with the Industrial Revolution, though now experiencing problems which leave it lagging behind other countries in Western Europe, is still one of the most important in the world and maintains a high level of local R&D which generates first class technology. Some British firms are among the

1 See Lecraw (1981) and Stewart (1979) on the subject.

most profitable in the world (Davis et al, 1991), and as a whole, its industry supposedly has a considerable technological base which has been exploited for many years.

The objectives of this chapter are to examine the literature related to the issue of international transfer of technology and to attempt to understand the process of British technology transfer at firm level.

Since there is not a generally accepted definition of technology transfer, this chapter will initially consider the meaning of the term, then discuss which options are open to firms as they look for new markets outside their national boundaries and why they choose a particular option.

In the process of crossing borders several elements influence the way receivers and suppliers negotiate technology. In this chapter special attention is given to the participation of governments in all the stages of the negotiation. In addition, the international environment where this transfer of technology occurs is examined, with attention to the main opportunities and constraints British industry will face in the 1990s. Two major aspects of the environment are represented by the strong Japanese industrial presence all over the world and the creation of a unified market in Western Europe from 1992 on.

Finally, the main theories of international production are presented in this chapter, in an attempt to seek a theoretical framework to support the research.

2.2 Process of technology transfer - definitions

To understand the process of transfer of technology, it is necessary to understand first what technology is. A number of authors[2] have formulated some interesting definitions of the term, describing technology as engineering documentation, manufacturing techniques, system-specific knowledge, knowledge embodied in process and products. Differing noticeably one from the other, these

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2 See the definitions of Cutler (1989), Madu (1989), Metcalfe (1986), Robock & Simmonds (1989), Rodriguez (1981), Magee (1981) and Krugman (1979).

definitions demonstrate the complex character of technology and the difficulty of formulating a comprehensive explanation of it. However, they have a common point: they identify one element which is crucial for explaining the process, i.e., technical knowledge. This technical knowledge is responsible for changing the face of the industry and, consequently, can alter dramatically the competitive equilibrium of forces among firms. This technical knowledge is related to (1) principles of physical and social phenomena, (2) application of these principles to production, and (3) day-to-day operations of production, as Mansfield (1971) proposes in his definition, where technology is essentially related to the industrial arts.

In Mansour's article (1981)[3] there is a definition suggesting that technology is ideas, knowledge and know-how. The author makes a distinction between industrial technology and scientific knowledge, saying that the latter, by itself, is not sufficient for the promotion of technological progress - it is only one part of a group of requirements necessary for the spread of technology among firms. The notion of technical knowledge is still part of the definition but the author introduces a new element in the definition, i.e., know-how.

To promote the transfer of technology four main items are necessary, as Contractor (1983) emphasises: information, services, rights and restraints. He is referring, for example, to the transfer of formulae, models and descriptions, the construction of plants or testing of products, the use of patents and trademarks, and the restrictions on purchases and sales. The notions of information and services can be correlated with the terms technical knowledge and know-how, as used by Mansour. Contractor limits the scope of meaning of the two notions when he adds legal constraints (rights and restraints), such as regulations on payments, prohibition of the use of knowledge and know-how in other locations, prohibition of the exporting of products to other countries, and so on.

In the study by Pugel (1981:12), following the neo-classical economic model, technology is the available methods by which the resources, or factors of production, may be combined into products. As a result, its international transfer is the process by which "newly created technology developed in one country is made available to other countries". Jenkins (1987), however, argues, contrary to the neo-classical

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3 Mansour (1981) offers a useful compilation of the main contributions of several authors on the transfer of technology; he refers to Hayen, Hall & Johnson, Roberts, Baranson, among others.

economic model, that technology is a commodity which is not universally available to all firms. Technology is not a free public good with zero social marginal cost; firms invest in new technology in the hope of earning surplus profits from the exploitation of an unique asset.

International transfer of technology, as Fransman (1985) views it, is the process whereby knowledge relating to the transformation of inputs into outputs is acquired by firms, research institutes or other entities in a country from sources outside that country. It should be added that it is not only the required knowledge which is transferred, but also various marketing rights associated with it (Stewart, 1979).

Although there is some overlap among the definitions of technology, there does not seem to exist a consensus as to what is meant by technology and its transfer. Lall (1984a), however, explains that in the conventional literature on the subject there is an area of convergence of ideas: it is considered that technology transfer does not include the sale of capital goods per se (without engineering or technical services included), the migration of skilled manpower or the diffusion of innovation through publications, conferences, and/or personal visits.

Technology, then, comprises several components and involves a complex group of activities for its transfer. It is the result of human effort and material resources; in addition, the transfer demands a real infrastructure, R&D facilities, legal procedures and so on. For the purpose of this research, considering the elements found in the literature, such as technical knowledge and know-how[4], and the commodity aspect of technology[5], the following definitions will be used, as stated in Appendix 1.1: (1) technology is the knowledge regarding the transformation of inputs into outputs; (2) technology transfer is a process by which knowledge and other items related to technology are transferred from one economic agent to another; (3) international technology transfer is any kind of transaction involving the transfer of knowledge and other items related to technology from one country (supplier) to another (receiver).

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4 See Mansour (1981) among others authors already cited.

5 The commodity aspect of technology is consistent with Jenkins (1987).

As the objective of this research is to study international technology transfer at firm level, an analysis will only be made of those aspects of technology transfer that have commercial interest. The definitions used in this research have a purposely broad character as the intention is not to restrict the interpretation of the data obtained. This delimitation is in keeping with what is found in Lall (1984a) and UNCTC (1987). These studies exclude from their focus "non-commercial" movements of technical knowledge such as technical journals, conferences, publications, international migration of manpower and the training of foreign students in technical institutions (which could be properly classified as cases of technology transfer), as well as capital goods sale.

2.3 Exporting of goods/services versus technology transfer

In the intricate universe of international business, an array of elements can influence the behaviour of companies, specially when they decide to go abroad. The transfer of technology usually follows an international movement of the firm. This movement can be of several types, and in almost all of them technology is one of the main factors in the transactions.

According to Porter (1990a), when there are economies of scale, firms must be forced by the competition to look for foreign markets in order to improve their efficiency and profitability. This flow is supposed to adhere to a pattern, which predicts a behaviour of, first, exports, second, licensing and, finally, foreign direct investment (FDI), "in a market subject to autonomous growth" (Buckley & Casson, 1981:80). This pattern was also found in Johanson & Vahlne (1977), who commented that the firms act incrementally because of the uncertainty and imperfection of information on the market[6].

Other authors have taken a similar view. Bilkey (1978), for instance, states that firms have an incentive to export in order to avoid losses from an already saturated domestic market with declining sales. Therefore, exporting would be the first step in the direction of the international market. This would increase the use of

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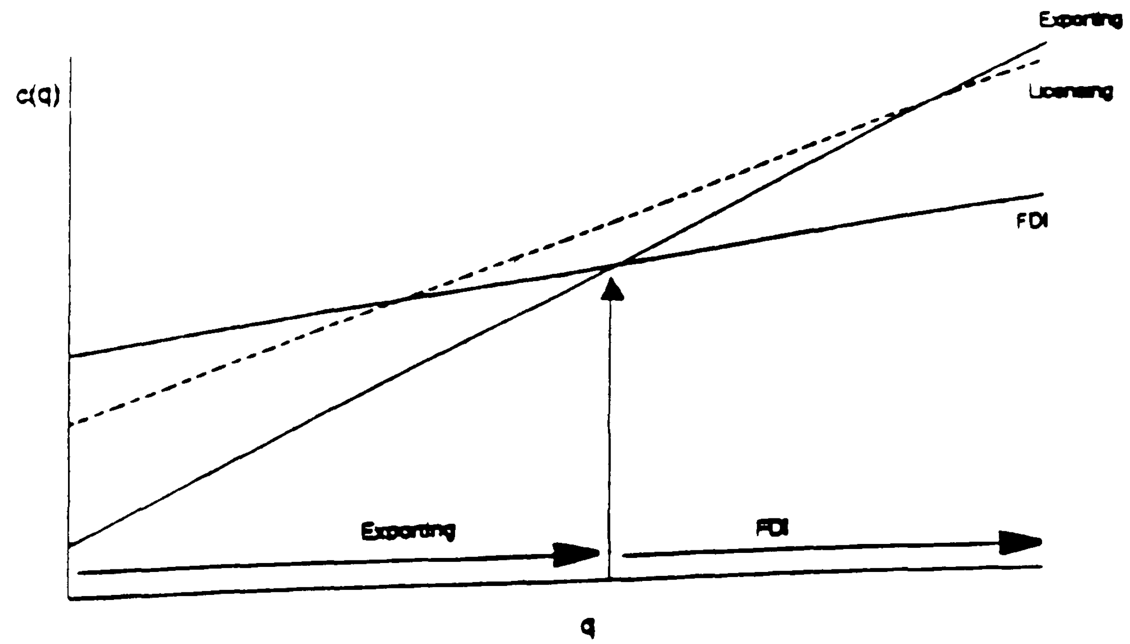
6 However, Millington & Bayliss (1990), in a survey of 50 UK manufacturing companies, did not find support for the "incremental view of the process of internationalisation".

the idle capacity of the plant in the source country, as Buckley & Casson (1981) point out. As shown in Figure 2.1, these authors explain the inverse proportion of the fixed costs in contrast with variable costs when the firm opts for exporting, licensing or FDI abroad. Exporting involves low fixed costs, because the firm is using its original plant whose capacity was increased to produce extra goods for sale abroad. But exporting involves high variable costs associated with transportation, tariffs and the establishing of distribution channels abroad. Licensing incurs costs relating to the monitoring of the licence, and these costs are added to the costs of production by the licensee. These fixed costs are higher than the fixed costs of exporting. On the other hand, this mode avoids the costs of transportation and tariffs, because the licensee is likely to have a distribution network already working; additionally, by producing in the host country, the licensee avoids incurring payment of importing tax. Therefore, the variable costs are decreased, when compared with the first option. Finally, because of the construction of a new plant and its work the FDI are likely to have fixed costs which are higher than the licence. However, once the plant starts producing in a steady state, the variable costs tend to be lower than those of the other two options.

Figure 2.1

Fixed costs versus variable costs



q = size of the market, quantity demanded at the limit price
c(q) = total cost function

Source: Buckley & Casson (1981: 90)

Furthermore, the authors suggest that the choice of the manner of market servicing depends upon "the cost structures of alternative modes and the pattern of market growth" (p.80)[7].

When exports to an attractive market encounter obstacles such as host government regulations, this is the time to start considering other forms of operating abroad. There are additional reasons for such a move: the need to overcome trade barriers, or to secure supplies of raw materials, the fear of losing a market to competitors and the penetration in a new market, the satisfaction of the foreign government regulations and the maximization of short and long-term profits (Czechowicz et al,1982). Further reasons for transferring technology are export-platform linkage which exploits cheap labour, and conglomerate operations which achieve risk reductions by exploiting the principles of a mutual fund.

Firms transfer technology to make profits usually because suppliers have the main share of the benefits[8]. In addition, they are able to realize returns on their technological assets in several ways, such as "dividends on equity investment, sale of components and parts, royalties, licensing fees, and technical assistance fees" (Baranson, 1970:436).

This section examined the decision of a firm to go abroad, when the firm has passed through the first option of exporting. This strategic alternative is usually taken after it has been recognised that expansion is necessary and growth in the home market is impossible. But the simple decision of the firm to start exporting is not enough for it to happen. Several factors, especially the direct prohibition of importing by the host governments, must be weighed before a firm opts for a way to mark its international presence. The factor cost is also an important element and there is an inversion of fixed costs in relation to variable costs when firms follow the progressive process of internationalisation, starting with exporting.

In spite of exporting being the first option of firms, many times it is not possible to follow through with the exports, and other forms of international presence

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7 A similar approach is found in Aliber (1970) and Hennart (1991).

8 This statement finds supported in Dunning (1981).

must be chosen. The next section will examine the main options firms have for transferring technology abroad, other than the exporting of goods or services.

2.4 Modes of technology transfer

Transfer of technology and administrative services abroad is a policy that firms have adopted as a way of generating a fast return on their investments in technology. The high costs of R&D and the tendency of products to have a progressively shorter life cycle make it necessary for the firms to exploit the new products internationally to generate cash for further developments. There is no statistical data on the value of all categories of the international transfer of technology, because most of the payments for it are hidden in other payments. Only the USA makes available data on management, professional and technical services, beyond royalties and fees under licensing agreements (UNCTC, 1987). There are usually no records of the transfer between affiliates or parents and subsidiaries, for example. But one can imagine the importance and the rate of growth of these international transactions through the data which are made accessible (Table 2.1):

Table 2.1

Technology trade of selected developed countries

1965 - 1985

(Millions of US dollars)

	USA		UK		France		Germany		Japan		Total	
	1965	1985	1965	1984	1965	1984	1965	1985	1965	1983	1965	L.Y.*
Receipts	1534	8512	138	1194	169	4804	75	545	27	1014	1943	16069
Payment	135	207	131	845	215	2872	166	995	133	1176	780	6095
Total	1669	8719	269	2039	384	7676	241	1540	160	2190	2723	22164
Balance	1399	8305	7	349	-46	1932	-91	-450	-106	-162	1163	9974

* L.Y. = latest year

Source: UNCTC (1988: 178)

As can be observed in Table 2.1, the amount of US dollars involved in transactions of technology are substantial. In the period of twenty years, the balance of technology trade increased in almost 860%. It should be noticed that Britain, in that period, strengthened its position as a seller of technology, in opposition to Germany and Japan, which were predominantly buyers of foreign technology.

Most of the foreign operations of firms include the international transfer of technology, which happens much of the time in a transnational corporation (TNC). Bertin & Wyatt (1988) claim it is essential that a firm transfers technology abroad to keep up to date with what is happening in the world of technology and R&D (irrespective of the cost and risk). Contractual arrangements are liable to differ between neighbouring countries and distant countries, and between countries at different stages of development. Differences in strategies for negotiation of technology over a period of time are common and may be explained by changes in the political climate, or by the state of international communications. Moreover, the differences may emerge as the firm evolves through phases of growth which are specific to the firm itself (Casson, 1987).

In his survey of technological change in the Third World, Fransman (1985) presents the most common modes of transfer of knowledge used by exporters of technology (Table 2.2).

Table 2.2

Modes of technology transfer

	Active role for foreigners	**Passive role for foreigner**
Formal (Market Mediated)	direct foreign investment joint venture turnkey project management contract licensing	machinery purchase
Informal (Non-Market Mediated)	learning-by-exporting	imitation trade journals scientif. exchange

Source: Fransman (1985:577)

For the purpose of this research, only the modes in which the foreigners (suppliers) play an active role in the transfer and which are market-mediated will be studied (see top-middle corner). It can be suggested that the commercial channels utilized for the transfer of technology are transferred to a subsidiary completely owned by the firm, or investment in facilities partially owned by the technology proprietor or sale of technology to another firm without any relationship (arm's length transactions).

The main influence determining the way technology is traded is the interference of the home and the host governments, as recognised by Dunning (1983a). However, what really determines the mechanism of transfer of technology is the willingness of the supplier to supply technology in a particular form and the desire and ability of the receiver to acquire it in a particular form (Stewart, 1979).

The discussion is extended by Erramilli & Rao (1990), who identify in the literature factors that determine the way firms enter foreign markets. These factors are shown in Table 2.3.

Each one of the factors shown in Table 2.3 strongly influences the way companies enter a foreign market, and, consequently, transfer their technology, as will be explained in detail in Chapter 3. To these factors can be added, among others, the structure of the market of the host country (monopoly/oligopoly), the nature of the production process, the politically risky situation for investment in the host country as well as the reciprocal use of technology[9].

It is worth pointing out the importance of cultural distance, in influencing the entry mode, and this phenomenon has been the object of several studies. It has been recognized that US firms prefer wholly owned subsidiaries in countries such as Canada, the UK and Australia, which have markets very similar to the US market. Cultural distance, however, increases the use of licensing and joint venture for transferring technology abroad[10].

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9 See on the subject Cosset & Roy (1991), Aggarwal & Agmon (1990), Clegg (1990), Fatehi-Sedeh & Safizadeh (1989), Bertin & Wyatt (1988), and Lecraw (1984) for examples.

10 See, for example, Solocha et al (1990), Kogut & Sing (1988) and Davidson (1982).

Table 2.3

Factors determining firms' choice of foreign market entry

Nonbehavioural Determinants	Behavioural Determinants
- **Product characteristics** (degree of differentiation, importance, age and technological content) - **Firm characteristics** (size, resources, degree of diversification, corporate policies) - **External environmental factors** (host country trade and investment restrictions, market size, geographical and cultural distance, exchange rate of fluctuations)	- Decision-maker's knowledge of foreign markets and the perceptions, opinions beliefs, attitudes born out of this knowledge - Knowledge: **objective** (which could be taught); and **experential** (which could be acquired only through actual operational experience in the foreign market)[11]

Source: adapted from Erramilli & Rao (1990:137)

One item that has raised a great deal of interest recently is the knowledge of the market[12]. The decision-maker needs a certain amount of information in order to be able to weigh the uncertainties and risks in the new market. If the level of information is low, the firms do not have an incentive to commit financial resources in the new market. Erramilli & Rao (1990), in their study of service firms in the US, concluded that experiential rather than objective knowledge influenced decision-makers more strongly in their commitment of resources to foreign markets.

In this section, the importance of the international transfer of technology was presented as well as the main modes of these transfers. Determinants of entry in international markets were highlighted in the first attempt to explain how firms start their international operation. The following sub-sections will examine each of the options of entry in the foreign market.

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11 Erramilli & Rao cite Johanson & Vahlne (1977) in this part of the classification.

12 Erramilli & Rao (1990) present a list of some relevant literature on the subject.

2.4.1 Foreign direct investment

According to the adopted definition of UNCTC (1987:3), the foreign direct investment (FDI)[13] is "the establishment by a transnational corporation of an affiliate in a foreign country over which the parent firm is therefore assumed to exercise effective control". Two considerations should be made on the definition: first, it defines as transnational corporation each firm that has at least one branch abroad. Second, it calls this branch "affiliate". Most of the literature surveyed calls the foreign branch of a transnational corporation a "subsidiary" when there is an effective control of the parent firm on it. The term "affiliate" is commonly used for joint venture, which is a specific form of FDI.

Technology is an important part of a complete package, in which can be incorporated "capital goods, industrial property rights, in the form of patents, trade marks, and brand names; secret unpatented process know-how that is specific to the investing firm; and the investing firm's accumulated experience and skills in organisation, management and marketing" (UNCTC, 1987:3).

FDI seems to be the preferred form of technology transfer in several industries characterized by research and development intensity, the role of patents, brand names and trade marks, and the importance of promotion and marketing strategies (UNCTC, 1987). This would be a way to protect the technological asset as the firm could have total control over it. However, this form of investment is found in all kinds of industries all over the world, and Gilpin (1987) remarks that what certainly determines the choice of FDI in both developed and less developed countries is the level of trade barriers around the globe. As Teece (1981a:46) comments, "the marginal cost of employing knowhow in a subsidiary is likely to be much less than its average cost of production and transfer". Dunning (1981:328) makes one further point saying that the main incentive to promote FDI is "to capture the full economic rent on the package of technological ingredients", because without technology FDI would become portfolio investment.

In his important contribution to the understanding of the foreign operations of US firms, Hymer (1960/1976) stated that there are two main motives for a firm to operate abroad (through FDI). One is to control enterprises in different countries and

13 Several authors call this form of investment a direct foreign investment - DFI.

remove competition between them and the other is to use the firm's competitive advantage abroad. Dunning (1988a) proposed that what makes a firm enter a foreign investment activity instead of exporting its products is the exploration of the location-specific advantage and the ownership-specific advantage[14].

Among other reasons to go international through FDI, there can be cited the defense of a market, better protection of the technology, the overcoming of tariff barriers and import controls by the host government, lower costs (especially transports and tariffs) in the new location, access to foreign knowledge, expansion of the firm, and the following of the competitors' moves[15]. On the other hand, dealing with a foreign government can constitute a significant burden for the firm, for several reasons: the level of necessary information for establishing a subsidiary abroad is, sometimes, very difficult to obtain; the investment to start a subsidiary abroad is considerable and the risks of operating in other countries are at times unforeseeable. As Giddy (1978) stated, FDI is expected when, in view of the international market imperfections, the firm has to pay higher costs (as happens, for example, in the case of the monopoly of raw materials) or obtain low returns (because of buyer monopsony, such as a foreign government). Otherwise, the cost of surmounting the social stigma of being a foreign-owned firm is steep.

The next section will discuss one special form of foreign direct investment, i.e., the joint venture, in which the parent firm has part-control of the foreign firm.

2.4.2 Joint venture

"Joint venture is a business association between two or more parties who agree to share the provision of equity capital, the investment risk, the control and decision-making authority, and the profits or other benefits of the operation" (UNCTC 1987:3).

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14 These thoughts of Hymer and Dunning will be discussed in more details in the section 2.10, on theories of international production.

15 See, for examples, Dunning (1991a), Porter (1990b), Solocha et al (1990), Bertin & Wyatt (1988), Gilpin (1987), and Giggy (1978).

Basically, joint venture is a foreign direct investment made by a firm, with the characteristic that in this case the ownership of the new business is divided by this firm with a local partner or another foreign firm. It is common that the participation of a parent firm in a joint venture is through the provision of technology, while the local partners provide the capital, the knowledge of the new market, the labour and the local government support. According to Buckley and Casson (1987), joint venture could be better understood with the inclusion of the following three factors in the definition: internalisation economies, indivisibilities and obstacles to merger. Casson (1987) builds on this point suggesting that joint venture (as well as the licensing) is more commonly adopted in the early stage of growth of the firm, when it still is not prepared to take a heavy equity involvement abroad.

The payment of the technology in a joint venture usually takes the form of royalties paid for the use of patents and trademarks, technical assistance fees, management fees or the supply of raw materials or component parts[16].

It should be emphasised that even when the firm prefers to establish a wholly owned subsidiary, it may not be possible to do so. This is the situation especially in the cases where there is an attractive domestic market but strong government intervention; joint venture may be the only possible option for having participation in a new market other than an arm's length operation. The literature[17] points out the case of countries such as Japan, China, India, Korea and Mexico that try to restrict whole foreign ownership investment in their territories but favoured partnership with locals. In past years US-TNCs were well known for their resistance in adopting joint ventures. However, more recently, they have come to use joint venture instead of FDI because of political, economic and technological factors, as host countries demand the participation of a domestic partner as a condition to giving access to their markets. An additional factor which has led to this tendency is the growing competition from European and Japanese firms which accept joint venture where US firms force their presence through whole ownership[18]. The policy of choosing joint venture has been followed for many years by Japanese companies, especially in the sector related to raw materials. Japanese companies have adopted joint venture with

16 For a discussion on the subject, see Rafii (1984).

17 See Gomes-Casseres (1989), Gilpin (1987), among others.

18 Gomes-Casseres (1989) and Gilpin (1987) discuss this subject.

a local partner in countries rich in raw materials in order to supply inputs for their own requirements not satisfied by Japanese production.

Risks of the foreign investment should be carefully weighed before the adoption of joint venture. Buckley and Casson (1987) explain that although there is no substantial difference between the cost of a joint venture compared with other forms of international operation, there is a difference in political terms, as political risks are lower in the case of the other forms of foreign investment.

It has been observed by Mowery (1989) that joint venture is a reasonable option in terms of costs and risks, compared with FDI, and in terms of fast access to a new market, compared with exporting. It also permits better control of the technology, compared with licensing. The author also suggests that joint efforts of partners in managing the development and the transfer of the technology are vital for the achievement of the goals of the new activity.

Gomes-Casseres (1989) considers both the reasons for joint ventures and the risks associated with them. He recognizes the tendency of host governments to restrict foreign ownership; yet, as the author suggests, the provision by local partners of management expertise and local connections is a faster way to enter new markets with limited capital. Also, in order to achieve global scale in R&D and production, and to share costs and risks, joint venture is an attractive option. Yet this option can result in failure. In fact, there are restrictions on the control of technology and production and there are divisions of interests, and these factors can erode the competitive advantage of the supplier. Furthermore, the author points out that between 1/3 and 2/3 of joint ventures eventually break up because the choice of partner was wrong or, in spite of the fact that the choice was initially right, there was a significant change at a later stage.

Joint venture does not seem to be a preferred choice of strategy in some cases. In his study of US transnational corporations, Gomes-Casseres (1989) found that firms with great experience in doing business abroad are less likely to adopt joint venture as their main choice of investment. In addition, the similarity of cultural environments of the countries of supplier and receiver has the same effect, i.e., of encouraging whole ownership. The same fact seems to happen within firms with unique intangible assets (such as technical know-how and product image), and when the new market is characterized by high transaction costs. Otherwise, in countries in which suppliers are completely unfamiliar with their environments, and where legal restrictions on incoming investment and political risk are bigger, the probability of joint venture increases[19].

Davidson & McFetridge (1985) argue that joint venture is a poor substitute for intrafirm exchange because the income received is less than through an FDI situation and because the local partner, having access to the technology, may try to change the terms of the transaction. Casson (1987:123) found in several authors the idea of joint venture being "the 'second best' solution imposed by host government requirements". The author, however, makes one further point by identifying that "there is growing recognition of the fact - fully supported by historical studies - that joint ventures are often the 'first best' strategy for an investing firm", because of the share of risks and managerial responsibility.

2.4.3 Licensing

The licensing agreement is defined by UNCTC (1987:3) as "a legal contract under which the licensor confers certain rights upon the licensee for a specified duration in return for certain payments. The right may consist of permission to use industrial property rights, such as patents, trade marks, brand names and copyrights; and it can include secret unpatented know-how, such as methods of production, scheduling and quality control, which are usually combined with the provision of technical services".

It is worth pointing out a particular form of licensing: franchise. This is an agreement in which the franchisor concedes rights to the franchisee in the form of the use of a trade mark, plus the services of technical assistance, training, merchandising and management, in return for certain payments (UNCTC, 1987).

As Clegg (1990:232) reports, licensing "is determined by the degree of impediments to trading via either route". When there are constraints against FDI or joint venture, licensing offers a way of commercialising technology and overcoming restrictions imposed by foreign governments on the internalisation of the use of technological assets. In these markets virtually closed to imports and any form of

19 For more details, see Hennart (1991), Gomes-Casseres (1989) and Davidson & McFetridge (1985).

FDI, licensing becomes the main option for securing returns on investments in technology. Evidence for this kind of procedure can be found in the case of some developing countries, who have or used to have a stringent policy against foreign investments. At the beginning of the 1980s, when owing to a slow-down in world economic growth, several of these developing countries started to allow the progressive liberalisation of international trade. They became more flexible with FDI and joint ventures, in order to attract new sources of technology, to gain access to foreign technology or even to increase domestic competition. This was particularly the case of countries such as Korea, and its policy change towards FDI was a typical example of this scenario (UNCTC, 1988).

Among factors determining the propensity to license are inexperience in foreign markets, characteristics of the environment, size and rate of growth of local markets, stage of industrial development of the host country, availability of qualified licensees, level of perceived political risk and knowledge of the new market[20]. The lack of knowledge of the market, as Buckley & Davies (1981) claim, explains licensing as a short-term venture, to be deserted or substituted by FDI as soon as the necessary information is obtained. This has been an increasing tendency in recent decades, and Prasad (1981) explains that in the 1950s licensing agreements usually had a duration of between 10 and 20 years. This period has been changed to 5 to 7 years' range, with 10 years being the longest.

Porter (1985:191-2) points to some reasons why awarding licences may be strategically desirable: (1) the inability to exploit the technology; (2) the tapping of unavailable markets; (3) rapid standardization of the technology; (4) poor industry structure; (5) creation of good competitors. Porter (1988), also, emphasises that licensing is a device used by firm-leaders to obtain income from their investments in technology and for followers to have access at low costs to that technology without expending resources in trying to imitate it. In the case of the licensing of firms that do not compete with the leader, it can be beneficial for the leader to do licensing as a way to increase its profits and favour its leadership strategy. However, the licensing to a noncontrolled firm deserves a careful study of the cost-benefit ratio[21]. In the case of the followers, there is a trade-off between the licensing fees and the cost of imitation.

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20 See Erramilli & Rao (1990) and Davidson & McFetridge (1985) among others.

21 The same line of ideas is found in Telesio (1984).

It has been recognized that many times a firm prefers to license technology rather than engage in its own development of technology (Stoneman, 1987). The reasons Stoneman gives for this procedure are the difficulty in absorbing the necessary knowledge for the development, the supplier's technological lead, the failures in their own research programme and the low cost of licensing compared with developing the technology.

Some authors, such as Prasad (1981), consider licensing as a complement to direct investment rather than a substitute. On the other hand, Clegg (1990) implies that licensing is a substitution, concluding that licensing is a leading mechanism of international transfer of technology. He extends his idea saying that, at the level of the firm, when there are scarcities of capital, managerial expertise and foreign market knowledge, as well as other restrictions on FDI, licensing is frequently a second-best strategy[22].

Licensing is the preferred way to transfer technology to industrially-advanced partners, who have background and infrastructure to absorb the technology easily and have other technologies to offer in counterpart, through cross-licensing agreements, according to Baranson (1970). In his study of the petrochemical industry, Stobaugh (1984) found that 76% of the international transfer involved licensing and there was a tendency to use a licence when technology was transferred to developed countries, when there were several sources of similar technologies available for the licensee, and when the licensor was a small firm. Clegg (1990) found a similar preference for licensing among developed countries. He also suggested that there was broad support for the use of licensing in technology-intensive industries.

The price of the licence will be determined within the limits of the minimum price offered by the licensor and the ceiling price of the licensee. This ceiling price is determined by the cost of developing new technology, the cost of getting the same technology through other sources and the incremental returns arising from using the technology. The final price will depend on the bargaining power of the two parties and the negotiation process. Among several factors influencing the adjustment of the

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22 This statement finds support in Buckley & Davies (1981).

price of technology, there should be cited: small number of buyers and sellers, limited information about alternatives and prices, and high costs of information search[23].

The literature[24] identifies two major situations when licensing is adopted: compulsory and voluntary. There is a compulsory use of licensing when foreign governments impose restrictions on other forms of investment. In this case, the use of licensing is advantageous for several reasons: to retain markets where there is a prohibition on exporting, to increase income from product development, to protect patents preventing 'pirating' of these assets, and to assure participation in new markets, waiting for future opportunities for business in later stages.

The literature mentioned above points out that licensing is frequently used voluntarily in cases where those government restrictions do not exist, but, for strategic or economic reasons, licensing seems to be the best choice, even when FDI is another option. Such is the case of a host market which is small, with a return on investment in a whole subsidiary which will not be interesting; or when a technology is in public domain and there are several sources available. Characteristics of the firms such as their size (relative to the industry), with limitations of financial and/or managerial resources also influence the choice of licensing. Furthermore, the age of technology, the number of competitors in the new market and the availability of technology with marginal interest to the firm are factors which lead to the adoption of licensing. Another case of voluntary adoption of licensing happens when a firm wants to have access to other firms' technology and vice-versa. This is the case of the cross-licensing agreement, when patents of both firms are exchanged. The advantages of the voluntary use of licensing are to obtain revenues from technology when there is lack of capital investment or personnel to send abroad on a long-term basis, to use new ideas and new markets rapidly, to exploit technology that is not strategic to the firm or that it does not wish to exploit, to access another firm's technology through a cross-licensing agreement, and to get to know the new market for future investments.

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23 On this subject, see UNCTC (1987) and Prasad (1981). There is also a large amount of literature discussing this subject in the context of economic analysis, which is beyond the scope of the present research.

24 For further evidence on the use of licensing, see Daniels & Radebaugh (1992), UNCTC (1987, 1988), Brooke (1986), Stobaugh (1984), Telesio (1984), Prasad (1981), Baranson (1970).

The same authors indicate that there are some strong disadvantages to the option of licensing, such as promoting a potential competitor, reducing the profits from exploiting the technology, which could be bigger through direct investments, and choosing a non competent licensee, which can ruin the asset through its misuse. The use of licensing in countries with stringent currency constraints, including the control of royalties payments, can be disastrous.

2.4.4 Other modes of technology transfer

A wide variety of modes of transfer of technology exist, resulting from environmental conditions, moment of contracting, characteristics of countries and firms, and so on. Among the numerous agreements, there are construction contracts, consortia, contracts of manufacture, and technical assistance agreements. All of them present some degree of overlap since contracts usually presume more than one form of technology transfer. It is normal, then, to find these forms in agreements for joint venture or licensing, for example. By the importance that they have had in the last few years, however, two forms of agreement, turnkey projects and management contracts, will be described below.

2.4.4.1 Turnkey projects

Using the definition of UNCTC (1987:5), a "turnkey contract is one in which the contractor firm undertakes the responsibility for carrying out all (or most of) the activities required for the planning, construction and commissioning of a discrete project".

This kind of agreement is a widespread form of transferring technology, when the supplier is responsible for each detail of the whole project, such as the feasibility and costs studies, the design of the plant, its construction, the transfer of technology, the start-up of the production and then the passing of the command to the receiver. This form of agreement also includes the training of operating personnel to assume the control of the plant. Robock & Simmonds (1989) have indicated that Japanese firms are traditional users of this strategy, and this form of transfer of technology constitutes a large portion of Japan's international trade. This form of contract is especially used in the chemical, pharmaceutical and petrochemical industries.

Turnkey projects may be contracted as part of a general contract of licensing or joint venture and in many cases the supplier may appropriate an equity interest in the new business.

2.4.4.2 Management contract

"Management contract is an arrangement under which operational control of an enterprise, or over one phase of its activities, which would normally be exercised by the board of directors or the managers elected or appointed by its owners, is vested by contract in a separate enterprise which performs the necessary managerial functions in return for a fee" (UNCTC, 1987:4).

Several functions can be contracted through this strategy, such as production management, personnel management, purchase and procurement of capital goods and raw materials, marketing, and financial management.

Usually, the local firm holds all the equity and chooses this form of contract owing to the lack of expertise in one of the areas covered by the agreement. The payment of the contractor may take either the form of percentages of sales, or a fixed amount, depending on what is agreed.

2.4.5 Summary

This section pointed out the advantages and disadvantages of transferring technology abroad, as well as the various modes of doing it. The generation of a fast return on technology, the necessity of the firm to keep up to date with new technologies developed elsewhere, and the high costs of R&D are indicated as being important factors that influence firms to transfer abroad their technological assets.

Host government intervention is a strong determinant of the mode of international presence of firms. FDI is the preferred option most of the time, because, allied to the full economic rent of the asset, there is total control of the technology. But, since this option is not possible all the time, other modes of international transfer of technology might be chosen. In the case of joint ventures, in spite of a loose control of the technology by suppliers, there are the share of risks and managerial responsibilities and the entrance in a new market with limited capital to attract their adoption. Licensing can be a very interesting choice when it is used voluntarily. Yet, even when licensing is chosen because of the prohibition of other forms of investment, it can become profitable and advantageous.

The literature seems to indicate that there are specific cases for the use of each of the modes of technology transfer; this is one of the aspects that will be examined in the present research.

2.5 Elements of technology transfer

Teece (1982) indicates that there are two important characteristics of the dynamic competitive system, that is, the available stock of knowledge acquired through R&D and learning and the frequent changes in market conditions which create profit opportunities in different markets at different times.

Furthermore, the way firms cope with transfer of technology is influenced by other factors: the monopolistic or oligopolistic nature of the target market as well as its stage of industrial development; the size of both the firm and the market. It is common to find TNCs developing technologies in one country and manufacturing the product in another where production is cheaper, specially because of low-cost labour[25]. Localizing R&D in a foreign country is also the method by which firms access new markets and/or new or unfamiliar technologies. This is called technological convergence (Mowery, 1989).

As an illustration of a classical package, Figure 2.2 identifies four sorts of technologies commonly transferred: process technology, product technology, management technology and quality control.

25 These points are developed in more detail in the following sub-sections.

Figure 2.2

Elements of a typical technology transfer package

TECHNOLOGY

PROCESS TECHNOLOGY	PRODUCT TECHNOLOGY	MANAGEMENT TECHNOLOGY	QUALITY CONTROL
1. Determination of the type of processing to be used. 2. Identification of economically and technically efficient machines and tools required. 3. Raw material specification. 4. Plant and design lay-out. 5. Identification and organisation of blue-prints, specification sheets, operating materials, etc. of all sub-systems. 6. Cataloguing the documents, checking for text completeness, translating them for local use.	1. Product specification. 2. Product design. 3. Identification of locally produced equipment and materials, and adapting them.	1. Personnel management: - skill specification - training - motivation - design of rewards and penalties 2. Financial management: - monitoring sales - prioritising capital spending - managing revenue expenditures - distribution of dividends - generating financial data useful for management decisions 3. Marketing management: - processing information to guide product development and production planning - training of sales personnel.	Ensuring appropriate design and standards of: - materials - equipment - end products

Source: UNCTC (1988:178)

It should be said that these forms can be transferred jointly or separately, according to the kind of agreement between supplier and receiver. It should also be understood that this model is not intended as an exhaustive analysis of the notion, as real-life situations usually present greater levels of complexity. In the area of process technology, the transfer goes from the study of the type of processing to the layout of the plant, including translation of the documents to be used. In the same way, the product technology transfer covers the specification of the product to be produced and the adaptation to the local conditions. The main concern of the transfer in management area is to prepare staff to assume positions in the areas of personnel, finances and marketing. And the importance of technology transfer in the sector of quality control is to ensure the same standards of quality as found in the parent firm.

In the following sub-sections these factors will be examined, as well as other elements of the investment decision: size of the firm, R&D activity, labour/capital intensity, number of firms within the industry, risk attached to the operation and knowledge of the new market.

2.5.1 Size of firm

Size of firm may influence the way technology is transferred. For example, there is a tendency of small firms to sell their technologies instead of investing in their own subsidiaries abroad owing to the lack of available assets (Stobaugh, 1984). Large companies tend to internalise their technology, using the facilities of investments already made in subsidiaries abroad. Large firms also have technical and managerial staff available to assist with any kind of technology transfer; this, however, usually does not happen with small firms that have scarce resources and may not be able to send their personnel abroad on a regular basis to follow a process of transfer.

According to Teece (1987), small firms may have to hire consultants to perform activities that are frequently developed internally in larger firms. In the light of these facts, the author hypothesizes that transfer costs decline with firm size, i.e., the larger the firm the smaller the costs of transfer of technology.

In their study on Canadian investments in the US, Solocha et al (1990), found that small firms try to explore foreign markets when their internal growth is frustrated in the home market, controlled by oligopolistic companies. However, this transition to the foreign market is usually not an easy task. Buckley & Davies (1981:86) suggest that "small firms may have advantages, but their lack of pull in the capital market and acute shortage of managerial capacity may dictate the choice of licensing" as the form of transferring technology abroad.

It should be mentioned that a great majority of the R&D programmes in the world are based in large size companies. Small firms, though sometimes very innovative and very open to technological changes, are not the biggest exporters of technology because of the restraints inherent in their size.

2.5.2 Capital versus labour intensity

As Gilpin (1987) observes, the increasing mobility of capital and technology and the immobility of labour encourage international production. In order to enlarge their competitive advantage, TNCs tend to locate their production in different places, where there is an abundance of some immobile resources. So, as Casson points out (1988:19), extraction of raw materials and exploitation of large-scale agricultural activities will be located in one place (usually a less developed country- LDC), mass assembly operations that require unskilled and semi-skilled labour will be established in another area (usually a new industrialised country - NIC), and highly automated activities that only demand skilled labour will be situated in still another area (usually an industrialised country). This author explains that one of the reasons for the production abroad is that developed countries have a reasonable contingent of highly paid skilled labour, trained for capital intensive production, but a virtual lack of unskilled labour for assembly lines. In this way, the assembly production is set up abroad where there is cheap unskilled labour, "creating a two-way trade in which components are exported and finished products re-imported into the high-income country" (p.20).

These findings, nevertheless, do not always find support in the literature. In his research on technology choice for textiles and paper manufacture, Amsalem (1984) indicated that capital-intensive technologies have been used in developing countries because they demand less supervisory labour than do labour-intensive technologies. Wells (1984:61), in his study of Indonesian industry, discovered that the managers chose capital-intensive technology for their firms for several reasons:

this choice reduces the operational problems with labour, responses to unexpected fluctuations in demand are quicker, products have better quality and "sophisticated machinery is more attractive to the engineer's aesthetic", in spite of the fact that the capital costs involved normally go far beyond any possible wage savings. And for foreign firms, the advantage of supplying capital-intensive technology was that the cost of adapting that technology to a more labour-intensive one could be very high. Lecraw (1984:100) recognized that what really matters in the choice of technology in low-wage countries is not only the costs of capital and labour, but also other factors beyond them, such as "the reduction of risk, lack of competition, firm strategy, and the cost and availability of information". Furthermore, as Keddie (1984) indicated, the choice of technology is not based on cost minimisation.

This debatable topic is of interest to the present research as the structure of activities of the firm can influence the way it transfers its technology.

2.5.3 Corporate strategy

Costs of operating abroad are very high and can become a real disadvantage for the firm in comparison with firms already established in the host country. Lecraw (1981:165) lists the main sources of costs disadvantages as tariff and non-tariff barriers to trade, costs of coordination and information gathering and processing, and government restrictions on any species of trade and/or investments. The author states that a firm must have a powerful competitive advantage to overcome these constraints.

Firms create entry barriers in their markets, in order to pose difficulties for new arrivals which may threaten their position and force profits down. These barriers can be in function of economies of scale, patents, trademarks, and experience of operating in the market. To protect their position, firms need to launch successively new products and/or differentiate existing products, in order to create barriers to new entrants, at home level and abroad. As Graham (1991) states, a new arrival into a national market should be fought with a counter-entry into that market from where the rival came.

Grant (1991) proposes that the formulation of the firm's strategy should be concerned with the most adequate utilisation of essential assets and expertise of the firm. He emphasizes that the strategy should start being developed by means of calculation of available resources and capabilities of the firm, because these will be the primary constraints and the primary sources of profitability. However, this strategy is not always followed by firms, as can be observed in a study of British companies by Clarke et al (1989): the authors did not find significant technological contents in the strategic plans of the firms, and only a few firms were capable of taking full advantage of their technological assets and strengths.

If a firm stops producing innovations and improving its performance, it will find its position in the market jeopardised. Porter (1990a:75) recommends a global approach to a strategy for maintaining the competitive advantage. He makes one further point by identifying the continuous necessity of firms to renew their advantages, even if they have to make an existing advantage obsolete - "even while it is still an advantage...or a competitor would do it for them". Yet he points out that the more intense the domestic competition is, the more pressure firms have to go abroad seeking global markets. Dunning (1991a) stresses the importance of competition, explaining that firms go abroad in response to a threat to their ownership advantage or in order to protect their advantages if they do not participate in the foreign market.

Dunning (1988b) also assumes that firms have a variety of strategic options owing to the fact that they do not know what is the best one. Furthermore, in the real world the available information about future markets is not accurate and variables involved in the process are countless, such as actions of governments, competitors and consumer behaviour, conduct of suppliers, labour unions, and so on. He criticizes the neoclassical models with their static scenarios, and their assumption that the best solution is always adopted. He underlines that, because of market failures, "an optimum solution is so difficult to identify that ...one is forced to compare a number of second best alternatives" (1988b:19). Items like risk and government intervention, for example, can change dramatically a *status quo* and create a reasonable number of different optimum solutions to be adopted. In his criticism of the neoclassical models Dunning affirms that if there is no market failure there is no reason for international production.

Taking into consideration market failures, as well as their strengths and weaknesses, firms design their strategy in order to maintain their competitive advantages and to increase their source of profits. The orientation of this corporate strategy might determine the way they transfer technology.

2.5.4 R&D

Firms need to be concerned with improving their effort in R&D so that they can hold their competitive positions; a well-developed program of technology transfer can raise the return on investments made in R&D.

Several authors[26] have written about the importance of R&D activities in assuring the technological supremacy of the country and consequently increasing its competitive advantage. Data on expenses with R&D and international patenting are an index commonly used to measure the dimension of the technological activities of firms and countries[27]. According to Stoneman (1988), usually there is a significant correlation between the size of the firm and the size of the R&D programme. Nevertheless, the author explains that high industry R&D is not a prerequisite for high rates of output because a great amount of inefficiency and repetition may result. Spence (1984) states that what makes R&D investments distinct from other kinds of investments is that they generate information that is applicable to almost all firms in the industry. And Patel & Pavit (1991) recognize that the R&D activities are heavily concentrated in large firms, and this fact makes them the leaders in technological development in any market.

When government funds that were used to subsidize R&D are heavily restricted, the firm must take on all the risks of the enterprise, and this situation may lead to a smaller return on investment (Gee, 1974). Increasing costs of R&D have been the object of several studies, justifying the necessity of firms to look for supplements to R&D budgets through the sale of technology. Indeed, Prasad (1981) has observed that in the past few years there have been considerable increases not only in R&D costs but also in the number of technology options. Similarly Bertin & Wyatt (1988) recognize that firms seek new foreign markets to spread ascending costs of R&D activities. Mansfield & Romeo (1980), in their study on transfer of technology to subsidiaries by US-based firms, explain that American firms could see

26 See Porter (1990a, 1990b), Stoneman (1988, 1991) and Bertin & Wyatt (1988), among others.

27 See Patel & Pavitt (1989, 1991), Cantwell & Hodson (1990), Stoneman (1990), among others.

their technological position weakened if they were unable to transfer their technology abroad and increase their domestic R&D budgets with these foreign incomes. Moreover Pugel (1981) suggests that R&D effort increases in the supplier country with the international transfer of technology owing to the perspective of exploitation of the new technology in a much larger market.

The location of R&D has been discussed by several authors. In his study on R&D and US-TNCs, Ronstadt (1984:262) proposes that, in general, the foreign investments in R&D follow an evolutionary pattern that starts with laboratories of technical service helping to adjust the technology to the new place, "expanding and evolving into an organisational unit seeking to develop new and improved products and process expressly for foreign markets...and for simultaneous manufacture in several major world markets" after further expansion. Ronstadt also comments that units performing R&D were created in countries where the American firms could not persuade foreign scientists to move to the US and perform exploratory research there. Dunning (1981) points out that the R&D is transferred abroad when it is cheaper and the conditions offered in the new location are better, but, most importantly, R&D will be transferred exclusively if the firm sees advantages in doing so. Cantwell (1990) indicates that, by transferring R&D programmes to the main sites of technological development, firms have direct access to what has been performed in major centres of innovation in their industry.

In relation to this, it can thus be proposed that the foreign production of a firm can be linked to a search for new sources of income for funding home R&D, or the use of an asset generated by internal research, or even an attempt to look for a new advantageous location for conducting the research. These factors are examined in the survey conducted in this thesis.

2.5.5 Monopoly and oligopoly

Bertin & Wyatt (1988) explain that a monopoly is the preferable situation for large firms in sectors that are critical for determining their growth and when the national market does not assure their position sufficiently.

As Gilpin (1987) observes, what explains the existence of the transnational company is the increasing prominence of oligopolistic competition in the contemporary world market economy. This fact could also explain how technology is transferred to other countries. But not only are the possession and sale of technology sources of monopoly; the access to markets and to raw materials is also important in a monopolistic situation (Stewart, 1979).

The internalisation of production does not happen exclusively because of imperfections in the market (transaction costs) but also because of the increase in value-adding capacities of the firm and its exploitation of a monopolistic situation (Dunning, 1988a) . According to Casson (1983), only when a monopoly situation exists will there be a full integration of extraction and use of a primary commodity, and the market will be internalised.

In an oligopolistic situation, profits will increase if there is some form of collusion. Otherwise, in a market with many firms, without barriers to entry and with heavy competition, the motivation for establishing an international operation and for controlling this market is weak (Yamin, 1991). In his research on the behaviour of business managers, Wells (1984) found that usually firms with capital intensive technology have a monopolistic condition in the market. Evidence in the literature[28] suggests that firms with a monopolistic position tend to transfer technology abroad through FDI, while a fragmented market does not attract this kind of investment.

2.5.6 Summary

Constraints in the domestic market such as saturation or heavy competition lead to the crucial decision of internationalisation of the firm. Firms possessing a stock of knowledge and identifying good opportunities in different locations are ready to look for international markets, seeking growth and new sources of profits. However, the decision about going abroad is also conditioned by various elements related to characteristics of firms and/or markets and countries.

Among the characteristics of the firms, size seems to be the most important in determining their behaviour. The literature shows several points of divergence between small and large size firms. Perhaps the most basic point is the lack of

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28 See Dunning (1988a), Porter(1988), Telesio (1984) and Hymer (1960/1976), among others.

capital and personnel, which is common among small size firms and which makes them use licensing when transferring their technologies overseas.

This section examined the relationship of the nature of the production process and modes of technology transfer used by the firms. It seems that the location of the activities of the firm is influenced by the intensity of its capital or its labour force. It is supposed, though, that the firm transfers its technology according to its structure of activities.

The corporate strategy as well as the amount of R&D activities are other characteristics of the firms examined in this section. The dynamic process of competition concerns the strong and weak points of the firm, and the orientation followed by the corporate strategy will determine the manner of transfer of technology. In addition, it seems that there is a relationship between the attempt to find new sources of funds for R&D activities and the propensity of the firm to transfer technology.

Finally, monopoly/oligopoly, one important characteristic of the market is discussed. There is evidence of a link between the mode of technology transfer and the position of the firm in the new market. Licensing is related to a fragmented market, while FDI is the preferred option in markets where the firm can maintain a monopolistic/oligopolistic position.

2.6 Market for technology transfer

As indicated by Dunning (1988a), the most important difference between international and domestic market failure is the additional risk and uncertainty associated with cross-border transactions. Often the market where firms operate is saturated, unable to expand, as happens in some low-populated European countries, such as Sweden[29]. At the same time, the competitive process is dynamic, involving uncertainty, struggle and disequilibrium (Schumpeter, 1950), and firms must survive in this environment.

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29 Dunning (1991a) explains most Swedish FDI as cases of saturated domestic market.

Market imperfections originate from several sources, such as external economies, monopoly power, incomplete information of the market, economies of scale and government intervention, among others. These imperfections create a regular state of precarious equilibrium and force the firm to look for opportunities in diverse locations, in order to benefit from different conditions of business and maintain their competitive advantage or even their existence.

According to Porter (1985), technological change is one of the main drivers of competition, and it can dramatically alter the competitive advantage through the change in the industrial structure. Technological change is frequently an incremental process that comprises a series of small and almost invisible improvements in innovations (Rosenberg, 1984). Firms must have the capacity of continuing to generate new technologies continuously to overcome market imperfections and to deal with the transfer of technology. If there is no possibility of internalising technology, firms opt to transfer it to a foreign firm, among other reasons, in order to solve their own problems of lack of capital and to compensate for heavy tariff barriers and importation restrictions, as long as there is a possibility of sharing a new market. Furthermore, Stoneman (1988) explains that one of the possible reasons for exporting technology is that factor prices vary from one country to another. If a firm has an advantage over competing firms, it exports the product which contains this advantage. But if the cost conditions change and the production abroad becomes profitable, this would be the first step towards establishing production in another country.

The literature indicates that, when transferring technology, firms retain an essential know-how element without which receivers are unable to develop improved versions or to become self-sufficient. Sophisticated processes and products may be transferred without the key to designing and changing products or substantially modifying processes (Lall, 1984b). Nelson (1978) points out that the buyer of a technology always receives a less complete information set than that possessed by the seller despite the transfer of blueprints, instructions, and so on.

In his important work on product cycle models, Vernon (1966)[30] suggested that when a product becomes more standardized its production technology becomes more efficient, more stable and less flexible. At this stage there is not an emphasis on the innovative aspect of the product, and the firm looks for minimizing production

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30 Vernon and his research are the object of examination in Section 2.10.4, Product Cycle Model.

cost. The literature[31] indicates that firms usually do not transfer the very latest technology, especially to countries on a lower development path. So it can be concluded that most of the time a new technology will be extended to different countries only when it matures.

In the remaining parts of this section, the role of receivers and suppliers of technology will be examined.

2.6.1 Receivers

The receivers of technology can be found within two broad environments: (1) industrially advanced economies, and (2) developing countries.

Within the first group, in spite of the fact that the countries are very different, there is a certain degree of homogeneity. Firms from these countries are able to absorb the know-how of the last generation, and, by using the imported technology, in a brief space of time they become able to launch similar or even improved products in the market. These firms can also offer access to their own technologies as an incentive to investment.

Within the second group of countries, there is a wide range of differential elements, in terms of level of economic development, industrial capability, governmental policy and capacity to absorb technology and in terms of bargaining power led by the possession of strategic raw materials. However, these countries can be characterized by the fact that they develop government policies with a view to rapid industrialization, based on foreign technology and on the growth of industrial installations for processing their raw materials. With these raw materials, countries can manufacture products for the world market. Generally speaking, firms located in these countries opt for the progressive transfer of administrative ability and substantial control of industrial installations in vital productive sectors (Baranson, 1978).

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31 This topic is dealt with in the works of Rosenberg (1984), Contractor (1983), Mansfield & Romeo (1980) and Teece (1977), for example.

One characteristic that has become evident in the last few years is the degree of sophistication of the technology receivers in developing countries. These firms are now much better prepared for discussing terms of contracts, they demand participation in the whole process of transfer and they no longer accept imposition of obsolete techniques by suppliers. They often have the support of their governments, which use their bargaining power in the purchasing decision to convince suppliers to offer modern technology (Prasad, 1981). The strength of this bargaining power is an important factor also in determining the price of knowledge during negotiations between supplier and receiver. On this last point, Fransman (1985) explains that there is a degree of uncertainty in the act of purchasing knowledge, especially when there are cultural differences between both parts. From the supplier's point of view, the price of the knowledge is the highest possible. From the receiver's point of view, the price of knowledge will vary between the costs of producing at home and the next-best alternative. At this moment, the relative bargaining power of the supplier and the receiver will be used to establish the final price of the knowledge.

One more point in the determination of the price of technology is that, recently, several kinds of knowledge have come to be supplied by an increasing number of suppliers. This makes a large number of options available to receivers, especially with new sources originating from countries that until recently were importers of technology (like the newly industrialised countries - NICs). A large number of competitors represents low prices and low revenues and profits. Another factor to enhance the receivers' bargaining strength is their monopsonic advantage, i.e., the number of buyers much smaller than the number of suppliers. Usually a firm with a monopolistic position in the market has a monopsonic position when it buys the inputs most intensively used in its monopolized activity (Casson, 1987). Monopsonic power means a great amount of bargaining strength in the hands of the buyer, who can establish conditions of supply.

2.6.2 Suppliers

It can be said that the vast majority of trade with technology at international level occurs with TNCs as, at least, one of the parts of the transaction. Transnational companies are very efficient in transferring technology because of their experience, know-how, capacity to mobilize financial resources and organisational skills, which, traditionally, other kinds of firms do not have[32]. In addition, Dunning & Cantwell (1987) explain that the growth of TNCs since the 1950s is closely linked with the international creation and dissemination of technology. Cantwell (1991) makes the further point that the growth can also be related to a process of technological accumulation within the firm, innovation and expansion of international production.

The first option of TNCs is to transfer technology through internal channels. Because of this, they tend to produce information that works more adequately when transferred internally than through markets (Teece, 1981b).

Gilpin (1987) reports that the main target of TNCs is to produce for world markets in the least costly way and this is sought through the spread of the production over several locations, which presents different compositions of factor costs. In an analogous approach, Bertin & Wyatt (1988) claim that the TNCs' strategy must meet the criteria of efficiency and minimum costs. This statement, however, does not always reflect what really happens; in his research on the selection of processes by US-transnationals, Yeoman (1984) found that the firm paid very little or no attention to the relative factor cost when they prepared the design of the new foreign plant. Similar findings were disclosed by Wells' (1984) research on TNCs in Indonesia, and Amsalem's (1984) studies of American TNCs in the area of textile and paper manufacture, where the conventional theory of rational behaviour for maximum profits did not explain the managers' options of chosen manufacture processes.

Foreign technology suppliers are unwilling to sell when they consider returns too low. Moreover, FDI is often the only means of obtaining access to closely guarded technological assets (Dahlman & Westphal, 1983).

2.6.3 Summary

The market for technology is characterised by imperfections of several orders, which force firms to examine the possibility of international production. Looking for a foreign location is also a form of protecting the competitive advantages of the firms. Technology is a very important driver of competition and firms possessing a unique

32 See Bertin & Wyatt (1988) and Marton (1986) on the subject.

technological asset must exploit it in other locations, taking advantage of differences in factor price in diverse countries.

The evidence in the literature suggests that firms do not transfer the complete information about the technology to the receiver nor transfer the latest technology to other countries. The consequences of these facts are that the receiver becomes unable to make any modification in what is received from the supplier and that the receiver will always be behind in terms of technological development.

This section has presented a discussion of the characteristics of receivers and suppliers of technology. Receivers are differentiated by the broad environments where they are located; these environments shape the characteristics of firms and influence the way technology is transacted. Suppliers of technology are often large TNCs, with great experience in transferring technology and manifest a tendency for internalising their production. It is supposed that they look for the most efficient and least costly way of producing abroad, in order to maximise their profits, but there are suggestions in the literature that this is not what always happens.

2.7 Government intervention

Governments of First World countries usually have a very liberal policy towards foreign investments and do not intervene in the process of buying or selling technologies by their firms, with the exception of products directly related to the national security and strategic products resulting from very high technologies. These countries have a long tradition of trade and, as Dunning (1991a) suggests, because of this tradition they impose few limitations on direct investment in their own markets. Japan is an exception as the Japanese government executes a very strict policy towards the participation of foreign companies in its market. The Japanese justify all the restrictions alleging that this way they maintain their competitive advantage.

The Japanese example has been followed by several Third World countries which have begun to participate in the discussion of terms of contracts of technology and initiated a series of demands and, as a result, have obtained adjustments of the conditions of technology transfer. Technological *laissez-faire* is seen as a thing of the past, so that governments of countries that import technology attempt to make a critical evaluation of the technology they are negotiating in order to maintain as much control of the operation as possible.

Another factor which strengthens this bargaining power is the capacity that many of these governments have for making investment capital available, as well as paying the costs of projects and of engineering. In addition, certain developing countries (those which have petroleum, for example) possess a sizeable quantity of strategic natural resources. These countries have decided to enter the 'Economic World' and have begun to process their own raw materials with technology from other countries, instead of selling the raw materials for a low price to be processed abroad. Gomes-Casseres (1989) recognises that if the country has an attractive domestic market, this means that foreign investors will accept several levels of restrictions to be able to operate in that location.

When governments participate in negotiations of technology, they attempt to control the following aspects (Contractor 1983:499): (1) the mode of association between foreign supplier of technology and local operator; (2) the cost or price (direct and indirect) of the transfer, and other negative externalities; and (3) the content of the technology transfer package.

The intervention of governments can be of several forms. They can subsidize exports, implement a policy of import substitution and close the home market to foreign products. They can act on quotas and tariffs on imports, non-tariff barriers, export subsidies, restrictions on the flow of capital and on the kind of technology being transferred, and so on, and because of this variety of types of intervention they can obstruct the way for firms that propose to use a global strategy for their foreign branches (Yip, 1989:38). On the other hand, if the market is interesting in the view of the firms, they always find a way to deal with host governments' exigencies, either by retaining the control of critical activity of production in a partnership with local firms or by trying to eliminate the obligation of sharing equities. Firms may even invest in a politically risky country if they assume a high return on investments or if host government incentives are sufficient to attract their foreign presence. But there will always be a conflict of interest between the host country and the firm trying to invest in that country[33].

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33 Several authors recognise the importance of government intervention in the negotiation of technology. Yip (1989), Gomes-Casseres(1989) and Fatehi-Sedeh & Safizadeh (1989), among others, can be cited.

The position of the government is very important for determining all the mechanisms regulating the market. Rugman & Verbeke (1990) recognise that the firm's competitive advantage can change completely because of changes in government regulations. Dunning (1991a:37) has a clear position about government intervention in markets, identifying "the role of government as both a creator of resources, a facilitator and sustainer of efficient markets, and as a compensator for intrinsic market failure".

Davidson & McFetridge (1985) hypothesize a greater reliance on external mechanisms in countries with restrictions on the internalisation of production. They also suggest that, with these kinds of restrictions, countries tend to receive a minor flow of technology, as much in number of projects as in quality of the technology, because firms will not risk their best technological assets in locations with such severe restrictions.

If some governments have a sufficient degree of attractiveness, there are others with low resources of labour, or of raw materials, and with constant political instability. They thus offer a limited attraction for the suppliers of technology who do not want to risk their investments, even through licensing (Davidson & McFetridge, 1985). Casson (1988) sadly concludes that, in the future, for these countries with no other appeal for the TNCs the only thing that they can offer to interest some industrial investment is the location for pollution-intensive activities that are undesirable in the home countries of the firms.

Finally, it deserves to be mentioned that the relationship between governments and TNCs is changing from one of conflict to one of cooperation. The world recession, the debt crisis, the difficulty in obtaining capital for investments and slower growth rates, for instance, have made governments reveal their policies and take a more relaxed approach towards TNCs[34] . Dunning (1991a) adds that the dramatic change in technological advances in the recent past was the main force making the governments re-evaluate their positions against direct investment because they perceived that this would be a reliable form of acquiring technological development without increasing the already existing gap.

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34 See Dunning (1991a) and Gilpin (1987) on this subject.

This section evaluated the role played by host governments when intervening in the process of technology transfer. This role is the most important external factor determining the modes firms must use for those transfers. Governments of receiver countries presently act as protectors of their markets and establish all the conditions (and restrictions) for firms to obtain a share of them. Firms are willing to accept a wide range of restrictions if the new market is interesting for them, with perspectives of good profits.

In view of the influence of government intervention on the way firms transfer their technology abroad, this role of government is treated with special emphasis in the present research.

2.8 Britain and world business environment in the 1990s

In the last few years the world has witnessed widespread changes in the history of international business and they have occurred at a much faster pace than ever seen before. The changes include the dismantlement of the Communist bloc, with the consequent division of the Soviet Union, and creation of several new republics, the end of chronic wars such as the one between Iran and Iraq and the civil war in Cambodia; and the world awareness of environmental issues transforming consumers' habits.

Britain is also undergoing in dramatic changes in its economy, resulting from a heavy process of privatisation that has already lasted for one decade and switched to the private sector the mission of creating the necessary resources for the development of the country. This process of privatisation is an effort to modernise the British industrial structure and make it as competitive in the world as the German and Japanese industries.

The general world-wide economic recession has brought about an accentuated tendency of foreign governments to improve their relationships with TNCs, as they need a means of surmounting the process of stagnation. Allied to this, there is an entirely new market in Eastern Europe, hungry for Western technology and investments to overcome their lag in several areas. Although new opportunities arise every day, the same economic restraints press British industry as a whole to a more conservative approach while waiting for better times.

In this environment, Japan emerges as the most important economic player in the world, rapidly covering markets neglected by other countries, and taking a tough strategy towards investment abroad. British industry will also suffer hard competition from other firms located in Western Europe when all the frontiers are open and the companies are free to do business in any market of the Western European community.

Predicting the tendencies in the world economy in the 1990s, Buckley (1991:15) suggests that competition will increase at different levels (national, industrial, firm, product) but at the same time the use of joint ventures and other alliances will also grow; the political scenario will include all forms of integration between nations (political, economic, financial); ongoing social changes will affect international business more intensively; technology will assume a more important position as a major element in the competitiveness of firms.

This section will discuss British industry as well as its two main sources of competition and opportunities in the 1990s: Japan and United Europe.

2.8.1 British industry

Britain was generally dominant in the world industry until the last century, but this leadership has been lost to other countries which have conducted a more aggressive industrial policy. Despite its present poor performance, British industry is still one of the most important in the world. This paradox will now be examined briefly.

2.8.1.1 Historic antecedents

As the country of origin of the Industrial Revolution in the eighteenth century, which brought an extraordinary change to the face of the world, Britain has a long tradition in inventions, discoveries and innovations. For many years British industry maintained a privileged position of world leader in productivity and ingenuity;

consequently, it was a major exporter of industrialised products and, of course, of know-how to produce them. British technologies which developed during the Industrial Revolution provided the basis for industrial development to spread first to Western Europe, later to the USA (Rosenberg, 1984).

The shortage of wood fuels in Britain was a strong incentive for the shift from a vegetable and animal raw materials economic base to a mineral based energy economy, which with its abundance of coal was a cheaper mineral source of energy. In this way it was possible to rely on a supply of fuel with high calorific power at low prices over a long period, and a totally new technology started to be developed taking advantage of the resources available. This made British industry take a radically distinct direction from that of the other countries in Europe, which began to lose export markets to Britain. The fascinating aspect of British technology at that time was the invention of machines and processes totally new, not used before in any other country (Harris, 1991).

In the middle of the nineteenth century the flow of British technology to Europe and the United States was almost uncontrollable. This transfer took place especially through the form of emigration of workers, artisans and industrialists, exporting of tools and machinery, as well as industrial espionage. This wave was so strong that the British government tried several forms of prohibition of the flow. As Dunning (1983a) remarks, all the efforts spent by the British government in order to control the technology transfer and protect the monopolistic situation of its industry were unfruitful. On the other hand, British export of technology in the nineteenth century was an important source of funds to finance new investments and reduce the price of goods through economies of scale (Dunning, 1981).

In the beginning of the twentieth century, British supremacy had to face the threat of the German and French industries as well as that of the Americans. Hennart (1991) explains that one of the causes of the decline in leadership of British industry in the world is that the country exported technology, through the migration of skilled artisans in the first half of the nineteenth century, instead of exploiting its technological competitive advantage through foreign investment, as the USA did. Nevertheless, in 1914 UK industry still was the largest foreign capital stake holder in the world and its transnational manufacturing activity was concentrated in the production of consumer goods and heavy engineering equipment (Dunning, 1983b).

2.8.1.2 Contemporary British industry

In a study on the most successful companies in the world (Davis et al, 1991), it is shown that three British and seven American firms lead the list of the ten most profitable in the world. The same study points to Britain's pharmaceutical company Glaxo as the most successful of the world's large firms at creating a surplus from each sale. The authors try to explain the paradox of Britain having the most profitable companies in the world, in spite of the well known fact of low productivity of British industry when compared with their counterparts in Japan and Germany. One first explanation that the authors found for the fact is that those firms are in oligopolistic sectors without severe competition (oil, pharmaceuticals, telecommunications). Secondly, those results do not reflect the superiority of British management systems over others but the fact that British firms tend to take profits instead of market share, as Japanese and Germans do, thus presenting a low profile in the ranking.

According to Chandler (1990), in the chemical sector (and many others), British firms failed to make investments in production, distribution and management and, consequently, lost their lead position to the Germans. Those facts could be pointed out as a general tendency in the country. Stubbs (1980) comments that during the decade of the 50s and 60s the economic growth of the country was high, but industry presented an unsatisfactory performance compared with that in other countries. This tendency widened in the 70s, making British economic performance inadequate. In his study of recession strategies in British industry, Whittington (1991a) recognises that British firms do not respond adequately to the fluctuations of the economic business cycles and instead of taking a long-term view to recovery, they have adopted a short-term efficiency approach.

2.8.1.3 R&D in British industry

The important series of studies conducted initially by the Science Policy Research Unit of the University of Sussex, and in cooperation with the University of Reading[35], has been used as a database for the number of British patents granted in the US, according to data available in the US Patent Department. As Cantwell &

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35 The studies have been conducted in SPRU/Sussex by Pari Patel and Keith Pavel (see 1989, 1990, 1991, among others) and in Reading by John Cantwell and Christian Hodson (see 1990, among others), using the same database from the US Patent Department.

Hodson (1990) remark, 40% of British patents registered in the US originate in R&D locations outside Britain. In spite of improving the competitiveness of British TNCs, the research which firms conducted outside the UK does not necessarily improve the national benefits. That is to say, in spite of an important part of their research being conducted in a foreign location, some firms may not improve their rate of innovation in the national sphere, as happens, for example, in the British motor industry, which has its major technological capacity coming from abroad (Dunning & Cantwell, 1987). In several sectors of British industry there is a tendency of dependence upon R&D conducted abroad. Pavit (1990) reports that British technological activities continue to be poor in many sectors when compared with other countries, in spite of the recovery of the British economy.

In his recent article on R&D in Britain, Stoneman (1991) argues that there has been a great increase in the volume of foreign investments in the sector, specially those originating from US-transnationals, since 1967. Looking for reasons for this growth, he hypothesizes that the availability of highly skilled labour at a relative lower cost, and the university system with its dynamic characteristics encourage location of R&D activities in Britain. Furthermore, with most investments coming from American companies, cultural similarities, specially language, increased the British advantage. However, he compares this research developed in Britain for American transnationals as a "brain drain", since firms taking advantage of the lower paid labour, transfer the results of the research overseas (p.140).

In spite of all the negative views about the performance of British industry when compared with that in other countries (like Germany, Japan and the US, for example), in a broader context, British industry is still one of the most important industries in the world and an eminent source of technological innovation.

2.8.2 Japanese challenge

At the end of the 1970s, Japan definitively took its place as one of the most advanced industrial countries in the world and it seems that it will achieve complete technological leadership of the nations in the 1990s.

The strong cultural elements present in Japanese society make it very difficult to examine the development of Japanese technology out of its environment, as Cutler

(1989) indicates. For example, most of the research activities in the country are targeted to be used for industrial purposes, instead of academic ones. Fransman (1985) states that the superior performance of the Japanese firms may be explained by the level of relationships within companies, and the success of commercialising a new product is not a credit to R&D personnel alone but to the whole group, from workers to production engineering, in a harmony of activities.

One explanation for the rapid expansion of the Japanese TNCs, as proposed by Dunning (1983b), is the fact that they have an extreme flexibility to produce what the market needs, to internalise their markets and to shift home production to other countries faster than other kinds of companies. On the other hand, the Japanese government, although supporting a market economy, maintains severe control over inwards investments, as well as the technology market, with absolute success[36].

As the country lacks all sorts of natural resources, there was an immediate interest on the part of the Japanese TNCs in looking for raw material abroad and internalising the market, assuring supply for domestic market. In a following phase, they moved their basic processing plants with low value added activities to other locations and started processing raw materials in places where they were extracted. As the manufacturing process became more sophisticated and labour more expensive at home, they could be reallocated to higher value added activities[37]. The Japanese move abroad represents an upgrading of its domestic industry, instead of the saturation of the domestic market, as has happened with the Swedish foreign investments (Dunning, 1991a).

Beginning with a massive licensing policy abroad in the early 1970s, Japan acquired the necessary knowledge of foreign markets and in the late 1980s it arose as an important outward investor.

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36 See Dunning (1991b) and Clegg (1990) on the subject.

37 See Dunning (1991b) and Cantwell (1991) for more details.

2.8.3 Europe 1992

A new challenge for British industry will be the European unification, with 1992 being a landmark in all aspects of life, especially business. The 12 unified countries are, however, far from being an homogeneous entity. National policies are not harmonized and regional differences are great. The experience of 1992 will probably favour similar experiences in other parts of the world.

Van Dijck (1990:474) thinks that to cope with the unification, only a European model of management would be able to foresee situations like international personnel mobility, competition at firm level instead of country level, international R&D, rational and strategic utilization of resources across borders. However, in their research on global manufacture in the sector of domestic appliances, Baden-Fuller & Stopford (1988:24) found that companies that are globally orientated in the sector are less profitable than nationally orientated firms in the same sector in the UK and France. The authors further suggest that the European market presents strong and increasing barriers at several levels: access to local distribution, local government regulations, consumer preferences, sunk costs and scale economies in advertising, promotion and product development, and local market needs; these would make it difficult to have a global orientation and to overcome barriers (p.474). Wensley (1991), on the other hand, agrees that a global marketing approach for the European market is a debatable subject on final consumer level but would be a paramount option in intermediary markets.

Peterson (1991) sees a way to overcome such a great range of differences through programmes of technological collaboration. He cites the example of the Framework programme and Eureka, which are being developed as a result of the joint research of several countries.

Furthermore, it needs to be remembered that a new market of 330 million people with high purchasing power is going to be open to British industry, and this fact may considerably alter the behaviour of British firms. This new 'country' will be the strongest side of the Triad (USA, Japan and Western Europe) and the most desirable market in the world.

2.8.4 Summary

The objective of this section was to provide a panorama of British industry, and of the world environment in the 1990s, with its main sources of competition and opportunities which affect British industry. Within this panorama and with the perspective of the 1990s in mind, the present research attempted to examine the modes of technology transfer by the British industry.

The overview of British industry from the Industrial Revolution to nowadays pointed out that in spite of presenting low productivity when compared with Germany and Japan, British industry is one of the most important in global terms. This can be confirmed by the fact that several British companies are among the most successful in the world.

R&D activities in Britain are increasing owing to the infrastructure in the country, formed by highly skilled labour at a relatively low cost and a long tradition of research originating at university level. However, these activities do not necessarily mean an increase in the national rate of innovation because a considerable part of R&D activities is taken by foreign TNCs, which transfer the research results abroad.

The environment in the 1990s is centred on the two most important sources of worries to the British: Japan and the unification of Western Europe. The tough Japanese presence in the world market ascends as a threat to the British, specially because of its extreme flexibility to produce what the market needs and, consequently, control a great portion of market shares. Western European unification, though, with the beginning of a new market with an enormous consumption power and consequent restrictions on products from countries outside of the union, creates excellent perspectives for British industry as a whole.

2.9 Theories of International Production

The objective of this section is to analyse the main theories that support the research on international production. Three major theories and one paradigm[38] will be treated as the theoretical framework for explaining the process of internationalisation of the firm. Beginning with the approach of Hymer, considered the pioneer in the field, the firm as an agent for market power and collusion will be discussed. Following this, the product cycle life theory will be examined with its implication for the age of the technology transferred to other countries. The internalisation theory with its transaction costs proposal and its evolutionary mode of servicing international markets will also be outlined. And finally, the Dunning Eclectic Paradigm will be discussed, with its ownership advantage, location advantage and internalisation.

This framework is applied in the present research as a source of questions for the development of the instrument used in the survey and as a base to understand and interpret the results obtained.

2.9.1 Market Power theory

According to Cantwell (1989:189), Hymer[39] is responsible for the first theoretical framework used to analyse international production[40]. Based on a theory of the firm and industrial organisation, Hymer explains that the firm is an agent for market power and collusion. Supported by this proposition, he identifies two principal reasons for the companies to control another firm in a foreign country: the removal of competition through collusion or by merger and the use of the unique advantage of the firm, such as easy access to factors of production, control of more efficient

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38 John Dunning calls 'paradigm' his synthesis of partial theories on international production and an integration of those thoughts.

39 Stephen Hymer wrote an outstanding doctoral thesis in 1960 on the use of FDI by US national firms in their international operations. This thesis was published in 1976 and was considered a milestone in the study of international production.

40 Several other authors, such as Yamin (1991), Buckley (1990), Horaguchi & Toyne (1990), Dunning (1988a), Casson (1987) and Teece (1986), hold the same opinion as Cantwell does and support the view that Hymer's work represents pioneering research.

production function, a better distribution system or a differentiated product. In a later paper, the author includes one new factor which leads a firm to produce abroad, that is, the internalisation of market imperfections (Hymer, 1968).

FDI cannot be accounted for as a case of portfolio investment, i.e., a firm trying to maximize its profits by investing in countries which offer the highest interest rates. Hymer shows evidence that the firm borrows resources abroad to finance its international investments. In doing so, if it were looking for a location that paid the highest interest rate, it would be losing resources by borrowing money exactly in the same place.

Hymer also observes that there is a tendency for the FDI to happen regularly within the same industrial distribution, and the same tendency is observed in different parts of the world. That the portfolio investment would present the same regular tendency does not seem to be an adequate interpretation. Since the portfolio investment is not a sufficient explanation for capital movements associated with international operations of firms, it is necessary to discover why it is in the benefit of the firm to control other firms in different foreign locations. Hymer thus proposes that what makes a firm expose itself internationally is the possession of a monopolistic advantage, and the necessity of displacing conflict through collusion or mergers[41].

In the view of Horaguchi & Toyne (1990), Hymer was interested in explaining the main objective of TNCs as well as their continuance and growth in the market. Large corporations are considered a broad internal market crossing borders of industries and countries. As there are imperfections in the market, it is more advantageous to coordinate activities of production within the firm rather than through the mediation of markets (Hymer, 1968). Thus, firms can internalise the market through FDI or externalise the market through licensing. If there is a choice between FDI and licensing, the firm will prefer the former option because this way it can avoid the problem of sequential monopoly (i.e., when a firm sells its advantages to other firms which possess monopoly power in their markets), the complication of achieving an understanding among licensor and licensee, including the supervision of price and output, and the loss in profits as well as the technological advantage.

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41 Yamin (1991) and Pitelis (1991) present their interpretation of Hymer's work in two interesting articles.

As a firm possesses a unique advantage, it should be advantageous to use it in other national locations. If imperfections exist in the market, the firm will choose the suitable form of action. When the market has a structure of monopoly or oligopoly the internalisation of the market will be the way taken. The control is desired in order to remove competition and to appropriate fully the returns on the use of the specific asset. If, on the other hand, the firm finds perfect competition in the market, licensing will probably be chosen.

It should be clarified, however, that there are costs of going abroad, or barriers to international operations, as Hymer called them. One kind is a high initial fixed cost. It is the cost of acquiring information on the country, i.e., economy, language, law, politics. The other kinds of costs have a more permanent character; they are the discrimination against the foreign firm by governments, consumers, and suppliers and the exchange rate risk (Hymer, 1960/1976:34). Because the foreign firm is faced with these costs, it starts its participation in the new market in a weak way, compared with the national firms. For this reason, the unique advantage of the firm must be strong enough to overcome these problems.

The aspects of Hymer's theory related to the possession of an unique advantage and the removal of competition through collusion interest the present research.

2.9.2 Product Cycle Theory

The main scholar in this theoretical approach to international trade and investment is Raymond Vernon (1966, 1979); prior work on the subject is attributed to Hirsch (1965), who, in a less elaborate way, brought to light characteristics of the product cycle, explaining losses of the American electronics industry in the face of competition from Japan and Hong Kong in the beginning of the 60s.

The principal objective of Vernon was to explain American FDIs in the 60s, and how standards of exporting, importation and foreign production of a product are modified throughout its life. Basically, the theory states that innovations are stimulated by a demand push in the home market and products (or technologies) move through a life cycle consisting of three phases: introduction, maturing or growth, and mature; according to the phase of the product (or technology), a different strategy will be emphasised by the firm. The first phase is usually played in the most advanced industrial countries, such as the United States, and is characterized by changeable technology, development of the market, oligopolistic advantages coming from the new technology, a large amount of resources granted for R&D and a large demand market at home, and high entry barriers. The second phase is usually marked by foreign demand. The technology starts being diffused although still in a phase of adjustment. It begins the process of mass production, the entry barriers are raised by competitors and production is spread to other developed countries. In the third phase, the product becomes more standardised, the technology more efficient, stable and less flexible. At this stage there is not an emphasis on the innovative aspect of the product and the firm looks for minimizing production costs. Then production is shifted to places with low production costs, like the newly industrialized nations, where there is cheaper labour; since technology becomes stable, there is no more need for skilled labour. These recipient countries become export platforms and export the product back to the developed world for a low price. As summed up by Jensen & Thursby (1986), Vernon developed a model in which the production of a good starts in an advanced country and would only reach a less developed country in the later stage of its life cycle.

According to Dunning (1991a), Vernon (1966) did not show great interest for organisational issues, as his contemporary Hymer did. It seems that when Vernon wrote that article, he was not aware of Hymer's work.

In support of Vernon's theory, Abernathy & Townsend (1975) stated that firms sell technology which is no longer considered essential to the business of the firm or which is no longer commercially viable without a substantial investment in R&D and Marketing. Mansfield and Romeo (1980) found that TNCs were transferring technologies to their subsidiaries in developed countries with a mean age of six years, while the ones transferred to subsidiaries in developing countries were about ten years old. And the ones transferred to non-subsidiaries had a much higher mean age. Nevertheless, in his criticism of the theory, Giddy (1978) declared that the product cycle was no longer consistent with observed standards of trade in the late 70s. Several TNCs adopted strategies for launching a product in different locations simultaneously, and investments in raw materials industries did not follow the trajectory suggested by the theory. Baranson (1978) reported, furthermore, that TNCs were transferring their latest technology to their subsidiaries abroad.

In 1979, Vernon himself acknowledged the deficiencies in his theory in view of the new international environment, with innovations being produced abroad just a few years after the production at home and with the shrinkage of differences among developing and advanced countries, and with firms adopting the policy of world products. Vernon recognised that "it seems plausible to assume that the product cycle will be less useful in explaining the relationship of the US economy to other advanced industrialized countries, and will lose some of its power in explaining the relationship of advanced industrialised countries to developing countries" (Vernon, 1979:265). But he insisted that smaller firms with innovating activities, which do not have international operations, will continue to conform to the standards of his theory when they start the process of exporting, followed by concerns with overseas investments. In addition, the standards will be upheld by the new TNCs from newly industrialized countries.

Mansfield & Romeo (1980) believe that there is a tendency of TNCs to transfer their latest technology to foreign subsidiaries and their mature technology to affiliates through joint ventures and licensing . Teece (1987) emphasises that there is a decrease in transfer costs as soon as the firm starts the first production, and international transfer becomes possible; this finding fits in with the product cycle model.

Preliminary field work developed by the present research brought up unexpected results, when interviewed firms denied transferring old technology in any situation. It seemed interesting, therefore, to study further the question of the age of the technology transferred overseas and see how other firms contacted by the survey behave in this case.

2.9.3 Internalisation theory

The grounds of the internalisation theory are attributed to a very important paper by Coase (1937) with a criticism of the neoclassical economic theory in the form of a dynamic analysis of internalisation of the firms. Among other things, the author views production as being coordinated either by market exchange or within a firm. The limit of expansion of the firm is when costs of structuring one more transaction within the firm become equal to costs of using market exchanges. But if the situation is such that the market cost limit is below the cost of organising another firm, the way chosen for expansion is the organisation of another firm.

Coase's work represents the foundation of the current internalisation theory, some of the main authors of which are Peter Buckley and Mark Casson[42]. Primarily, they constructed a framework founded on internalisation of markets to explain the growth of the firms, based on choice of low-cost location for their activities and internalisation of markets until the limit of costs of market exchange.

One important element of the theory is the question of vertical and horizontal integration. A firm seeks vertical integration to overcome barriers to entry and to avoid market uncertainties, and this is a reaction to non-competitive prices. It also seeks horizontal integration to use scale economies to generate new knowledge (Buckley, 1983). Buckley (1983) hypothesizes that there is a great disposition to internalise when there is a great volume of trade between two plants and that branded product producers tend to internalise backward their production.

Casson (1983) identifies the growth of the firm with the possession of a monopoly of a product with increasing demand. This growth will stop when the local market becomes saturated and so the firm needs to expand to another location or to create new products to continue growing. Since market imperfections are a source of transaction costs, these can be minimized through internalisation of production (Casson, 1990).

One early statement made by Buckley & Casson, still generally accepted, is of particular interest to this research. Explaining the modes of servicing the international market, the authors report that "in a market subject to autonomous growth the theory then predicts that the firm will begin by exporting, switch to licensing as market size increases, and then finally switch to FDI" (Buckley & Casson, 1981:80). This evolution is not absolute and several exceptions can occur. For example, if the market is small and stable, there is no incentive for the firm to stop exporting and try another form of servicing. The firm will stay in the licensing phase if the market is of medium size and can pass from exporting directly to the

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42 Both authors have, jointly or separately, written a considerable number of papers on the subject. The book of 1976, The future of the multinational enterprise, can be said to be their first noteworthy contribution to the attempt at explaining international production.

establishment of international production if the market is very large. Thus, the authors attribute to "the cost structures of alternative modes and the pattern of market growth" (p.80) the choice of strategy for servicing the market. They go one step further in suggesting that "the only firm prediction that can be made is that in an expanding market where two or more different modes of servicing are used, FDI will never precede licensing, licensing will never precede exporting, and FDI will never precede exporting" (p.81).

Finally, it should be noted that, in recent papers, Buckley (1990, 1991) has concluded that market power and internalisation are not competing but complementary theories, and, combined, give a complete explanation of the growth of multinational firms.

One of the propositions tested by the present survey is the modes of servicing the international market, as proposed by Buckley & Casson. The pilot study showed that firms had a different standard of foreign investment and this is explored by the survey.

2.9.4 Eclectic Paradigm of International Production

The concept of the eclectic paradigm was developed in the 1970s by Dunning[43], whose aim was to devise a broad explanation of the international production of firms, with the help of several branches of economic theory. The author tried to integrate existing theories and suggested that the intra-industry trade had not been adequately justified by the classical and neo-classical theories of trade, which were still valid for explaining several other aspects of the trade.

Basically the paradigm explains that a firm must possess some unique advantages over its competitors when it decides to start international production. If a firm possesses these unique advantages, it will internalise production if it perceives such action to be in its best interest, instead of giving up rights to other firms. Finally, there will be an economic interest in spreading the production outside their home countries, in order to capture the economic benefits of different locations. These are

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43 John Dunning has been developing his paradigm for a long time through a significant number of papers. His main thoughts are well explained in his 1988 book Explaining International Production.

the three columns of the paradigm: ownership-specific advantage, internalisation, and location-specific variables.

Dunning (1988a) states that there are two genres of competitive advantage that can create a monopolistic position for the transnational corporation: those that are derived from the ownership of specific assets and those that are derived from the ownership of complementary assets. The first are related, for example, to the technology held by the firm, which can be commercialised in several forms. Alternatively, the second cannot be sold and these assets are only usable within the firms, such as the capacity of generating new technology, organisational competence, entrepreneurial capability, experience of producing abroad, and so on (Cantwell, 1989).

Dunning (1988a:1) explains international production as a "value-adding activity owned or controlled, and organized by a firm (or group of firms) outside its (or their) national boundaries". The author (1983) states that international production is positively related to world technological capacity and its distribution between nations.

Dunning emphasises that if TNCs perceive the costs of transactions related to market failure as high, they tend to use their advantages rather than negotiate them at arm's length. However, if they perceive that "administrative costs of hierarchies and/or the external diseconomies of operating foreign venture" are very high, they tend to prefer sharing responsibility of the production abroad, or even selling the advantages (1988:43). And he admits that different firms, owing to their particular characteristics, may have different perceptions of opportunities abroad in the same period of time.

If there are no trade restrictions to consider, the first step of the internationalisation of the firm will be the FDI with exploitation of its competitive advantage in sectors that use intermediate products . Later on, when it becomes more experienced and uses a global strategy for its foreign investments, the firm will rely less on its ownership advantage and more on its capacity to coordinate and manage a group spread throughout different national locations.

There is an incentive for a firm to internalise production when it expects that internalisation will give it access to the best economic rents for its advantage. This expectation leads firms to, for example, opt to transfer technology through FDIs instead of licensing that technology.

The Eclectic Paradigm, as postulated by Dunning (1988a) is not a theory but a general framework for the analysis of international production. The present research will take advantage of this general aspect of the paradigm to understand results obtained in the field work.

2.9.5 Summary

The relevant theories of international production were presented in this section as the theoretical framework underlying the main ideas of the current study. It should be mentioned that these theories, in spite of their pertinence to the research as a whole, sometimes are not central to the subject under analysis. In this case, the work of other authors is used as a framework for the analysis.

Hymer's market power theory views international production as a form of removal of competition through collusion and exploitation of unique advantage. The aspect of the product cycle theory related to the age of the technology transferred abroad is the main point in Vernon's theory studied in the present research. The hierarchy of modes of servicing the international market, related to the internalisation theory, is also studied in the present research. At the same time, Dunning's eclectic paradigm is used as a general structure to assist the process of data analysis.

2.10 Conclusion

The chapter cites several authors on technology and its transfer and a broad definition is chosen. Facts related to the exporting of products as the first international path of a firm are discussed, as well as the consequences related to them, including the associated costs of the option. Firms seem to follow an incremental process of internationalisation, which starts with exporting, continues with licensing and ends with FDI.

The main modes of technology transfer are analysed, with their advantages and disadvantages, and the likelihood of their adoption and the costs associated with them. It is suggested that FDI is the preferred option for foreign operation of the firms, in spite of the fact that they are not always able to choose this kind of mode. Joint venture has become more popular recently, specially because of the pressures of host governments in the sense of imposing associations with local partners as a condition to agreeing to receive the firm in their countries. Licensing is related to a lack of knowledge of the market and with the cultural distance suppliers and receivers have from each other.

Various characteristics of firms cause differences in their behaviour. Investments in R&D create a strong technological base in the firms, and this is supposed to raise the number of transactions with technology. Comparative size of the firm within its industry influences the way it transfers technology and there is a tendency of firms to use a specific form of international participation according to their size. Strategies are available for coping with commercialisation of technology. With respect to the composition of the market, from monopoly to perfect competition, in a market with many competitors and without entry barriers, the firm does not have the incentive to operate and usually prefers the use of licensing.

The receiver of the technology is viewed as more sensitive to the negotiations of the terms of transfer; the supplier, most of the time TNCs, is seen as having to cope with the new phenomenon of host government intervening in the technology transfer.

The brief historic overview of British industry shows its strong and its weak points; in its environment in the 90s, two main sources of competition and opportunities are Japan and the United Europe.

Finally, from an examination of the major theories of international production, the main points of interest for this research are problems of market imperfection, competitive advantage, structure of the market, locational advantages, internalisation and age of the technology and its distribution around the world.

The objectives of the chapter were to provide an overview of the literature on the subject and to find a theoretical framework on which to base the research hypotheses, developed in Chapter 3.

CHAPTER 3

DEVELOPMENT OF A MODEL OF TECHNOLOGY TRANSFER

3.1 Introduction

Chapter 2 gave an overview of the literature on the international transfer of technology. The literature concentrates on the modes of transfer of technology, the constraints in the environment determining the way firms handle their technological assets, the characteristics of these firms and the main actors in the scene: the supplier and the receiver. The chapter also outlined the theory behind the approach to the problem examined in this research.

The objective of Chapter 3 is to identify and discuss key ideas in the literature review which could support the elaboration of a research hypothesis to be tested through a survey. This support was sought in mini-case studies as well, in the form of a pilot study, which will be discussed later. All the technical details of the methodology followed for the field work of this research, both for the pilot study and for the survey, will be explained in detail in Chapter 4, and its operationalisation in Chapter 5; for this reason, the procedures taken will not be mentioned in this chapter.

It should be explained, however, that the mini-case studies were developed in order to understand how British companies transfer technology and to collect any other convenient information for the research. These case studies were conducted through nine semi-structured interviews with top managers involved in technology in six firms.

The final part of this chapter will be used to construct a model of transfer of technology, based on the literature review and on the pilot studies; the hypotheses on which the model is to be tested will be elaborated.

3.2 Pilot study

This section will analyse some preliminary findings from the interviews conducted during the pilot studies.

There was no formal criterion for selecting the companies that participated in pilot study[1]. The study was conducted with firms that consented to collaborate with the research, both in giving access to their data and in agreeing to an interview with an average duration of 80 minutes. By coincidence, the interviews were concentrated in the telecommunications and petroleum areas. However, as these companies were highly representative of their sector, very useful information could be gathered, and the answers received from the interviewees were generally consistent with each other.

3.2.1 Firms studied

The companies interviewed were large sized TNCs, belonging to the telecommunication and petroleum sectors. Among the telecommunication companies, two were product manufacturing and one was a service company, with a huge R&D Centre. In the three petroleum companies, the main business was continuous processing. Although together they formed a very homogeneous group, they had differing organisational systems, especially the organisation of their R&D resources. Being TNCs, they had branches in several parts of the world but they differed in their perception of the investment of resources in other countries, as will be explained later. However, they were unanimous in preferring to transfer technology to large markets, where they were able to maintain oligopolistic positions.

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1 For technical details, see Chapter 4.

3.2.2 Reasons for transferring technology

From the interviews there emerged many reasons for transferring technology overseas and the answers confirm, to a certain extent, what has been found in the literature.

Firms invest overseas, and consequently transfer their technologies, in order to obtain technology from new affiliates, i.e., they transfer technology to use technology reciprocally. Furthermore, when the rapid standardisation of a product developed in their laboratories becomes necessary, they do not transfer on an exclusive basis to a single firm. In the specific case of the service firm, as it is not a manufacturing company, the products developed in its laboratories will be licensed simultaneously to several firms because it wants others to produce products which it wants to buy competitively on the world market.

If there is an available stock of knowledge acquired through R&D the transfer may occur, when the firms are not interested in exploiting it themselves. This saves some resources and does not waste the investment made in R&D. Nevertheless, although the funds raised from selling technology are considerable they are not sufficient to subsidise the R&D activities. Selling technology for funding R&D activities does not seem, therefore, to be so important for firms.

All the companies stated that their R&D centres develop technology primarily for internal use. Their function is to provide a service for the benefit of the business. The technology is usually generated to obtain a commercial edge and advantage over the competitors. The companies try to maximise the use of the technology within the group from one company to another under various agreements.

If the technology is a commodity type, i.e., not a strategic product and it is available from other sources, firms license to third parties. The interviewees explained that if firms keep it for themselves other people will be licensing similar technology. Yet most of the time they do not develop technology to put a third party in business. They only do so if the technology is not strategic. Certain technologies are not made available to third parties under any condition, the interviewees admitted. One of the firms suggested that for certain technologies, the world can have one dozen plants, but for others the world needs only two or three. If, however, the companies see a very good market where the only way to get in is to select a partner and invite him to join them, they do not hesitate, because some countries in the world are excellent market opportunities. Firms do not want to give the market away.

It is a general thought among the companies that they do not transfer mature technology for the following reasons:

(a) they lack spare resources to manage the transfer;

(b) the buyers are very much aware of what they want and they do not accept what they perceive as mature technology;

(c) the users are leading edge oriented.

It could not be verified whether this is a sectorial trend (telecommunications and petroleum) or a general rule among British industry. In fact one of the companies admitted that they had examples of licensing technology that they no longer wanted, but this was a less common phenomenon. Another said that there are products that have reached maturity in the sense that the UK has ceased purchasing them, though they are totally satisfactory products for other countries. One example of this would be a product with a style that has gone out of fashion or has lost its acceptability in the UK. The company emphasised that such a product is not a case of mature technology but of a mature style.

For buyers, mature technology is not at all acceptable. On the contrary, one of the firms remarked that developing countries in particular do not want just the latest technology but the "latest plus". One other said that the clients do not want to buy yesterday's technology and that the less the country of the client is developed, the more that attitude is evident. This seems to be a tendency that has grown more dominant in the last few years, i.e., the buyer being more prepared to buy technology and the governments of the recipient countries having a more active participation in the negotiation of transferring of technology.

It was also a general thought among the interviewees that the option of transferring technology at arm's length is the last one. They only transfer technology because there are barriers to the direct export of the product to the territory concerned, and FDI is not permitted.

"We do not transfer technology out of the kindness of our hearts; we do it because we want to retain the market share where it is difficult to have a market share without a local manufacturing", declared one interviewee from a telecommunication firm.

There are cases, on the other hand, when a base technology that was used for one purpose could be exploited in another way. When there is no interest in doing that, firms can license to third parties. This fact was confirmed in more than one company: they may achieve some useful results which the operating part of the company, for some reason, does not want to take up. Therefore, in order to avoid wasting the investment in R&D they license to somebody else. One firm declared that, as an operating company, they want manufacturing to make products for them to buy. This way they license what they develop in their laboratories.

However, it seems that what mainly impels the companies to transfer their technologies is market opportunity in the host country. In spite of all the problems related to transferring technology, a good market opportunity is enough reason for companies to overcome all the inconveniences.

Summing up this section, Table 3.1 presents the main points raised by the six firms.

Table 3.1

Main reasons for transferring technology;

. Reciprocal use of technology
. Necessity of rapid standardization of a technology
. Availability of stock of non-strategic knowledge
. Maximisation of the use of a technology
. Achievement of commercial edge over competitors
. Rise of barriers to entry in a market
. Transfer of commodity type technology before competitors
. Good market opportunity in the host country

3.2.3 How technology is transferred

It seems that there is no general way of transferring technology among the firms interviewed. Each case has its characteristics, even when the firm has had previous experience in transferring technology to the same country. General guide-lines on transfer of technology exist in all the companies to permit the negotiation to move smoothly. Details are specific, however, and they are discussed case by case.

Three of the companies had a special department in charge of all the matters related to the transferring of technology, and in the other three the units had complete autonomy to handle the procedures. Usually the Board of Directors has the final word in the process, though their decision is a formality; once the process reaches their jurisdiction, the subject has already been discussed exhaustively at lower levels and the Board of Directors is expected to agree with the recommendation from below.

The companies examined did not have clear similarities in terms of organising their R&D departments. Two of them had a centralised R&D for the whole group, whilst the rest had several units performing specific tasks for the companies. Thus, no generalisations could be made about organisation of R&D.

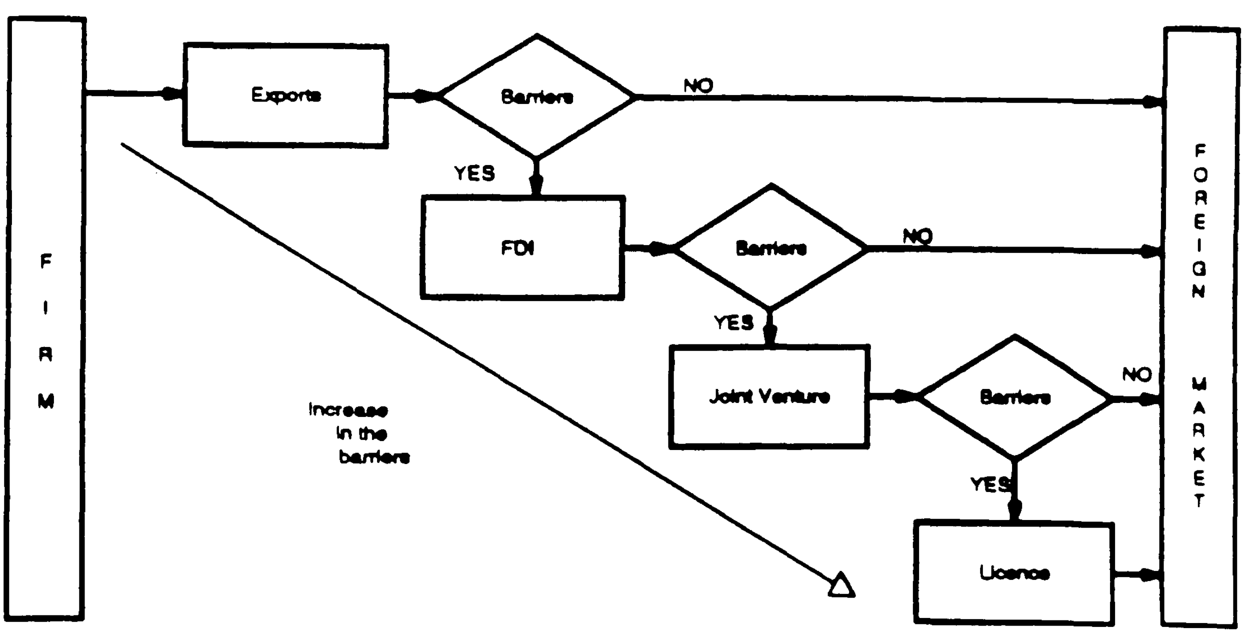
The companies do not use agents to sell their technologies abroad. They have reached a phase of growth such that they have operating companies all over the world and these operating companies establish all the necessary contacts. Furthermore, they are not an R&D company and the research they do is for the benefit of their firms. Only if circumstances are favourable will they transfer technology.

In the case of a product using a current technology, the first option for the companies is to sell the product directly through exporting (with the exception of one firm, which is an operating company, instead of a manufacturing company). If there is no possibility of selling the product, they look for a whole ownership approach or, if this is not possible, for a participation as a majority (equity share basis) shareholder of the company in order not to lose control of the technology they transferred. In this case, they transfer through a joint venture to share the risks and the opportunities. As a last option, they license to a non-related company. But this is very much the last choice. It is only where there are no other opportunities of exploiting that technology that they would license, according to the interviewees, because immediately the technology is transferred to one country, the possibility of getting any sales in that area is destroyed. These findings, disclosing the reality of six large TNCs with great experience of internationalisation of their production, are summed up in Figure 3.1 .

Figure 3.1

Options of internationalisation of firm

(according to pilot study firms)



With two exceptions, the firms did not have a main client for the purpose of transferring technology. One firm explained that they practically only transfer technology to the "Triad" (North America, Western Europe and Japan) because that Triad contains 14% of the world population, 60% of the world GNP and 95% of the world telecommunication revenues. For these companies, there is no point in seeking a buyer outside the Triad. A second firm, on the other hand, declared that over the last ten years it still happens that more technology is being transferred to developing countries because there is less investment going on in developed countries in the petrochemical area. That suits the company because they wanted to have a wide geographical spread of investment.

Business with the developing countries is usually a difficult task. The interviewees complained about the protection of the market, the artificial barriers created by governments and the legal restrictions concerning confidentiality in some countries. Another factor that makes transfer of technology difficult is the lack of local expertise. According to one firm, some developing countries have immensely good theoreticians but have virtually no experience in practical work. In these countries, the companies usually have a considerable amount of teaching to do, beginning with the basic production procedures. They try to transfer technology at the pace of the receiver.

Appendix 3.1 presents tables summing up the principal aspects of the pilot study.

3.3 Dimensions of the transfer of technology

Several non-exclusive dimensions of the transfer of technology will be identified, in light of the review of the literature and the pilot study. Table 3.2 shows these dimensions, which are related to the characteristics of the internal context, characteristics of the firms, characteristics of the recipient markets, and characteristics of the recipient countries. This chapter will seek to draw a relationship between the modes of transfer and some of the dimensions identified. It is, however, not the intention of the research to test all the relationships found in the model, owing to limitations of time and cost.

Table 3.2
Dimensions of the transfer of technology

1. Modes of transfer	CHARACTERISTICS			
	SUPPLIERS		RECEIVERS	
	2.Internal context	3. Firm	4. Market	5. Country
1.1 FDI 1.2 Joint venture 1.3 Licence 1.4 Others	2.1 Home market 2.1.1 Demand 2.1.2 Competition 2.2 Technology 2.2.1 Age 2.2.2 Similarity 2.2.3 Complexity 2.2.4 Rate of changes	3.1 Size 3.1.1 Small 3.1.2 Medium 3.1.3 Large 3.2 Ownership 3.2.1 National 3.2.2 Transnational 3.3 Structure of activities 3.3.1 Capital/labour 3.3.2 Process/product 3.4 Corporate strategy 3.4.1 Production/marketing 3.4.2 Pioneer/laggard 3.5 Sector of activities 3.6 R&D activity 3.7 Market knowledge	4.1 Size 4.1.1 Small 4.1.2 Medium 4.1.3 Large 4.2 Structure 4.2.1 Monopoly 4.2.2 Oligopoly 4.2.3 Fragmented 4.3 Costs 4.4 Growth	5.1 Stage of development 5.1.1 Developed 5.1.2 NIC 5.1.3 Less developed 5.2 Political risk 5.3 Resources 5.3.1 Raw material 5.3.2 Infrastructure 5.3.3 Labour 5.4 Cultural distance 5.5 Barriers 5.5.1 Tariff/quotas 5.5.2 Non-tariff 5.5.3 Export subsidies 5.5.4 Restrictions: a. flow of capital b. kind of knowledge

3.3.1 Modes of transfer

Three main modes of technology transfer are considered: FDI, joint venture, and licence. It is common for other modes of transfer to be used to complement the principal procedures[2]. All the modes were explained in detail in Chapter 2.

The present research assumes that there are several levels of relationship among the modes of transfer technology and the other dimensions presented in the table.

3.3.2 Characteristics of internal context

Two main internal factors influence the behaviour of supplier firms in their attempt to expand abroad: the structure of the home market and the kind of technology possessed. The main characteristics of the home market are demand and competition. When there is an obstacle to expansion in the home market owing to the saturation of the demand, expansion of firms becomes very difficult and the costs of incremental penetration in this market could be enormous. This situation is commonly observed in several European countries, where, in spite of great consumption power, the small population (and consequently small market) inhibits further efforts by firms to grow at internal level. The choice of producing abroad also results from heavy competition in the home market. Firms look for foreign markets in order to compensate their losses in the share of the domestic market owing to competition and in order to justify their production in economies of scale. If, on the one hand, the heavy competition can be a stimulus for the firm to create a situation of strong competitive advantage, on the other hand, it can make profits smaller, waste duplicate resources and hinder the adoption of economy of scale (Porter, 1990a, 1990b).

Four characteristics are related to the technology available in the firm: the age, the similarity, the degree of complexity and the rate of change presented by the technology in comparison with other available technologies.

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2 Refer to Chapter 2 for details on the modes of technology transfer.

The age of the technology is a subject of great controversy, as explained in Chapter 2. Vernon (1966) suggested that technology would start being transferred overseas after reaching the stage of maturity. Later, he rebuilt his line of thought accepting that this standard had been changing in previous years and the behaviour of firms reverted to transferring their newest technology abroad almost immediately after the launching phase in the home country (Vernon, 1979). In this case, the supplier would be a large size firm. For Vernon, the original theory was still valid for the cases of technology transfer by small size firms. Several researchers sustained this proposition through empirical studies realised specially in the USA[3]. However, as indicated in the pilot study of the present research, the large companies denied transferring old technology; their justifications for not doing so were the difficulty in arranging experts in out-of-date technologies and the position of the receivers, who no longer accepted old technologies. The literature refers to cases of transferring latest technology to subsidiaries abroad and transferring mature technology through joint ventures and licensing (Mansfield & Romeo, 1980). This debatable subject is one of the focal points of this research.

The second item, similarity, refers to the quantity of similar technologies available in the market at a certain moment. A large range of options of technology means that no supplier has a monopolistic advantage and that the price of the technology tends to fall because of the competition. In this case, there is an inclination to use licensing, instead of a direct form of investment.

Complexity in technology means the result of intense R&D efforts, with a high degree of sophistication, and involving a certain amount of difficulty of reproduction; it represents the state of the art. It is usually transferred to developed countries where there is critical mass ready to absorb this know-how of the latest generation and start the process of production in a very short time. The developing countries usually receive less refined versions of the technology, due to their presumable lack of capacity to deal with sophisticated versions.

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3 As mentioned in Chapter 2, the works of Abernathy & Townsend (1975), Teece (1977), Contractor (1983), Rosenberg (1984), among others, can be consulted in this area.

Finally, the rate of change signifies that some technologies, such as those in the electronic industry, have a very fast rate of change. This tendency has increased so rapidly that users do not have a capacity to take full advantage of the new technology or do not have time to understand all its potential, as Voss (1989) indicated. A firm possessing technology with a high degree of change, according to the natural standards of technology transfer, should have a tendency to license it instead of establishing a whole subsidiary especially for producing the product abroad, because the rate of obsolescence is very high and the return on investment can be low.

3.3.3 Characteristics of firm

Another group of dimensions consists of characteristics of the firm. Size, ownership, structure of activities, corporate strategy, sector of activities, R&D and market knowledge are very important components of the 'personality' of the firm and can contribute to establishing the links in the way firms seek to transfer technology.

There is a rich literature on the relation between the size of firms and their behaviour, including the way they transfer technology[4]. Among the elements that discriminate firms by their size, there can be cited not only the absolute number of employees, turnover or production, but, most importantly, the style of management, the geographical distribution of the firm, the origin of capital, and the relative size within its industry (Carson, 1990). According to the size of a company, the management style varies from complete independence (in the case of a small size firm) to total dependence on a central headquarters. The capital either is supplied by resources of the proprietor or originates from the conglomerate. The geographical distribution is a differentiating factor as well, because it is supposed that small firms operate within only a regional market and large size companies have branches spread over several locations. What is critical in differentiating the size of firms, however, is the amount of available resources, such as financial and human resources, to support an investment abroad. The inadequacy of these resources, as frequently happens in small size companies, limits the choice of form of foreign participation. Buckley & Davies (1981) justify the choice of licence by small firms, stating that they suffer from lack of capital together with shortage

4 For more details, see Sharkey et al (1989), Solocha et al (1990), Patel & Pavitt (1991), Carson (1990), Bosworth (1980), Magee (1981), Bilkey (1978).

of managerial capacity. Stobaugh (1984) makes the same point, suggesting that small firms tend to sell technology instead of opting for FDI, because of their lack of capital. Casson (1987) indicated that joint venture and licensing are more commonly adopted in the early stage of growth of the firm. On the other hand, large firms, having sufficient technical and managerial staff, tend to internalise their technology.

A second characteristic of the firm is its ownership. Here a distinction is made between national and transnational firms. It is assumed that firms with a transnational presence have a very different style of management from those with a national range of action, which are said to have a more personalised method of command. Also, since national firms lack experiential knowledge of international markets, their process of internationalisation is much more difficult than that of transnational firms. The experience of servicing a foreign market is valuable when the mode of transfer of technology is to be chosen and so the transnational firm has an advantage over the national one. As stated in Chapter 2, transnational firms are more efficient in transferring technology than the nationals because they have more experience, capacity to mobilize financial resources and organisational skills, and know-how. These factors can differentiate the way firms transfer technology abroad.

The structure of activities of the firm is the third characteristic which is supposed to influence the mode of technology transfer. In the present research there will be an attempt to discover a relationship between the nature of the production process or services in a firm and the way technology is transferred abroad. As Casson (1988) suggests, firms tend to transfer their capital intensive activities to developed countries, which have skilled labour able to work with these more sophisticated technologies. Labour intensive activities, on the other hand, tend to be transferred to a NIC, which usually has available abundant unskilled and semi-skilled labour. In view of the controversies in the literature about this point[5], it will be interesting to examine the approach of the firms studied in the present research.

Another sub-division of the structure of activities is the process versus product orientation of firms. Stobaugh (1984) found that in the petrochemical industry, known as

5 As mentioned in Chapter 2, these controversies are found in the studies of Amsalem, Keddie, Lecraw and Wells, published in the book of Stobaugh and Wells (1984).

a typical example of a process orientated industry, there is a tendency to use licence rather than FDI and joint venture when transferring their process to another country. Thus, it seems that the type of production procedure influences the way firms transfer their technologies; furthermore, the kind of production process influences the way firms are organised[6]. Consequently, there should be a relationship between the range of production possibilities and the mode of technology transfer.

The corporate strategy, the fourth characteristic, refers to constraints on firms in relation to their available resources and capabilities. As stated by Grant (1991), a strategy should be concerned with the strengths and weaknesses of the firms and their transformation into a source of profits, and with the support of their competitive advantages. Keller & Chinta (1990) are more drastic in connecting the future of a firm with its use of strategy to transfer technology abroad more effectively than the competition.

As Porter (1990a:47) indicates, the first to move has the advantages of establishing economies of scale, obtaining the best locations or best sources of raw materials, initiating a strong relationship with customers without direct competition, and so on. Because of being the first, the firm can sustain its leader position in the market for a longer time than other competitors can. However, it should be mentioned that the first to move also faces higher risks and uncertainties. The present research will attempt to trace an association between the orientation of the corporate strategy of the firm and the way it transfers technology. Thus, what will be explored in the analysis of the results is whether the orientation of the firm toward production or toward marketing influences the way it transfers technology abroad.

Similarly, the orientation toward being a pioneer or a late producer will be examined in light of the results of the present research. In reference to the seminal work of Rogers (1973) on the diffusion of innovations, the present research presupposes that individual characteristics of the managers facing the adoption of innovations influence the corporate strategy of their companies, specially on the launch of a new product or service into their home markets. A company can then be described in a range that goes

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6 Woodward's (1965) early work on technology and organisational structure of the firm supports this approach.

from pioneer producer to laggard, or very late producer, which will be analogous to Rogers' description of the individual actors in the innovation process. It is postulated that the speed of introducing a new product/service in the home market is reflected in the way the firm transfers technology.

The fifth item concerns the sector of activities. Some sectors of the industry have a more stable pattern of innovation and diffusion of technology, whereas others have an energetic performance in the area. Furthermore there are different standards of behaviour related to the sector of activity of the industry. For example, it is common in the electronics industry, known for their highly intense technological activity, to start foreign production of their components in countries with cheap labour shortly after the technology is developed in the laboratories of the parent companies (Marton, 1986). As cited above, there is a tendency of firms in the petrochemical sector to choose licensing as a way of transferring their technologies. It is presumed that the sector of activities is a determining element in the way firms go abroad.

R&D activities, the sixth item, provide essential support for the competitive position of the firm. On the other hand, the costs of these activities are increasing significantly because technologies are becoming more and more sophisticated, and firms have to look for additional funds for financing them. The large firms are leaders in technological development because they have the greatest concentration of R&D activities (Patel & Pavit, 1991). It is expected that firms with important R&D activities are the ones with greatest involvement in technology transfer and tend to internalise their production.

The knowledge that firms possess of the market is another aspect. If a new market is relatively unknown, there is a tendency of firms to use licensing, as Buckley & Davies (1981) suggest. This way, without substantial involvement abroad, the firm can obtain the level of information necessary on which to base further participation in that market. On the other hand, when there is complete knowledge of a market and the evidence suggests that there is a good opportunity for business, then the foreign direct investment is the preferred option.

3.3.4 Characteristics of recipient market

The size of the host market is the first characteristic to be examined in this section. An investment in a whole subsidiary in a small market is usually not interesting for firms because of the expected low return. In this case, there is a tendency of firms to transfer technology to small markets through licensing. In contrast, a foreign large market is the most attractive reason for setting up a subsidiary abroad.

The second item is the structure of the recipient market. As emphasised in Chapter 2, a monopoly is a preferable situation for large firms. This means that profits will be higher, and that there is an exclusive market at the disposition of the firm. According to Gilpin (1987), the transnational corporations exist because of the increasing oligopolistic competition in the world market. This oligopolistic situation can produce high profits if there is collusion among the competitors, as Hymer (1960/1976) explained. In these two situations, foreign direct investment is the preferred form of internationalisation of the firm. On the other hand, in the case of a fragmented market, with low barriers to entry, the profits tend to be little and uninteresting for the firms. In this case, licensing will be the first option for establishing a presence abroad.

Costs are the third aspect to be related to the host market. The structure of costs varies from one market to another. It creates different opportunities for profits at different times (Teece, 1982). Coase (1937) indicates that costs of structuring activities in a market are determinants of limits for the expansion of a firm. This line of thought has been followed by Buckley & Casson (1976), who recognise that transnationals seek a low-cost location to internalise their market. Therefore, in a market with low transaction costs, the tendency of the firms is to opt for internalisation of production, through the establishment of a whole subsidiary. Otherwise, in a market with characteristic high transaction costs, there is a tendency to opt for licensing.

The fourth aspect to be related to the recipient market is its growth. The growth of the market has a strong influence in the way it is organised and has the attribute of diminishing the importance of barriers introduced by economy of scale (Hymer, 1960/1976). It should be emphasised that growth of a market is related to the pattern that is followed during a period of time. An expanding market is an attractive ground for direct investment because of many continuously arising opportunities.

3.3.5 Characteristics of recipient country

The first characteristics of recipient country is its stage of development of a country. As mentioned in Chapter 2, there is extensive literature on forms of technology transfer and the economic background of the host country. It is supposed that firms tend to transfer their latest technologies to developed countries, because these receivers are potentially able to absorb them. These countries develop their own technologies, which might interest foreign firms and this fact creates a favourable environment for a cross-licensing agreement. The newly industrialised countries have cheap and abundant unskilled and semi-skilled labour, which creates a degree of attractiveness. In some cases less developed countries are an ideal place for establishing large agricultural projects as well as extraction of raw materials, as Casson (1988) points out.

Politically risky countries are usually not a favourable ground for establishing a subsidiary. However, the size of the market and the expected return on investment in some of these countries can be extra attractions, leading foreign firms to decide to overcome the fear of loss and to invest there directly. Political instability in the host country can influence firms to use licensing more commonly when transferring their technology (Prasad, 1981).

Countries can also be characterised by availability of resources. Countries which present abundant resources of labour, raw materials and infrastructure, in general, have a relatively high degree of attractiveness. Transnational corporations from rich countries with poor reserves in natural resources, as happens with Japanese firms, endeavour to establish subsidiaries or affiliates in places where there are plentiful resources, in order to protect the supply of the inputs. At the same time, the low cost of labour abroad is a motivation for firms to transfer to those locations activities that are concentrated in labour intensity.

Cultural distance, the fourth item, influences the way firms transfer technology. As pointed out in Chapter 2, there is reasonable literature available on the subject. It was demonstrated that cultural proximity between the receiver and the supplier favours the implantation of the subsidiary, while cultural distance increases the use of licensing and joint venture (Erramili & Rao, 1990).

A final important item to be examined here is the barriers created by the host countries. As Rugman & Verbeke (1990) observe, these barriers can dramatically change the competitive advantage that a firm possesses. Governments' intervention in the markets has the power to create resources, promote efficiency, compensate failures, yet it can increase imperfections. For example, Davidson & McFetridge (1985) emphasise that the excess of restrictions tends to create a flow of technology with inferior quality, because firms will not put at risk their best products, or technological assets in such a regulated market. Dunning (1983) emphasises that what in fact determines the mode of technology transfer is the interference of the home and the host governments.

With these dimensions explained in this section, a model is developed representing the flow of technology transfer in the industry; this development is explained in the next section.

3.4 Model of technology transfer

This section is dedicated to the construction of a model of technology transfer, in which are included characteristics of a firm's home market, the technology, the foreign government policy and its barriers, the recipient market, and the firm, as presented in Figure 3.2. The flow of technology transfer is a very complex process and needs a model to render it understandable. Through a model, showing the interaction of a number of dimensions affecting the flow, the process may become transparent to the eyes of decision-makers.

Figure 3.2

Flow of technology transfer

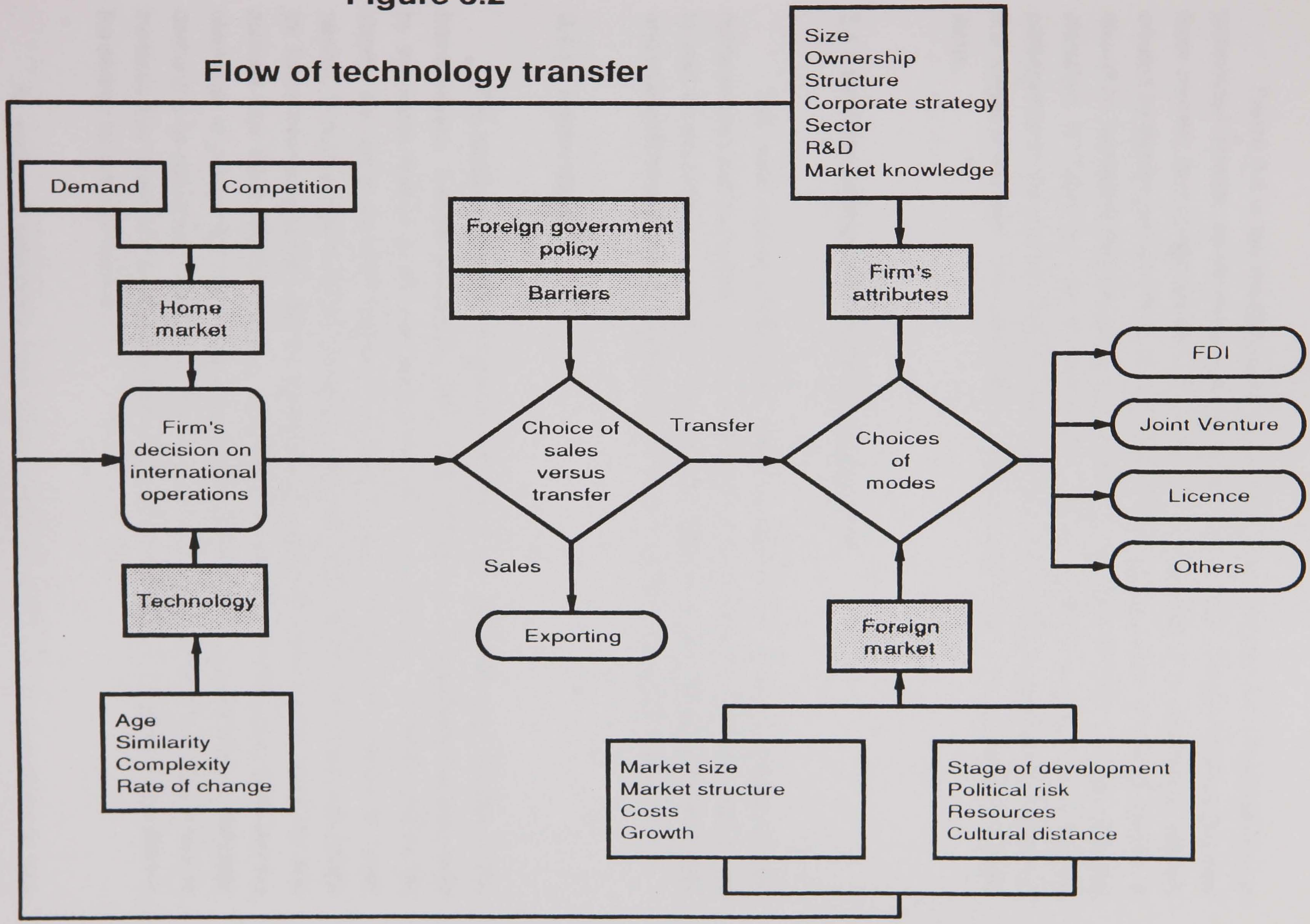

Figure 3.2 is the representation of an analytical framework of the global flow of technology transfer, as viewed in the present research. Five factors influence the way firms transfer technology abroad: home market, characteristics of technology, barriers created by foreign governments, firm's attributes and characteristics of foreign market. It should be explained that the barriers created by foreign governments, in spite of being classified in Table 3.2 as a characteristic of the foreign market, has a special participation in the process because they influence the modes of technology transfer in first stages of the flow. The rest of this section will be devoted to the discussion of these items.

3.4.1 Decision of firms on international operations

Two main factors immediately affect the decision of firms to operate abroad: home market and technology. There are, however, other factors which may lead a firm to start an international operation. Among these factors are the characteristics of firms and characteristics of foreign markets, both of which will be explained in Section 3.4.3 .

3.4.1.1 Home market

The decision of firms on international operations starts with their position in the home market. Internal demand as well as competition are the main stimulus generated by the home market for the decision of the firm to go abroad. As Porter (1990a:79) states, the home demand makes the firm "perceive, interpret and respond to buyer needs", in such a way that it contributes to the preparation of the competitive advantage for future international operations. Demanding domestic consumers can make the firm achieve high standards of production and, because of this, the firm is ready to accept the challenge of producing in any part of the world. One other aspect related to domestic demand is its saturation. This may imply that the firm lacks further channels in which to increase their sales and such a situation justifies supporting an international operation in the search for a better market.

As explained previously, competition in the home market can drive firms to look for new locations where they might have a better share of the market. This is especially critical in an industry that depends on economies of scale to produce efficiently and profitably (Porter, 1990a).

In short, the saturation of domestic demand and the heavy competition at the home market might make the firm transfer its activities overseas because it is no longer profitable to produce in the home country or the return on investment is becoming shorter.

3.4.1.2 Technology

The technological content of the product/service of the firm is another component of the flow. As described previously, the age of the technology may be correlated to the form of technology transfer. Firms invest a large amount of resources in R&D with the intention of creating an unique competitive advantage. Their first move will be exporting the good which has the technological content of the latest generation. If it is not possible to export, firms will have to choose the more convenient mode of penetrating in a foreign market. Brand new technologies may be positively related with foreign direct investments and mature technology with licensing, as can be inferred from evidence[7]. There is also evidence in the literature[8] that firms still transfer old technology to less developed countries, while new technology is transferred to the developed world. However, this view was denied by the firms interviewed during the pilot study for this research.

In the market there are similar technologies that compete among themselves and make gains go down. The degree of complexity of the technology and its rate of change are additional factors in the way the firms transfer their technologies.

Characteristics of the technology are important determinants of the form in which it is transferred. Age is the main point in this section because, in spite of having been studied widely, it is still a live issue.

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7 See Mansfield & Romeo (1980) for example.

8 See Contractor (1983), Rosenberg (1984), among others.

3.4.2 Choice of exporting versus transfer

When a firm has come to the point of having to react to the pressures of the home market and when this firm possesses a product/service which embodies the above-mentioned technological characteristics, it is ready for the choice of exporting versus transfer. As stated before, the first choice is for exporting the goods or services directly from the home market. At this moment the host government starts acting. The governments' presence is extremely important in determining the way technology is transferred. The government can force the adoption of a mode that normally would not be chosen by the firms; alternatively, it can create artificial barriers through tariffs, protection of infant industry, exports subsidies, restrictions to flow of capital or kind of knowledge. It can also prohibit all importing of goods or services to its territory or the establishment of a wholly owned subsidiary, in a way that pressures firms that have interests in entering its host market to accept compulsorily a local partnership or to licence at arms' length. The government has a predominant influence on the way firms are allowed to transfer technology, a fact which finds support in the literature[9].

Summing up, if there is no intervention from the host government, firms that have chosen to export their goods or services directly from their home countries as their first option can do so. If the intervention exists, firms try different forms of international operation, according to other factors that will be explained later.

3.4.3 Choices of modes of technology transfer

The decision of what mode to choose for the transfer of technology will also depend on the characteristics of the firm and characteristics of the foreign market.

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9 See Davidson & McFetridge (1985) and Dunning (1983, 1991) on the subject.

3.4.3.1 Firm's attributes

Behaviour of a firm is closely linked to its characteristics and this reflects in the way it chooses to transfer technology. The size of the firm influences the manner in which it behaves specially considering restrictions of financial and managerial resources. Usually a small size firm does not have sufficient resources to consolidate a strong presence abroad, through a wholly owned subsidiary. Since licensing does not involve a great amount of resources, this should be the preferred option for small size firms. Through this form of international operation, the firm starts obtaining return from its investments in R&D and acquires knowledge of the foreign market. When the firm reaches the stage of being a large transnational corporation, the world market will not cause it a great amount of surprise, owing to its extensive experience in operating overseas. The large firm, much more mature and confident, will elect direct investment as a first option for transferring its technology and licensing becomes the last preferred choice. At this stage, there is a complete range of firm's representatives abroad, from agents to subsidiaries, and the initial investment has already been incurred, making the internationalisation a much more predictable process.

Large firms are also supposed to maintain strong R&D activities, and there is a great expectation that these firms will internalise their transactions more frequently than the ones with low R&D activities, according to Davidson & McFetridge (1985).

Distinct industrial sectors have specific attributes. As Porter (1990a:34) points out, "industries differ widely in the nature of competition, and not all industries offer equal opportunities for sustained profitability". This means that firms belonging to different industrial sectors may have a preferred form for transferring technology. In the same way, large firms, having monopolistic positions, tend to internalise their production, protecting their competitive advantage and extending their profit opportunities over a longer period of time.

To summarize, the firms' attributes influence the way they transfer technology. The analysis of the results of the research will attempt to relate some attributes to the form in which firms operate abroad.

3.4.3.2 Nature of market and country

The host government intervention again creates limits to the ambition of firms when it decides, for example, that licensing and joint ventures are the only acceptable forms of technology transfer. In the face of this, firms have two logical options: either to give up and not operate in that country or to accept the government rules and start producing their goods or services abroad under licensing or joint venture agreements. If there exists this sort of constraint, other factors can influence the decision of firms, such as the size of the market, the rate of its growth, its structure, and costs associated with the new location. Firms will invest, no matter what kinds of obstacles they must overcome, or how risky the political situation is, if they perceive an attractive market, with high rates of return.

The presence of a critical mass ready to absorb technology of the latest generation is another incentive which supports the decision to transfer to other countries. At the moment that domestic labour starts demanding high wages, there is the choice of transferring the production to a location that provides cheap semi-skilled labour. This phenomenon happens continuously; the most important example is the US consumer-electronics companies moving their labour intensive activities to Asian countries (Porter, 1990b). In this regard, it is worth recalling the characteristics that attract direct investments to a country: the availability of resources (such as raw material, infrastructure) and cultural proximity, as explained in Chapter 2.

Characteristics of the foreign market, which are associated with its size and structure, will be examined in the present research.

3.4.4 Flow of technology transfer

The analytical framework representing the flow of technology transfer (Figure 3.2) integrates all the dimensions highlighted by the present research. They seem to be the most important factors influencing the way firms transfer their technological assets.

From this analytical framework, hypotheses will be developed to be tested through statistical analyses.

3.5 Hypotheses

Non-exclusive dimensions of the technology were identified and transformed into an analytical model presenting the way technology is transferred. In this flow several relationships are underlined, but, as stated previously, only a few of the relationships will be tested due to limitations of time and cost.

To test the relationships, hypotheses were developed based on the literature and on the pilot study. The hypotheses to be tested are the following:

a) Relationship with home market:

a.1 Firms tend to transfer their technologies abroad when their home market is saturated and the competition is heavy[10].

b) Relationship with technology:

b.1 Firms transfer abroad their mature technologies which are no longer considered essential to their home business[11].

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10 This hypothesis is based on Dunning's (1991a) and Porter's (1990a,1990b) assumptions about saturation and competition at home market level.

11 Vernon's (1966,1979) theory is examined in this hypothesis.

c) Relationship with government barriers

c.1 There is a sequence of modes of international operation, where exporting is the first preferred choice[12].

c.2 Foreign government policy, restricting the direct sales to its territory, is one of the main incentives for a company to start producing its products/services abroad[13].

d) Relationship with firm's attributes

d.1 Firms with the most sizeable R&D departments are more active in the transfer of technology abroad[14].

d.2 Firms transfer technology abroad to support their R&D activities[15].

d.3 The manner of transfer of technology abroad depends on one or more of the following factors:

a) sector of activities;
b) ownership
c) nature of production process;
d) qualification of the labour force;
e) nature of corporate orientation;
f) speed of introduction of new products/services into the market[16].

d.4 Small and medium size firms, which lack sufficient available human and financial resources, tend to utilise licensing to transfer their technologies abroad[17].

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12 The incremental mode of internationalisation of the firm found in Johanson & Vahlne (1977) and Buckley & Casson (1981) is explored here.

13 This hypothesis is based upon the extensive literature, cited in CHapter 2.

14 This hypothesis was developed through the work of Stoneman (1988) and Patel & Pavit (1991).

15 This hypothesis finds support in Bertin & Wyatt (1988).

16 The vast literature sustaining this hypothesis is explored in Chapter 2.

17 Idem.

e) Relationship with foreign market

e.1 Firms transfer technology through foreign direct investment ventures to countries that have a large market[18].

e.2 Firms transfer technology to markets where they can maintain a monopolistic or oligopolistic position[19].

3.6 Conclusion

The process of development of the hypotheses was explained in the present chapter. They were grounded in the literature reviewed in Chapter 2 and in the pilot study described in this chapter. This process involved the identification of non-exclusive dimensions of the technology and the construction of an analytical framework, with a graphic representation of the flow of technology transfer and its relationships.

Finally, the hypotheses were delineated and divided into five different groups of relationships. These hypotheses will be tested through the methodology described in Chapter 4.

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18 Hymer (1960/1976, 1968) is the main author behind this hypothesis.

19 Idem.

CHAPTER 4

METHODOLOGICAL PROCEDURES OF GATHERING DATA

4.1 Introduction

The objective of this chapter is to describe in detail the procedure followed in preparation for the actual gathering of the necessary data. The use of techniques of scientific enquiry is necessary to guarantee good results and to make possible the reproducibility of the outcome. This kind of enquiry not only is an insurance against failure but also represents an ordered effort to bring under close scrutiny the phenomena being studied.

As Phillips (1976:3) states, scientific methods should be considered "an extension of the reasoning abilities that we use in everyday situations." Based on such techniques, a research design was developed to guide the whole process, from the collection of the data to their analysis.

During the development of the research design, considerations were made on the availability of a data source and the limitation of the process of collecting the necessary information. Although a scientific approach was followed, the structure of the research design was flexible, so as to take advantage of the learning process which occurred along the way. In addition, changes were allowed during the process, to increase the understanding of the problem.

This chapter will explain in detail all the theoretical paths adopted in this research and is divided into eleven sections. In the second section there will be an explanation of how the research design was chosen. In the third section, the survey process will be analysed and in section four the measurement process will be shown. The validity of the design will be examined in the section five. The development of the data gathering device will be described in section six. The pretest and the pilot study as well as the use of secondary data will be presented in sections seven and eight. The field work procedures and the sampling process are presented in sections nine and ten. Finally, the conclusions of Chapter Four can be found in section eleven.

4.2 Research design

In any research, the design of the procedure is the preliminary step toward obtaining a solution to solve the research problem and this involves decisions on the optimisation of the use of all available resources.

Nachmias & Nachmias (1976:29) described the research design as a "logical model of proof that allows the researcher to draw inferences concerning causal relations among the variables under investigation, and define whether the obtained interpretations can be generalized to a larger population or to different situations."

According to Abrahamson (1983), in any systematic collection of data, three main methodological paths should be followed: (1) establishment of a set of conditions under which the subjects would be examined; (2) choice of the way the data would be obtained; (3) decision on which ways the data would be analysed. There are several manners of following these paths and the most appropriate one should be chosen with the aim of rendering the research more efficient under the conditions available.

As explained by Ackoff (1953:50), the idealized research design should consider "the most efficient conceivable conditions and procedures for conducting the research, and requires the observation of the following aspects: subject, environment, stimulus and response".

Social science research can be done in different ways, including case studies, experiments, histories, analysis of archival information and surveys. Each strategy has its own advantages and disadvantages and should be chosen with three categories in mind, according to Yin (1984:13): (1) the type of research question; (2) the control that an investigator has over actual behavioural events; (3) the focus on contemporary as opposed to historical phenomena. In Yin's (1984) opinion, the survey is advantageous when the research goal is to describe the incidence or prevalence of a phenomenon or when it is to be predictive about certain outcomes.

After consideration of all the advantages and constraints of the circumstances, it was decided to collect the information by asking questions in the form of a sample survey with some support coming from a pilot test. The frame of analysis chosen was a mix of qualitative and quantitative analyses.

What survey would best suit the purpose of the research?

The literature describes several survey methods of gathering primary data that can be basically categorized as: observations, interviews and correspondence (Rummel & Ballaine, 1963). Essentially, the observation procedure (active or passive) is commonly used when a phenomenon can be observed directly by the researcher. Its main restraints are the degree of difficulty for the observed sample in assimilating the outsider and the high cost associated with the limited geographical area studied. Questioning people participating in the phenomenon through face-to-face or telephone interviews is the second form of data collection. This method should have a limited area of action, because it is another very expensive and time-consuming method of research. The correspondence method, as the authors denominate mail questionnaires, permits the collection of data from a large number of persons, in a large geographical area, at a relatively low cost.

Fowler (1988) reported that if the data is going to be collected in a population that is highly literate and that, presumably, is likely to be highly interested in the research, mail procedures become more attractive. As the sample to be examined in the present research could be described as having the above characteristics, this was another justification for the choice of the mail questionnaire.

4.3 Survey

It was therefore decided to conduct a survey through a mail questionnaire, to test causal relationships that could explain the phenomenon under study.

Tull & Hawkins (1987:105) suggest seven criteria for the selection of a survey method: (1) complexity; (2) required amount of data; (3) desired accuracy; (4) sample control; (5) time requirements; (6) acceptable level of nonresponse; (7) cost. In a comparison with other survey methods, according to the above criteria, these authors maintain that a mail questionnaire is strong in the criteria of desired accuracy and cost. The required amount of data, sample control and acceptable level of nonresponse are classified as fair by the authors. On the other hand, a mail questionnaire is considered weak in terms of (1) ability of respondents to deal with complex questionnaires and (2) time requirements, in spite of the fact that by the means of mail questionnaires, relatively complex questions and attitude scales can be administered with a good rate of success.

There is a vast literature on advantages and disadvantages of mail questionnaires. Support for the choice of mail questionnaire can be summed up with the main characteristics of this survey procedure. The advantages are the following: (1) lowest cost, compared with other survey methods; (2) lack of requirement of an interviewer; (3) simplest and cheapest to analyse; (4) no bias from personal interviewer; (5) cover for a substantial heterogeneous group; (6) easy access to a huge geographical area. A further advantage of mail questionnaires is that the respondent is more at ease to complete the questionnaire without the inhibiting presence of an interviewer. This is specially important for sensitive questions, as observed by Tull & Hawkins (1987:108): "since the mail interview removes the element of social interaction, it is often assumed that this approach will yield more accurate responses." With respect to questions that demand considered answers, involving consultation of personal documents or with other individuals, mail questionnaires are very appropriate (Nachmias & nachmias, 1976).

The main disadvantages of mail questionnaires are: (1) difficulty of obtaining adequate response rate; (2) recommended use mainly with structured questions; (3) lack of flexibility of the instrument; (4) no sure evidence as to whether the right person answered[1]; (5) lack of supplement to answers; (6) difficulty of estimating effects of nonresponses. Furthermore, the fact that the respondent sees all the questions before answering the questionnaire may result in a less natural and a less satisfactory answer. Tull & Hawkins (1987) also argue that mail questionnaires can confuse respondents as there is no interviewer to remove doubts concerning

1 According to Tull & Hawkins (1987:113): "A mailing addressed to a specific individual or job title may not reach the individual who is most relevant for the survey. In addition busy executives may often pass on a questionnaire to others, who are not as qualified to complete it".

questions. Thus the researcher is under greater constraint to design a self-contained set of questions. Finally, there is lack of control over time.

In an assessment of these points, the advantages of a mail questionnaire seemed to weight more heavily for to the survey than negative features of the process. The main factors taken into consideration were the cost of the survey and the national character of the research, rather than the regional, when only local firms would be studied. It also appeared that the main disadvantage of the procedure, the relatively great number of nonrespondents, could be minimised with a careful research design, as suggested by Yu & cooper (1983). And to secure a reasonable rate of response, various points were taken into careful consideration, as explained in detail in the next section.

4.4 Measurement process

Questions can be classified as open-ended and closed-ended, the latter consisting of dichotomous, ranking, check-list, multiple choice and scale questions (Luck & Rubin, 1987). According to the level of measurement, questions can have nominal, ordinal, interval and ratio levels[2].

Kinnear & Taylor (1979) have pointed out that the postal questionnaire is more likely to gain cooperation of the respondent if a structured-response format is presented. Such a questionnaire is simpler and less time-consuming to answer and to analyse. The literature describes several advantages of closed-ended questions, when used in the mail questionnaire. They: (1) are easier for the respondent; (2) are essential for securing adequate cooperation; (3) reduce interviewer bias; (4) are easier to administer; (5) are easier to codify. Also, they reduce bias that results from varying levels of respondent articulateness in open-ended questions (Tull & Hawkins, 1987). Closed formats are, in addition, very appropriate for quantitative analysis, owing to their guarantee of a uniform measure and their ease of tabulation.

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2 These classifications have been exhaustively discussed in the literature cited. For example, see Brook (1987), Fowler (1988), Ferman (1975), Kinnear & Taylor (1979), Luck & Rubin (1987).

On the other hand, the main disadvantages of closed-ended questions, according to the literature, are the considerable amount of time expended in developing alternatives to be presented to the respondent and the difficulty of including all alternatives as responses.

Abrahamson (1983) has emphasized that open ended questions should not be asked in a mail questionnaire for two reasons. The proportion of respondents who do not answer a question, claiming not to know the answer, is higher specially because of the nonpresence of the interviewer. Furthermore, it is a very difficult task to code open-ended questions for statistical results.

For the measurement of many variables, Likert-type scales were used. Originally developed to measure attitudes, this type of scale has been widely used for several other kinds of measures. Abrahamson (1983) argues that there is no fundamental logic to the restriction of the use of the Likert scale to the estimation of attitudes. It was decided to measure the variables in nominal, ordinal and interval levels, using closed-ended questions, such as multiple-choice, dichotomous and ranking, and a few open-ended questions.

4.5 Validity of research design

The process of developing the questionnaire involved other aspects beyond form, wording, and order. The final instrument was the result of much work and a careful pretest, but it was subject to producing measurement error.

Measurement error occurs when there is no direct correspondence between the result of the measurement and the phenomenon being studied. Only in an idealized situation, which is very difficult to achieve, does the measurement represent precisely the characteristics being measured, and nothing else (Kinnear & Taylor, 1979). Actually, it seems that every measuring tool has some degree of error and that the conclusive result is an approximation of the phenomenon under investigation.

Kinnear & Taylor (1979) point out several kinds of potential sources of error that might affect the measurement process. Personal factors (such as mood, fatigue), situational factors (such as changes in the environment), and instrumental factors (such as difficulty of the questions and ability of the respondent to answer them), among other factors, may interfere in the final product. These sources cause two main types of errors: systematic errors and variable or random errors. The measurement will be reliable if there are no variable errors in the responses and will be valid if there are no variable and systematic errors in the responses.

Validation procedures of the questionnaire take two different forms: the first are related to wording of the questionnaire, and the second are related to provision of an internal check. Measurement error can be reduced substantially through better design of questions and, according to Fowler (1988:95), this is one of the cheapest ways to improve survey estimates. If an instrument is well designed, there is no apparent reason for two respondents, who are in the same situation, to answer the questionnaire in different ways. The author suggests three steps to improve the validity of the questionnaire: (1) make the questions as reliable as possible, avoiding ambiguities and being sure that all the respondents will understand the same meaning; (2) have more categories than fewer, when trying to measure through ordered classes along a continuum; (3) measure the same thing through multiple questions asked in different forms. Luck and Rubin (1987) also encourage the use of the method of approaching a phenomenon through several questions, because these multiple questions can be cross-checked to certify that there is consistency in the responses of each person questioned.

The literature suggests several major methods for estimating the reliability of the measuring device, such as the test-retest method, the alternative form technique and the internal-comparison method (also called split-half reliability)[3]. For practical reasons, the internal-comparison method was chosen to measure the reliability of the questionnaire. This method consists in dividing questions into two sets of the same size. Each of the sets is treated separately and correlated later. If high correlation coefficients are found, it means that the items are measuring the same characteristic. However, according to Liddell (1990), the use of the correlation coefficient between the values of a particular variable for one group against the values of the same variable for the other inevitably results in an arbitrary and unwarranted pairing of, for example, the first case in group A with the first case in group B. With the T-test, the association between groups as a whole can be measured without that artificial

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3 For illustration of these techniques see, for example, Nachmias & Nachmias (1976), Kinnear & Taylor (1979) and Tull & Hawkins (1987).

pairing. For this reason, the T-test was chosen as the statistical test, instead of correlation, and this will be described in Chapter 5.

Tests of validity and of reliability of the questionnaire will be explained in more detail in the next chapter, when the results of the fieldwork will be described.

4.6 Questionnaire design

A considerable amount of time was dedicated to the development of the data collection form. This instrument was designed as a link between information sought and data to be collected. As claimed by Luck and Rubin (1987), a researcher may need more art than science to compose a questionnaire. It is necessary to have a clear understanding of the information needed and the significance of the respondent in the whole process, as well as extensive pretesting, as Kinnear & Taylor (1979) recommend.

Luck and Rubin (1987) have identified a series of steps that should be observed when a questionnaire is being designed. The researcher should: (1) determine specific data to be sought; (2) determine interviewing process; (3) evaluate content of questions; (4) determine format of questions; (5) determine wording; (6) determine questionnaire structure; (7) determine physical characteristic of form; (8) pretest, revise, prepare final draft.

In relation to the present research, steps 1 and 2 have been discussed, in sections 2 and 3. The next task undertaken was the examination of format of questions. As explained above in section 4.4, it was decided to use a structured response format to accelerate the return of the questionnaire. In accordance with this, sets of multiple-choice questions were developed, after a literature review on the subject of the research, i.e., transfer of technology. Personal experience in contact with managers in the area and in previous studies, was also taken into consideration during the elaboration of questions. Given that it was not feasible to include all possible alternatives in each question, the option "Other (please specify):" was incorporated when appropriate.

Tull & Hawkins (1987:266) advise that "the overall questionnaire should move from topic to topic in a logical manner, with all questions on one topic being completed before moving to the next." Questions were accordingly sequenced in a form that sought to facilitate the process of completing the questionnaire. The sequence adopted is one proposed by the literature[4], starting with general questions, followed by warming-up questions and then difficult questions. The reason for locating the core of the study near the end is that it will be enhanced by the warming-up effect of the other questions.

The design of the questions was made, following all steps found in the literature, as explained in the next section. It should be emphasized, however, that multiple choice questions were designed to be mutually exhaustive and mutually exclusive, as recommended by Kinnear & Taylor (1979). The wording was carefully considered, specially because of the nonpresence of the interviewer. Jargon was avoided, questions were constructed in a straightforward manner, and questions that might embarrass the respondent were avoided. They were formulated in direct language, with terms that respondents would be familiar with, and statements were as brief and as specific as possible and avoided double-barrelled questions, as recommended in the literature (Luck and Rubin, 1987). Following Kinnear & Taylor (1979), several types of questions were avoided: leading questions, biased questions, implicit alternatives; implicit assumptions and estimates.

Another item mentioned in the literature is information that can be obtained through secondary sources. If data can be obtained from indirect sources, then questions concerning such data should be avoided. It is emphasized that no request for information readily available from other sources was made in the questionnaire. These items were not included in the questionnaire in order to make it easier to answer and not tire respondents. This subject will be explained in more detail in the section on secondary data, in this chapter.

A great deal of attention was given to the appearance of the questionnaire. Its visual aspect can be important in gaining the cooperation of the respondent; it is, in fact, taken to be fundamental to the rate of response. Visually, the questionnaire must give an idea of the seriousness of the research. It must look professional and easy to answer. As stated in the literature, the paper and the printing process should

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4 See, for example, Kinnear & Taylor (1979), Luck & Rubin (1987), Tull & Hawkins (1987).

be of excellent quality, the paper should be A4 size, and the lay-out should be attractive. All these items were taken into careful consideration when preparing the final version of the questionnaire used in the survey.

It is appropriate to make some comments about the front page. The name of the Warwick Business School, Marketing and Strategic Management Group was printed in the top, showing clearly who was responsible for the survey. Below, the name of the project was printed, as well its objectives. The operational definition of international transfer of technology was also given, and it was stated, in bold letters, that all replies would be treated as strictly confidential. In addition, the front page contained directions on how to answer the questionnaire, and the name and address of the supervisor of the research were provided, for the return of the questionnaire.

At the top right side of the paper was written the number of the firm, and it was explained that that number would be used for data process purposes. Tull & Hawkins (1987), based on a number of studies, emphasize that placing a visible code number on the questionnaire and explaining its purpose to the respondent does not affect the rate of return.

A final consideration needs to be made about the print-out of the cover page. First, a specialist was asked to lay-out the cover page and give an agreeable and distinctive look to it. Second, it was printed on blue paper, because, as stated in the literature, this would attract the attention of the respondent and would differentiate the questionnaire from other documents found on his/her desk (Jobber, 1986).

In much of the literature, it is claimed that a long questionnaire is responsible for higher refusal rate. However, according to Tull & Hawkins (1987:108), "the intuitive idea that short questionnaires will generate a higher response rate than longer questionnaire has not been supported by research. " In view of the lack of consensus on the significance of the length of the questionnaire, the researcher did not hold this as a matter of high priority.

A first version of the questionnaire was developed, using data from previous questionnaires developed by the researcher, together with data from the literature and some original contribution. This first version was shown to several researchers in the University of Warwick, as well as the supervisors of this research for identification of problems of the instrument, that the researcher himself might not have been able to recognise, owing to his involvement with the study. After many suggestions were received and revisions were made, the first operational version of the questionnaire was ready for the pretest. Finally, an exhaustive pretest was conducted to check the design of the questionnaire, the clarity of questions, and their purposefulness. The pretest is explained in detail in the next section.

Once the pretested questionnaires were returned and results from the pilot studies were analysed, a new version of the questionnaire was made. This version was also discussed with researchers and supervisors, and finally, after some further modifications, the final version was sent to be typed.

The questionnaire is divided into four parts. The first part, called "company background", contains general questions about the way companies are structured, regarding production process\services, labour, corporate orientation, introduction of products in the market, companies' share in the market, and companies' main products. The second part, "R&D activity", aims to discover how the companies structure their R&D activities. The third part, "transfer of technology", seeks information on how companies use technologies they develop and what policy and practice companies adopt regarding these technologies. And finally, part IV, "respondent details", is the space used for the identification of respondents, who could leave the section blank if they chose to remain anonymous.

A copy of the final version of the questionnaire is shown in Appendix 4.1.

4.7 Pretest and pilot study

The importance of the pretest has been cited by various authors. Yin (1987) compares the pretest to a 'dress rehearsal', with a careful simulation of the application of the questionnaire. The pretest is said to be so important that it should be used to examine the complete research design (Hunt et al, 1982).

This examination is needed for an evaluation of the questionnaire. The pretest often reveals which questions are not very clear, which are difficult to answer and which lack a specific objective. Other factors examined are the appropriate understanding of questions, time required to complete the form, obscure intentions and wrong order of questions (Luck and Rubin, 1987). The pretest is carried out in order to receive feedback from people closely involved in technology transfer. The feedback can provide a more precise measure of whether or not the questionnaire is serving the aims of the research or whether corrections are needed before sending out the final version. A final way in which the pretest helps the research design is in the detection of double questions and ambiguous terms, as Hunt et al (1982) have confirmed.

For the application of a pretest, a researcher must choose a sample that is as similar as possible to target respondents (Tull & Hawkins, 1987). Hunt et al (1982) point out that there is no fixed size for the pretest sample; size should be a function of the complexity of the questionnaire and of the population to be studied.

For the present research, a pretest was carried out parallel to a pilot study in six companies. The criterion for selection of these companies was primarily access which the researcher had to the data. The objective of the pilot study was to understand how the process of technology transfer occurs in British companies, as well as gathering useful information for improving the final version of the questionnaire.

Several dimensions related to technology transfer are brought out in the review of the literature, as described previously in Chapter 3. Based on these dimensions, the first set of hypotheses was generated, as a series of assumptions for the initial research process. In order to build support for those hypotheses and in order to examine the natural environment, it was decided to undertake some interviews, conducted in the places where normally the information is produced.

As Yin (1987) states, the pilot study enhances the data collection plan with respect to its content and the method to be followed by the researcher. It can give answers to some important questions as well as the logistics of the field procedure. The pilot study, in addition, can be a source of hypotheses that will be tested in a subsequent phase of the research. For the present study, it was felt that a pilot study would provide useful support for the hypotheses.

The pilot study was conducted personally by the researcher through semi-structured interviews with top managers in companies that export technology from the UK. In keeping with the nature of this type of interview, a series of questions was formulated as a loose guide for reference during the meeting (Appendix 4.2). A passive posture of listener was adopted during the interviews, and the main participation of the researcher was to encourage respondents to talk. These meetings were held in six different companies and had the duration of 60 to 90 minutes. In three of the companies two managers participated in the interview while in the remaining three companies one manager talked alone with the researcher. All the interviews were recorded, and the transcription of the tapes constituted a basic document for the research. The day after each interview, a letter was sent to the firm thanking them for their assistance in the research as well as their time given in the interviews.

As explained above, companies were chosen by convenience, i.e., they were the ones in which managers agreed to talk with the researcher about the policy of their companies. As companies were very representative of their sectors, the pilot study was fruitful in providing many insights on the way the transfer of technology is conducted in this country and in clarifying some ambiguous points found in the literature.

At the end of each interview, the researcher left copies of the questionnaire with the interviewees. Then the pretest took place. The top managers were asked to read the questionnaire carefully and think about appropriateness of questions, degree of difficulty in answering it and suggestions for that instrument. In addition, they were asked to give names of other people to help in examining the questionnaire. Approximately one week after the interview, the questionnaires were returned by mail to the researcher with several suggestions on how to improve them. One firm failed to return the questionnaire, in spite of the fact that they were contacted by telephone and that a letter was sent explaining the importance of receiving comments of that firm on the questionnaire. Nevertheless, the attempt failed. On the other hand, one of the other companies put the researcher in contact with some very helpful people involved in technology transfer in two different branches. Summing up, the researcher received six questionnaires pretested with abundant comments and suggestions for revision.

Based on the comments received and on the pilot study, the researcher devised a new version of the questionnaire. This new version was also discussed with other researchers and the supervisors, and finally, after some modifications, the final version was prepared.

The main objective of the modifications was to make the questionnaire shorter and clearer, as most of the people consulted said the original questionnaire was too long and sometimes difficult to answer.

4.8 Use of secondary data source

As stated before, no request for information readily available from other sources was made in the questionnaire. Because of this, it was necessary to obtain some complementary data from the companies, concerning items such as turnover, number of employees, sector of activities, and ownership.

These questions were not included in the questionnaire in order to make it easier to answer and to avoid tiring respondents. If it was possible to obtain data from indirect sources, why ask people for them? It is not convenient to request information which is already available and can usually be obtained readily and inexpensively. Furthermore, this was one of the recommendations received during the pretest.

The use of secondary sources to obtain data for a research is widely recommended in the literature. However, according to Tull & Hawkins (1987:66), they can become problematic if they are not "available, relevant, accurate and sufficient." Other problems to be aware of when collecting data from secondary source are the units of measurement and the definition of classes. Sources can have distinct systems of classification, which may make it difficult to adjust the necessary information to the research at hand.

The initial step in this part of the present research was to explore facilities of the University of Warwick library, which offers a wide range of data sources. Among numerous indirect sources available to the researcher, what were chosen were reliable published sources and computerized databases. The unit of measurement adopted was data from the fiscal year ending the nearest to June 1990; all numbers related to turnover were converted into millions of pounds; and sectors of activities were found to be as the same as the ones listed in the S.I.C.[5]. An intensive search

5 S.I.C. , Standard Industrial Classification, Central Statistical Office.

was conducted in the library, through available database, like FAME[6] and through Kompass[7]. After an exhaustive research, the data of thirteen companies still remained incomplete. It was necessary to order, through the library, the information needed from Companies House[8], which supplies data on microfiche of all the companies registered in the U.K.

Finally, as there were missing items on the data of four companies, it became necessary to telephone them, with a direct request for the information needed.

Thus, information about the turnover, number of employees, sector of activities and ownership were gathered from secondary sources for each firm.

4.9 Sampling process

A representative sample of a population is the base for a formal test of hypotheses about that population. In the development of a sample survey, the items which should be taken into account are: population, distribution of elements of the population, and design strategy for surveying a representative portion of the whole (Abrahamson, 1983). Tull & Hawkins (1987) also emphasize the necessity of defining population to specify sampling frame (i.e., population that actually had a chance to be selected), and specify sampling unit. However, the choice of a sampling strategy should be based on the criteria of feasibility and cost, as stated by Fowler (1988). Therefore, in spite of the fact that the primary choice should be a study of a probability sample, it is often the case that working in such conditions is not viable.

Tull & Hawkins (1987:378) recommend that the researcher should choose between probability and nonprobability samples based on the "cost versus value

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6 FAME, Financial Analysis Made Easy, Co. Rom database. Produced by Co. Rom Publishing Company and Jordans.

7 KOMPASS, United Kingdom 1990 (1990), 28th Edition, vol. 1 and 2, Reed Information Services Ltd.

8 Companies House, Company Registration Office, Alphabetical Index of Companies for March 1990.

principle", i.e., the sample to be choose is the one that yields the "greatest margin of value over cost." In the case of British companies that export technology from the U.K., there was no comprehensive list to be followed. The identification of the sample thus became difficult. No data was found on the total number and types of British firms involved in transfer of technology abroad and this suggested the impossibility of choosing a probability sample from a specific population. When the definition of a population is made impossible owing to the lack of a list of that group, the researcher is compelled to use a non-probability sample (Moser and Kalton, 1971). As observed by Abrahamson (1983:238), in the case of purposive samples, "representativeness determines selections rather than vice versa."

Kinnear & Taylor (1979) have explained that the convenience sampling is extensively used in practice. This view is also held by Fowler (1988), who attests that almost all of the major public opinion polling groups, political polling groups, and market research organisation surveys rely exclusively on nonprobability sampling methods. The scope of the convenient sample is the closest possible proximity to the desired phenomenon when there is the necessity of obtaining this approximate estimate quickly and inexpensively (Luck and Rubin, 1987). However, as observed by Nachmias & nachmias (1976), it is difficult to estimate the sampling error statistically because, in the nonprobability method, there is no known chance of a particular member of the group being selected, and each unit has a different possibility of being included in the sample. Kinnear & Taylor (1979:187) advise that even when definitive or conclusive statements about results cannot be made, the nonprobability sampling can be justified at the exploratory stage of research and for conclusive studies, as the risk of probable inaccuracies in the results is being accepted by the researcher at those points.

The choice of a nonprobability sample is weighed by Phillips (1976:294). He raises the point that such an approach makes the estimation of the external validity difficult (as a consequence of the estimation of the sampling error). Nor can generalisations of the results be made to the whole population. On the other hand, Phillips' justification of this sample is that, being less expensive and less time-consuming than the probability sample, the nonprobability sample allows more resources to be available for the task of providing internal validity, i.e., "how well the findings apply to the particular research situation under investigation." Moreover, the author says (1976:295) that the study of people directly involved with the phenomenon "may produce far more understanding per individual studied than the most rigourous probability sample."

In the present study, the search for the sample had to be conducted in several directions. The first step in discovering the desired population, i.e. British companies that transfer technology abroad, was to consult available sources in the library of the University of Warwick, with little success. A visit by the researcher to the British Department of Trade and Industry was also non-productive. The fact that such a list was not available is probably because in the U.K., contrary to other countries, the state generally refrains from intervening in the transfer of technology. Following those attempts, the Science and Policy Research Unit of the University of Sussex was contacted to learn whether they have that list, as they have been working for a long time on transfer of technology between countries. Likewise, the Confederation of British Industry and the British Technology Group were contacted. All the attempts were unfruitful.

Finally, the British branch of the Licensing Executives Society (LES) was contacted, to gain access to their list of members. The LES is a nonprofit and educational international society that congregates executives actively engaged in domestic and international licensing and other transfer of technology and intellectual property rights. The branch which was contacted is responsible for serving Britain and Ireland and has 600 members, belonging to industry, universities, consulting companies, patent offices, and law offices. The survey received the immediate support of the organisation, which sent the researcher a complete list of its members in Britain and Ireland, as well as a letter to be mailed with the questionnaire. In this letter members of the society were requested to collaborate with the study.

From that general list of 600 members a selection was made of names of all persons involved in industries in Great Britain. That list, totalling 192 people, included the name of each member, his/her position in the firm, the firm name and its complete address. It was used as the sample for the research and mailing list for the survey. That list of members solved an additional problem that the researcher faced, in discovering the target-person to answer the questionnaire, because each firm has its own organisational structure with proper divisions of labour and responsibilities. As a result of the spectrum of structures in the companies, departments that deal with technology vary from one firm to the other. At the same time, based only on information of the job title, it is very difficult to determine whether a person does or does not handle transfer of technology in the firm.

The use of the LES mailing list could create a bias in favour of licensing and skew the whole survey. Nevertheless, the LES mailing list is very representative of the British industry as a whole. Comparing the LES derived list with a list collected by Patel & Pavitt (1989) of the 50 largest British patentees in the USA, from 1969 to 1984, 54% of the firms on Patel & Pavitt's list[9] were among the members of LES studied by the present survey. Another 12% on the same list are divisions of the British government, performing government-funded technological activities (such as the Atomic Energy Authority and the Secretary of State for Defence), and as such do not fall within the scope of the present research.

4.10 Field work

With this in mind, a series of guide-lines was adopted in order to increase the motivation of respondents as much as possible in the first contact with the questionnaire, thereby reducing the nonresponse error.

The literature on techniques to increase response rate is exhaustive and supports a number of procedures to be followed by the researchers[10]. As stated by Kanuk & Berenson (1976:451) in their complete literature review on the mail survey, "there is no strong empirical evidence favouring any techniques other than the followup and the use of monetary incentives." However, Fowler (1988:54) believes that "almost anything that makes a mail questionnaire look more professional, more personalized, and more attractive will have some positive effect on response rate." This is corroborated by Brook (1987:131) who says that there is no solid evidence that strongly recommends the use of techniques to improve response rates, but even so the researcher should exploit them because they inject a sense of importance and emergency into the initial approach.

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9 It should be mentioned that the firms on Patel & Pavitt's list are the biggest transferors of technology in the UK.

10 See Dillman et al (1974), Parasuraman (1982), Yu & Cooper (1983), and Jober (1986) for examples of these techniques.

In order to increase the number of returned questionnaires and, consequently, decrease the nonresponse error, right in the first contact, the researcher should as much as possible motivate the respondent to collaborate. After this, the researcher must remind the respondent of the importance of his/her collaboration through repeated mailing or other forms of contact.

With the target of obtaining the largest participation as possible a series of procedures was followed by the researcher. The initial mailing of the questionnaire was made using a good quality envelope with the logo of the Warwick Business School, printed labels with the personal name of each respondent, and first class stamps.

Inside the envelope, the respondent found a cover letter, a questionnaire, a self-addressed envelope with a first class stamp for returning the questionnaire, and a support letter from LES.

The cover letter was printed on the official paper of the chairman of the Warwick Business School, a very good quality paper with the letterhead and the logo of the institution. The first cover letter was short, as the literature recommends, and explained the reasons for the study, invited people to respond to the survey and stated the purpose of the research and the benefits the respondent would receive from it. Respondents were assured that all the data would be treated with confidentiality and the identification of any firm would be made only with its formal permission. The name of the researcher in charge of the survey was given and it was explained that he would call respondents in ten days to see if they had any problem in answering the questionnaire. Also the researcher's telephone number was given just in case respondents needed to contact him. Respondents were advised to use the self-stamped envelope to send the questionnaire back and finally they were thanked for their collaboration. Each cover letter was signed by the supervisor of the research, in order to show to the respondent the seriousness of purpose of the survey. As Rummel and Ballaine (1963) state, the more important the recipients perceive the research to be, the more impressive is the support for the study. A copy of the first cover letter constitutes Appendix 4.3.

Scott (1961) points out some evidence that the response rate varies according to how prestigious the respondent considers the sponsor of the research. Considering the importance of a separate endorsement for the research, the

Licensing Executive Society (LES) was asked to send a letter to its members backing up the survey. In the letter from LES, the society's support for the project was highlighted and members were requested to collaborate by completing the questionnaire. A copy of that letter is shown in Appendix 4.4.

Finally, it was said in the letter that results of the survey would eventually be made available to the society, which was going to publish a summary of those results. It is a common procedure to promise a copy of results of the survey to respondents, as made in LES' letter. This functions as a substitute for monetary incentives, which are so effective in promoting a good rate of return (as stated in the literature[11]), but it was not possible to use this means in this research, for financial reasons. However, Jobber (1986) found no evidence in the increase of response rates when promising copies of results of the research to industrial respondents. This finding also corroborates similar findings made by Yu & cooper (1983).

All the literature consulted on methodology of research is unanimous in recognising the importance of the follow-up in increasing response rate and suggests two main approaches to be followed: follow-up through telephone call and follow-up through successive mail, including a reminder card, a letter or a complete set composed of letters, a return envelope and a new copy of the questionnaire. According to Kanuk & Berenson (1975), the literature is rich in examples of how essential an intensive follow-up is to increase response rate. Tull & Hawkins (1987) support this idea, explaining that three or four mailings, including the original are necessary to promote a reasonable rate of response. A mixed follow-up system was chosen, combining telephone calls with the mailing of a complete set of letters.

Beyond the original, two more mailings were made. In the meantime between the mailing procedures, the researcher tried by telephone to reach all the companies that failed to return the questionnaire, to emphasize the importance of the participation of the firm in the survey and to learn whether the respondent had any doubt about answering the questionnaire. As the persons to be contacted were usually high level executives in their companies, many times it was not possible to talk with them personally either because they were travelling or because they were in meetings. When this happened, the procedure adopted by the researcher was to

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11 Emphasis on the effectiveness of this procedure is found in Kanuk & Berenson (1975) among others.

explain the reason for the call in detail to the closest secretary of the target person and to stress that the University of Warwick was expecting the participation of the firm in the survey. This procedure was adopted following Hansen et al (1983), who suggest in their paper about industrial surveys that leaving a message for the prospective respondent is just as effective as reaching him/her directly. In the total, around 75% of the companies were reached by the researcher through a personal telephone call. It was not possible to call all the companies that did not reply to the questionnaire because several of them moved or changed their telephone numbers, and it took a considerable time for the researcher, who worked alone on the project, to discover the new numbers. In general, the people who were reached by the researcher were supportive of the survey and promised to mail back the questionnaire as soon as possible.

The first reminders, or second mailing, were sent four weeks after the mailing of the questionnaire, only to the people that did not reply to the first appeal. The same procedures adopted in the first mailing was followed, including one letter from Warwick Business School, a copy of the LES letter, a new copy of the questionnaire and a stamped self-addressed envelope. The second cover letter explained to the member of the LES that one month earlier a questionnaire on international transfer of technology had been sent to him/her and until that day of the second mailing the Warwick Business School had not received any reply from the firm. Since it was possible that the first questionnaire had been lost, a second copy of the instrument was enclosed. Promises were reiterated that a copy of the findings would be given to the membership, and the telephone number of the researcher was given, if the respondent had any doubt about answering the questionnaire. This letter was printed on the Warwick Business School official stationary, and each one was signed personally by the researcher, for two reasons. First, it was not the initial contact and the prime impact had already been made. In the initial contact the researcher responsible for the survey had been identified in the letter. Furthermore, the researcher had been making telephone calls to almost all the companies and making his name familiar to respondents. Second, it was felt that it was not necessary for the supervisor to spend his time in signing 120 new letters. A copy of this letter is included in Appendix 4.5.

After evaluating the response rate, it was decided to send a second reminder (third mailing) eight weeks later; this was done in view of the Summer holiday. Care was taken with the timing of the questionnaire to avoid periods corresponding to major holidays and periods especially busy for the recipient. Again, a complete set of documents was sent to the ones that still had not returned the questionnaire. It was decided that the third letter should be the last one. It was printed again on the stationary of the chairman of the School and it was signed by the supervisor of the research. This letter emphasized the significance of the participation of the firm, so that policy recommendations of use to all firms involved in technology transfer could be made. It was mentioned that many companies had already sent back the questionnaire but that his/her firm still had not returned the device. Following the suggestions of Brook (1987), a mix of disappointment and concern was used, in attempt to give the impression that nonresponse was not normal. The respondent was also asked to forward the questionnaire to the appropriate person if he/she did not think he/she was the right one to answer it, and finally it was emphasized that the research was counting on their participation (letter in Appendix 4.6).

One last comment should be made about the day of the mailing of the questionnaire. There is no agreement in the literature reviewed about the best day of the week to mail the questionnaire and the evidence found was not strong enough to justify a particular procedure. Because of this, it was decided to use common sense and, since the survey dealt with professional people, three times the questionnaire was mailed at the end of the week. This meant that the respondents supposedly were going to receive the questionnaire on the next Monday or Tuesday and would have the whole week to deal with the device. It was supposed that this procedure would contribute to the quality and speed of the response because they would have the questionnaire on their desk for around four days before the break of the weekend.

The complete procedures adopted in the field work will be described in details in Chapter 5.

4.11 Conclusion

The objective of this chapter was to illustrate which methodological paths were available for the researcher, why he chose the method he used and what he expected to achieve with the procedures. The survey and the questionnaire design were explained, as well as the planning and execution of the fieldwork. The efforts to validate the process and to reduce the nonresponse rate were discussed.

Summing up, it was shown how the researcher reached his target of constructing a research design, in terms of the quality of the data being gathered and with the reproducibility of the procedures.

CHAPTER 5

OPERATIONALISATION OF METHODOLOGICAL PROCEDURES

5.1 Introduction

Based on theoretical support described in the previous chapter, and on common sense, the field work of the survey was organized and executed, with the aim of obtaining the most accurate representation of reality as possible. As explained in Chapter 4, in spite of all the care taken with the development of the questionnaire, it would be impossible to prevent occurrence of some problems. The objective of this chapter is to describe in detail the process of operationalisation of the methodological procedures adopted, the validation of the obtained measurements and the manner of solving problems which arose during the process.

This chapter is divided into seven sections. In the second section the application of the questionnaire is explained, emphasising the control adopted by the researcher during the field work. In section three the problem of the nonresponses is discussed. The initial treatment of the questionnaire is examined in section four, including the coding process. The preliminary adjustment of the data is explained in section five, with the description of the programmes used for standardising the obtained data. In section six, the concern with the validation of the survey process is outlined, including a description of the test used for this purpose. Finally, the conclusions of Chapter 5 are given in section seven.

5.2 Application of questionnaire

During the application of the questionnaire, a series of procedures was adopted to assure a reasonable control of the whole process. These procedures are described in the following sub-sections.

5.2.1 Mailing process

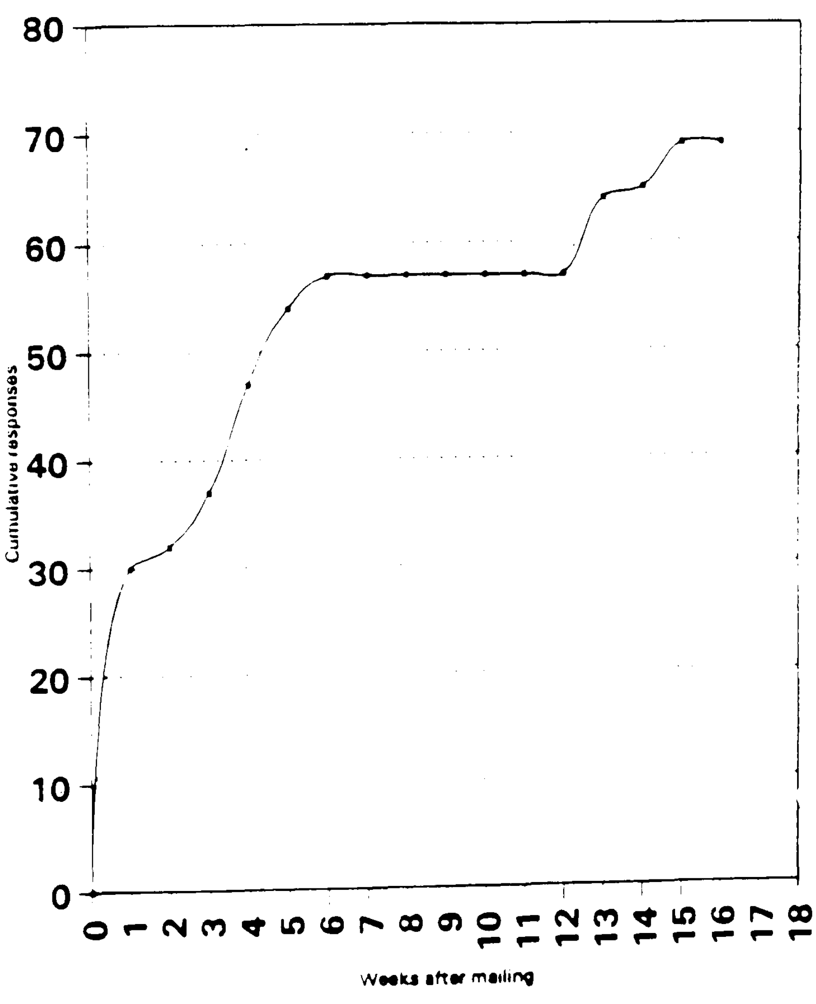
With the final version of the questionnaire ready for application, the work on the list of addresses given by LES was started. The original list of 600 members belonging to several categories was collapsed into another list, containing 192 names related exclusively to industry. From this list, four companies had duplicate registers in the society and, consequently, were eliminated from it, reducing the number to 188 companies.

The first mailing was at the end of June 1990 to 188 companies. One week later, the first returns were received. Eight questionnaires were returned because of a wrong address. Two weeks later a telephone call was made to each firm that did not send back the questionnaire. Telephone calls were also made to check addresses in the cases of those companies whose mailing was returned. Approximately 140 calls were made and people were contacted either personally or through their secretaries. Of the eight companies that moved, four new addresses were collected. Three companies literally disappeared and it was not possible to discover any sign of them from the Telephone General Directory Inquiries, from LES or from the available sources in the library. They were thus considered extinct and were eliminated from the list. Similarly, another firm was eliminated from the list because it was officially registered as having ceased trading one year earlier. In this first stage, 37 questionnaires were returned.

As verified through telephone calls, several respondents were not reachable in that moment because they were either travelling or on holiday. For this reason, it was decided to wait a little more for the answers of these particular people. However, at the end of July the first reminders, with a new copy of the questionnaire, were sent to 121 companies to the people that were apparently available and had not answered the questionnaire. New telephone calls were made, now for a small number of companies. In this second stage, 18 more questionnaires were returned.

Parasuraman (1982) states that there is clear indication that the cumulative response curve for a mail survey has, in general, an S-shape and follow-ups prolong the time during which a curve continues to rise. As the curve of responses of the present survey had failed to reach the referred S-shape, a third mailing of the questionnaire was tried to encourage new responses. Finally at the end of September, 93 questionnaires were sent to the companies that had not shown any sign of collaboration. In this third phase, 14 more questionnaires arrived. The cumulative response curve of the survey is shown in Figure 5.1 and Table 5.1 show the summary of the mailing process, as follows:

Figure 5.1
Questionnaires Received



Jul-Oct/90

Table 5.1

Summary of the mailing process

(1990)

Waves of questionnaire	Date	No. of questionnaires Mailing	Return
1	29/7	188	37
2	27/7	121	18
3	24/9	93	14
TOTAL		406	69

5.2.2 Monitoring responses

During the complete mailing routine, a control book was maintained, with almost a daily updating of the returns. To permit the total control of the process, each questionnaire was numbered at the top right side of the front page. It was mentioned to the respondent that the number was for data process use. As it was possible that the respondent could cross out the number to avoid identification, and the identification was vital to the research control, the same number was written inside the questionnaire, with discretion, in very small letters, using Arabic characters. Only one respondent complained about the number, but identified himself in the questionnaire.

In the control book, there was a register of the day of each of the three mailings, the return of the questionnaires, the return caused by wrong address, the telephone follow-ups, and the refusals to participate in the survey, either through a letter or by telephone.

It should be mentioned that 38 companies sent letters explaining their reasons for not participating in the survey. These companies represented 19.5% of the sample. Their justifications were grouped as shows in Table 5.2:

Table 5.2

Letters justifying not answering the questionnaite

Justification	No.of letters
Unable to participate because is foreign subsidiary Respondent no longer in the firm Confidential information involved in survey Technologies no longer transferred Unable to participate because is holding company Policy of not participating in any survey	8 8 7 7 5 3
TOTAL	38

5.2.3 End of field work

After almost four weeks following the third mailing, as the questionnaires stopped coming, the sampling was considered complete with 69 companies, which represented 37.5% of the initial number of companies. As explained above in section 5.5.1, from these 69 questionnaires, 5 were discarded because they could not be used, reducing the number of usable questionnaires to 64. Table 5.3 shows a summary of the whole field work, as follows:

Table 5.3

Summary of the field work

Mailing procedure		**No. of questionnaires**
Initial number of companies Minus duplicates = Minus ceased trading = Minus disappeared =	 4 1 3	192
Total of the sample		184
Returns		**No. of questionnaires**
Initial number of returns Minus questionnaire discarded =	 5	69 (37.5%)
Total of usable questionnaires		64 (34,8%)

5.3 Dealing with nonresponses

One serious problem to be faced in a survey is how to estimate whether nonresponses affect the results of the questionnaires received. Using a regular probability sampling, findings are only representative of the population if the nonrespondents do not differ in significant ways from the respondents. Nonrespondents may be so unlike the other group that their answers can greatly change the results of the measurement in comparison with what actually was obtained. This factor was a motive for concern in the survey.

As Sudman (1976) observes, the quantity and quality of efforts invested in following up the questionnaire do not matter: there are nonresponses in almost all surveys. Since this problem is probably inevitable, it is important, whenever possible, to compare all known characteristics of those who respond and those who do not, as recommended by Abrahamson (1983:328): "the more alike they are, the lower the rate of return can be without nullifying the entire study."

It was explained in section 5.1 that 184 companies composed the total sample of the survey, out of which 64 companies answered the questionnaire and the remaining 120 companies, for various reasons, did not collaborate.

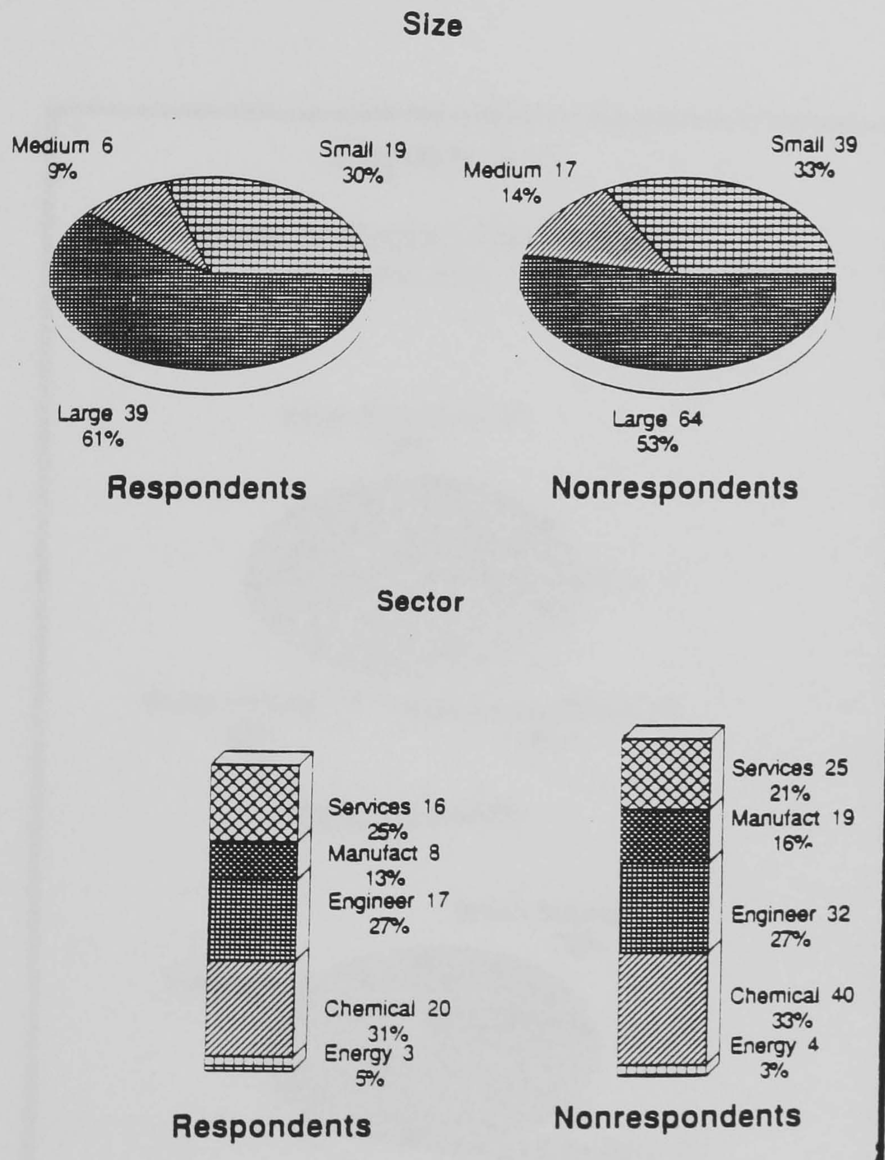
According to Kanuck & Berenson (1975), there is a basic assumption that those who respond late are like those who do not respond at all. The same statement is supported by Fowler (1988:49), who suggests that the nonresponses' bias can be studied "by comparing those who respond immediately with those who respond after follow-up steps are taken."

As will be demonstrated in section 5.6.3, a Kruskal-Wallis one-way analysis of variance by ranks was run to verify the differences in the waves of return of the questionnaire. The null hypothesis was accepted that there was no difference between the participants that answered the questionnaire first and those who answered late. That is, all of them belong to the same population. This could indicate that if the late respondent is similar to the nonrespondent, and if there were no evident differences between early and late respondents, the nonrespondents probably would not differ very much from the sample.

After this first evidence, a further search was done to verify characteristics of companies that did not answer the questionnaire. Kompass publication and FAME database revealed data on the size of the companies, the sector to which they belong and their ownership[1].

Figure 5.2

Sample of British Companies

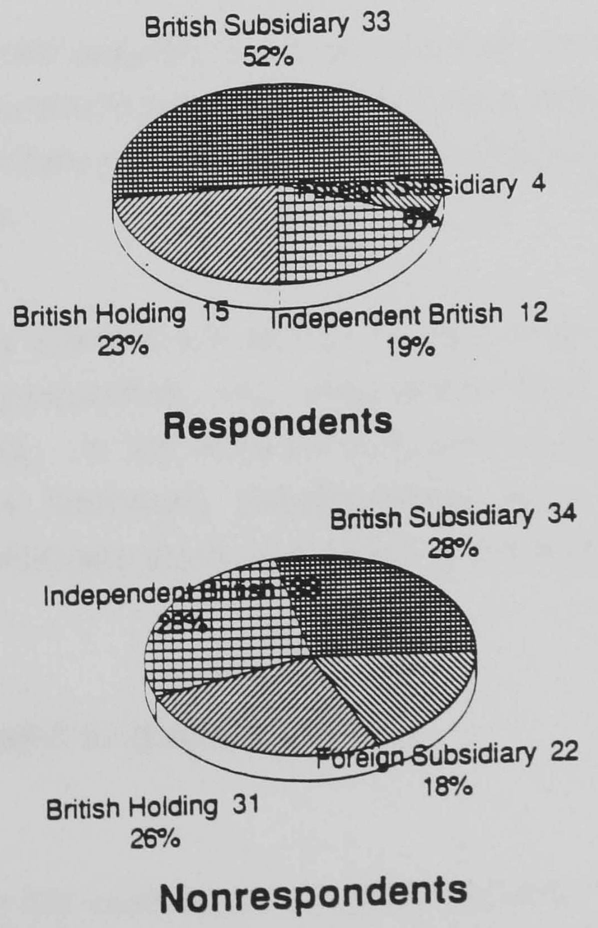


1 The operational definitions used for "Size", "Sector" and "Ownership" are explained in Appendix 1.1.

In Figure 5.2 one can see the similarity between respondent and nonrespondents companies related to their size. There is a slight increase in the number of medium-size companies among the nonrespondents, and a slight decrease in the number of large size ones in the same group. But, in general, both distributions are very similar. The comparison of the sector to which companies belong is shown in the same Figure. In an identical way, there is a high degree of likeness between the two samples, including the order of the sectors, Chemical sector being the first, followed by Engineering, Services, Manufacture and Energy sectors.

Figure 5.3

Sample of British Companies
Ownership



However, in Figure 5.3, there can be seen a difference in the pattern of ownership between respondent and nonrespondent companies. A smaller number of foreign companies answered the questionnaire in comparison with the total number of them that were present in the sample. This occurrence can be explained by the fact that many of the subsidiaries of foreign multinational companies in Britain do not handle transfer of technology from the UK to abroad and are much less likely to be "exporters" than they are to be recipients of technology developed abroad, in the country of origin of the firm. Even if technology arises from research carried out in the UK subsidiary, the parent firm will take the total responsibility of transferring it abroad. This was revealed through several letters received from foreign multinational companies, explaining why they did not answer the questionnaire. Since the process of transfer of technology from Britain is not so active among foreign companies as it is in the whole of British companies, the fact that the sample has a small number of representatives of foreign companies is not likely to result in a bias and, consequently, does not affect the overall measurement.

Despite different patterns, it can be observed that there is no tendency to favour one type of ownership instead of another among nonrespondents. All the four divisions are very similarly represented. This means that no specific type of firm was left out of the sample.

Based on the statistical test and on the data, when comparing the available information on nonrespondents with respondents, there cannot be found any substantial difference. In the absence of further evidence, it is assumed that nonrespondents are functionally indistinguishable from respondents and their answers to the questionnaire would not change the measurement substantially.

5.4 Initial treatment of questionnaire

As soon as the questionnaires started arriving, they were examined to determine whether they should be used or discarded, and they were coded in such a way as to transform answers received into data to be processed by the SPSSx package of programs, available in the Computing Services Centre at the University of Warwick. After this phase, preliminary adjustments were made so that the research was ready to be run on the main statistical programs. This section explains how the adjustments were made.

5.4.1 Data processing

Data processing included editing and coding of the instruments. The editing process was used to discover errors, omissions, and to check legibility and consistency. Following an exacting scrutiny, four questions were cancelled, because many respondents either did not answer them properly or simply skipped them. They were: question 10 (in which department is R&D carried out?), question 14 (which department is responsible for dealing with transfer of technology?), question 15 (the number of employees in transfer of technology) and question 20 (% of revenues from transfer of technology). Also, at this stage, five questionnaires were completely discarded from the quantitative analysis, because too many data items were missing. However, they were maintained reserved for further qualitative study, due to the information and comments they offered.

As the answers needed to be prepared for use by the computer, numerical codes were assigned to a given set of alternatives presented and, in this way answers were translated into readable values by statistical programs, according to a code book.

As the questionnaire was composed for the most part of closed-ended questions, it was possible to write, *a priori*, the code book. Code books are necessary for documenting a coding scheme that will be applied to the variables studied; these books are thus indispensable to interpreting the data. According to Kinnear & Taylor (1979), code books are useful as guides to the coders, they serve to locate variables the user needs for a particular analysis and they make possible the identification of variable categories as computer output is interpreted. In the case of this research, the code book was composed of a number of questions, a format that variables were going to assume, variable labels, and value labels, and it was written in a form to be used as an initial command for all the SPSSx programs. Questions not answered were considered missing data and no values were assigned to them. There was maintained a consistency with values. For example, in the case of dichotomous questions, the option "Yes" always received the value **1** and "No" the value **2**. In the same way, in the Likert scale, the value **1** was applied to the most important choice, **5** being the least important. Appendix 5.1 presents the Code Book used in this research.

Finally, a few open-ended questions presented in the questionnaire were coded and the questionnaire was ready to have its answers transcribed to the computer.

5.4.2 Transcription of data to computer

A copy of the code book and all the questionnaires received, appropriately edited and codified, were given to the Computing Services Centre. With that code book, the adjustment of the conditions for interpretation of the answers was prepared, in order to enable the optical scanning to be used. Then the questionnaire data were captured by specialist data entry staff of that centre. Some data were captured by transcription and other by automated data captured through the optical scanning facility. This last technique involved a direct reading of the codes, employing an optical scanner, and consequent transcription into a SPSSx datafile, which was going to be used by SPSSx analysis programs.

5.4.3 Necessary cleaning of dataset

Possible errors must be cleaned from the dataset, in order to permit the running of statistical programs. Errors exist in every transcription of data to computers, even with the help of sophisticated apparatus like the optical scanner. This research was no exception at all, so that after having a list of the datafile printed, a random check was made to see whether the numbers were positioned in the respective rows and columns or whether some absurd values were present. The result of this check was that several errors were detected and, returning to the Computing Service Centre, it was verified that one column had been skipped and all the data after that were therefore in the wrong columns. The problem solved, with the replacement of the missing column, the rest of the data moved to their correct position. Another check was performed, now much more carefully, but no additional errors were detected.

5.5 Preliminary statistical adjustment of data

Some preliminary adjustments were necessary to allow the researcher to run the main statistical programs for obtaining the frequencies of the variables as well as for testing the hypothesis.

Two new datafiles were created to add supplementary variables to the dataset with data collected from secondary sources or through the collapse of existing variables into categories. The process of dealing with these new components is described bellow.

5.5.1 Generation of new variables

Initially, the first and the main datafile was constructed with the data obtained from the 64 returned questionnaires. This datafile held the data related to all the questions, except nine in which the respondent was asked to rank the answers. These nine questions received special treatment, which is demonstrated in the next subsection, and they constituted the second datafile. A special code book was created with the meaning of the new categories.

As described in Chapter 4, it was necessary to obtain some complementary data from the companies, concerning turnover, number of employees, sector of activities and ownership. These data, obtained mostly from the library, were collected in parallel with the return of questionnaires and formed the third datafile. Another code book was conceived, with definitions of categories to be studied, according to operational definitions for size, sector and ownership, which were already described in Appendix 1.1.

The data for these two new datafiles were captured by manual transcription, personally by the researcher, since the quantity of data to be transcribed was not so big and special attention needed to be paid to the process, instead of being a more automatic task.

To manage the three different datafile, a system of SPSSx programs was used, correlating the distinct sources of data in a way that would make them produce the expected results. The procedure of adjustment of data is shown in Appendix 5.2, which contains the chartflow of the SPSSx programs used, before starting the main statistical procedures.

5.5.2 Ranking questions

As explained in the previous subsection, in nine of the questions the respondent was asked to rank the three most important options according to his\her firm's point of view. The answers received for these ranking questions were divided into three main groups:

a) people that ranked the three main options correctly;
b) people that only ticked three options but did not rank them;
c) people that did not reply to the question.

To start running the principal statistical program, it was necessary to discover which option the respondent considered to be the most important answer for this type of question. The most important answer would be equivalent to the option which the respondent marked as number one. The first step in solving this difficulty was taken with a program written in SPSSx, specially designed to treat this kind of problem. This program is shown in Appendix 5.3. Each of the nine questions was divided into the same number of variables as the number of options that one could choose. So, fifty four new variables were created. Then, a special data file was created with all the values found for the 54 variables in the questionnaires received. So, when the respondent answered the question with ranking, that question was given the value of 1 for the first option, 2 for the second option and 3 for the third one. As these nine questions, on average, had six options and the respondent was asked to choose only three alternatives, theoretically three options would not be chosen, i.e., this was the situation of an incomplete ranking.

On the other hand, when the respondent answered the questions by ticking only, without attributing a specific order of importance, all the options ticked were considered to have the same value.

As these problems arose independently for each of the nine questions, the following was constructed:

N_0 is the number of unranked options;
N_1 is the number of ticked options (where no explicit ranking has been given);
N is the number of options.

When the respondents attributed values to the questions, they indicated that when option number 1 was chosen, it was more important than option number 2, which was more important than option number 3. Since there were options that were not chosen, these items could not be ignored and thus there arose the necessity of incorporating this information into the ranking. To equalize these unanswered choices, in a quantitative way, a normalisation procedure was adopted. First, it was considered that the sum of the ranks should be the same for each respondent, and this sum should be:

$$1 + 2 + \ldots + N.$$

Consequently, the rank attributed to the unranked options should be the mean of the ranks not assigned, that is:

$$N - 1/2\,(N_0 - 1)$$

In the same way, where the respondent only ticked the options, they were assigned the mean rank of the first N_1 ranks, i.e.

$$1/2\,(N_1 + 1)$$

It should be added, however, that these established ranks were calculated separately for each respondent, and there was variation in these values, according to the number of options ranked by each respondent. The unanswered questions were considered missing values and were not computed in the calculation of the means. For the answer to each of the 54 variables there was obtained a frequency.

In a second phase, another program was developed to regroup the 54 variables and their respective frequencies again into nine groups, as originally was designed before the statistical treatment. The program for this is shown Appendix 5.4. Finally, with the obtained frequencies representing the answers for the nine ranking questions, it was possible to start running other statistical programs, as explained in Chapter 6.

5.5.3 Test for measurement of differences in population

The frequencies obtained for the questions with ranking options were described in previous sections. But these frequencies were obtained with two groups of respondents. In the first group were found respondents who ranked questions and in the second group were found respondents who ticked answers. Did they belong to the same population?

To answer this question, a program was specially developed, dividing the sample into two groups and examining whether there was a difference between these two groups through the test of the difference of mean rank value between "rankers" and "tickers" (Appendix 5.5).

If the test was done individually at the 5% level, the expected number of significant results under the null hypothesis would be 2.7 (2.7=NP, where N=54 and P=0.05). If, however, a composite 5% level was chosen, there must be set an individual significance level **p** (and there is q=1-p) such that:

Prob (at least one result if significant) = 0.05

Thus:

Prob (no significant result) = 0.95

Prob (1st not sig.).Prob (2nd not sig.)...P(54th not sig.) = 0.95

$q^{54} = 0.95$

$q = 0.99905$

$p = 0.00095$, or around 0.1%

This individual significance assumes that all 54 tests are independent. They are, nevertheless, dependent within each question. But the fact that there are a reasonable number of options for the questions (at least 5) means that the mutual dependence is decreased. A more conservative approach must be taken as regards such tests. According to Liddell (1990), a rule of thumb would be to reduce the value of **p** in line with the reduction in degrees of freedom. Thus, the individual significance level would be placed near 0.08%.

The test of difference of mean was run and the results demonstrated that out of the 54 pairs of variables only three failed to reach the expected level of significance. One possible explanation for this occurrence is that one of the variables was chosen only by "tickers" (variable q21p5) and the other two are related to the option "Others" (variables q11p6 and q28p5), which were abandoned. In light of this, the results from these questions need to be interpreted with a certain degree of caution.

5.6 Acceptability of results

Three statistical tests were run to verify whether the collecting data device exactly measured what the researcher was trying to measure. The results confirmed the quality of the instrument. In the remaining parts of this section, the results will be described.

5.6.1 Test for validity

As seen in Chapter 4, there is a proper reproduction of reality if the measurement is free of variable and/or systematic errors (bias). Care was taken with the construction of a valid instrument ranging from the thorough choice of words and intensive pretest of the questionnaire before the realisation of the field work to an *ex post facto* statistical test, measuring the association between variables through non-parametric correlations, by means of the SPSSx program.

The questionnaire also needed to include a means by which the correspondence among responses could be assessed. Thus, during the development of the questionnaire, three pairs of question were formulated to measure three statements so that for each statement there were two questions with different forms asking for similar answers. In this way, these probing questions could be cross-checked to certify that there was consistency in the responses of each person questioned, as suggested in the literature[2].

Taking these three pairs of variables, non-parametric Kendall and Spearman correlations were run (Appendix 5.6). Both correlations require the same sort of data, that is, at least the ordinal measurement of both X and Y variables. In their final result, they provide a single number which summarizes the relationship between two variables. The objective of the correlation analysis is to estimate the intensity to which a variation in one variable is dependent on a variation in the other (Nie et al, 1975). The use of non-parametric tests means that no assumptions are made about the distribution of cases on the variables. The value obtained ranges from **+1.0 to - 1.0** and the more that value approaches **1.0**, the stronger is the linear relationship that can be assumed. According to Nie et al (1975), a rule of thumb for following any of the methods is that Kendall is more suitable when a fairly large number of cases are classified into a relatively small number of categories, and Spearman is more useful when the ratio of cases to categories is smaller. However, the authors emphasise that there is no fixed rule about selecting Kendall over the Spearman correlations and vice versa. Both techniques produce standardized coefficients based on the amount of agreement between two sets of ordinal ranking. Both coefficients use the same amount of information in the data and thus both have the same power to detect the existence of an association in the population (Siegel, 1956). As the statistics of these techniques are explained extensively in textbooks mentioned in the present account, they will not be discussed in this work.

The three pairs of questions as well as the score obtained are the following:

First pair: Question 30 (3) *versus* Question 32 (11)

Question 30 (3): (when your company decides to transfer its technology overseas, how important are...) territorial control restrictions on local imports.

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2 See Fowler (1988) and Luck & Rubin (1987), for example.

Question 32 (11): (with company practice in mind, measure the following statement:...) your company chooses to transfer its technology overseas when there are important restrictions or protection of domestic market in the host country.

Table 5.4

Correlation of the first pair of questions

Correlation	Coefficient	Significance
Kendall	0.6199	0.000
Spearman	0.7128	0.000

Second pair: Question 30 (7) *versus* Question 31 (5)

Question 30 (7): (when your company decides to transfer its technology overseas, how important is...) comparative advantage of your company in manufacturing the product.

Question 31 (5): (with company practice in mind, considering the destination of the transfer of technology, how important is...) transfer to countries where your company has competitive advantages over other companies.

Table 5.5

Correlation of the second pair of questions

Correlation	Coefficient	Significance
Kendall	0.2613	0.010
Spearman	0.3054	0.011

Third pair: Question 32 (6) *versus* Question 32 (12)

Question 32 (6): (with company practice in mind, measure the following statement:...) your company chooses to transfer its technology overseas to countries where it can create a dominant position in the market or there are only a few competitors.

Question 32 (12): (with company practice in mind, measure the following statement:...) your company chooses to transfer its technology overseas to maintain its leading position in the international market.

Table 5.6

Correlation of the third pair of questions

Correlation	Coefficient	Significance
Kendall	0.3343	0.001
Spearman	0.3716	0.002

As demonstrated, the levels of significance rejected the null hypothesis that variables are unrelated in the population, at 0.05 in the above three pairs. Having found a sustainable relationship in the pairs, it is accepted that there is a link between them and it seems that the questionnaire is suitable of confidence concerning this test of validity.

5.6.2 Test for reliability

As stated above, the data obtained would be reliable if the measurement process did not contain random errors. According to Kinnear & Taylor (1979:289), reliability is concerned with "consistency, accuracy, and predictability of the research findings." The literature describes several approaches to assessing the reliability of a measurement[3]. There is no best approach for the assessment of the reliability and so the selection of a technique depends on the viability and/or cost. For this measurement what was chosen was the test called "Split-Half Reliability", which measures the internal reliability of the instrument. According to Abrahamson

3 See Tull & Hawkins (1987), for example.

(1983:144), "the rationale behind internal reliability assessments is that a measure which is not internally consistent will not be consistent over time either." As the random error reduces the consistency of the measurement, this problem can be detected through a statistical test.

The split-half test was run by randomly dividing the questionnaires into two groups and testing the replicability of the two subsamples through a T-test (Appendix 5.7). The range of the significance level obtained for 50 pairs of variables was shown in Table 5.7. In order to simplify the table, only the three extreme means of the long test were chosen to represent the obtained values.

Table 5.7

Split-half test for reliability

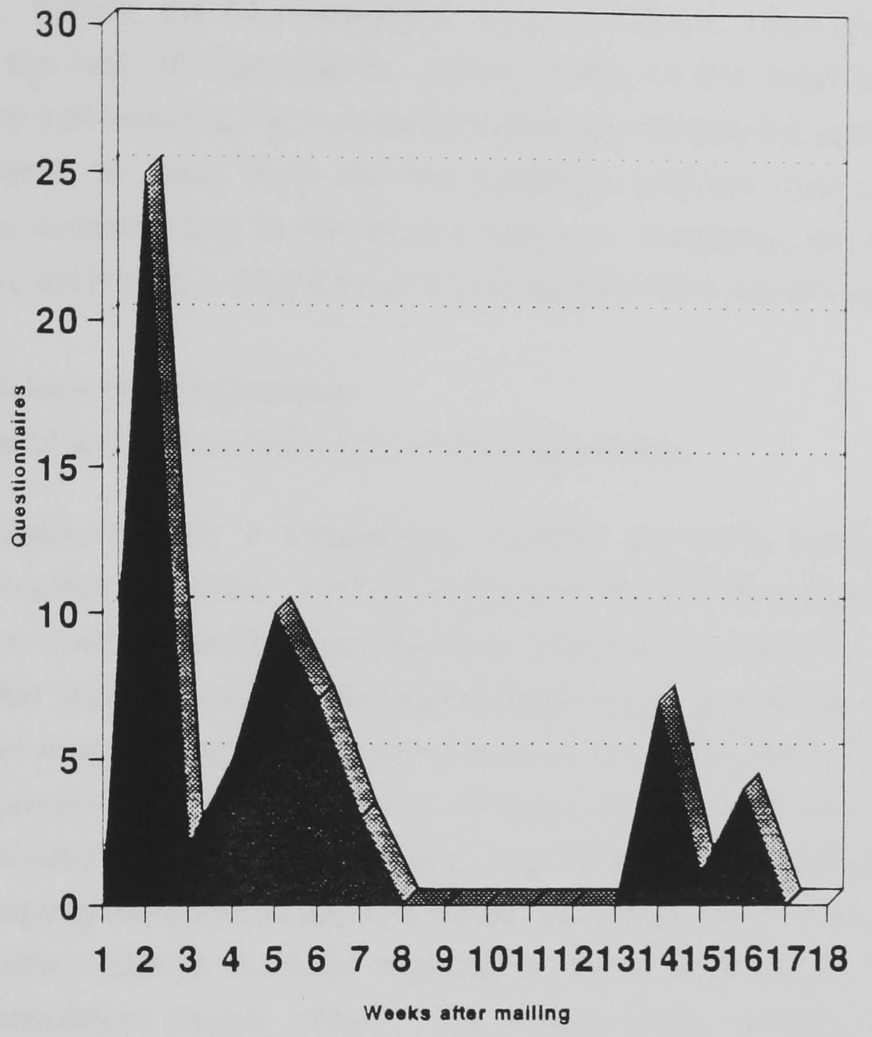
Range of mean values	2-tail probability
Minimum	0.098
Median	0.443
Maximum	0.936

In this case, the null hypothesis that the difference between the two sample-means is not big enough to signify a real difference between populations cannot be rejected. This way the measurement instrument is suitable of confidence concerning its reliability, because the statistical test did not detect any random errors.

5.6.3 Test for waves of return of questionnaire

As explained in section 5.1, three waves of questionnaires were sent to the respondents. Figure 5.4 represents the waves of questionnaires received by the researcher. As can be seen, there were three distinctive waves of returns in the field work. This is specially obvious for the last wave since there was a five-week interval between the second and third wave, because it coincided with the return of the Summer holiday, as mentioned above.

Figure 5.4
Waves of Questionnaires



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The literature describes the existence of a bias related to the late respondents. The early respondents are supposed to possess different characteristics from the late respondents, having, for example, a higher level of education[4]. It is common sense that the initial response rate is strongly influenced by the respondents' interest in the subject matter of the survey[5]. This means that late respondents have a weaker interest and have only answered the questionnaire because of the increased stimuli represented by the successive follow-ups. According to this reasoning, they may, consequently, be less rigourous in answering the questionnaire. It is frequently found that there are differences between responses of first and late respondents.

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4 See Fowler (1988), for example.

5 See Abrahamson (1983), Fowler (1988), Kinnear & Taylor (1979), Nachmias & Nachmias (1976) and Tull & Hawkins (1987).

It was necessary, in view of this, to measure the consistency of responses over time, i.e. to verify whether there is any bias resulting from respondents being first or late. Initially, the 64 respondents were divided into three groups: the first group had the first 32 respondents, corresponding to the initial mailing of the questionnaire (not including the five discarded questionnaires); the second group had 18 respondents, or those from the first follow-up; and the third group had 14 respondents, corresponding to the second follow-up. Subsequently, five questions were chosen, each from a different part of the questionnaire, observing the following criteria:

a) an interval level of measurement;

b) a high rate of answers (at least, 95% of the respondents).

A suitable test for **k** independent samples was then selected. A non-parametric Kruskal-Wallis test, which is available in the SPSSx program, was run to verify the overall differences between the three groups of respondents answering the same question (Appendix 5.8). The Kruskal-Wallis one-way analysis of variance by ranks is used when it is essential to verify whether **k** independent samples are from different populations; this test requires a minimum of an ordinal measurement. As the sample values differ one from the other, it is necessary to discover whether the differences among the samples signify a difference in population or whether they are chance variations such as are to be expected among several random samples from the same population (Siegel, 1956). The Kruskal-Wallis method tests the null hypothesis that the **k** samples come from the same population. A level of significance of 0.05 was chosen and the results obtained are shown in Table 5.8.

As observed, the mean ranks of the three groups are quite similar and the significance levels are high. This demonstrates that the null hypothesis is accepted, or that the three groups belong to the same population. Summing up, there is a consistency over time in the results and there is no bias related to differences between the waves of respondents.

Table 5.8

Kruskal-Wallis test for waves of return of the questionnaire

Question number	Waves (mean rank)			Chi-Square	Signif Level
	First	Second	Third		
1	34.47	30.75	30.25	0.7212	0.6872
5	30.72	36.81	31.04	1.3420	0.5112
32 (5)	33.55	27.15	32.35	1.4134	0.4933
32 (9)	28.60	33.85	35.07	1.6405	0.4403
32 (19)	33.19	30.47	29.00	0.5973	0.7418

5.7 Conclusion

The objective of this chapter was to explain the procedure followed in the operationalisation of the methodology adopted. Measurements obtained through the questionnaire were tested by means of a set of statistical tests run in a SPSSx package of programmes.

The results of statistical tests provide strong support for the validity and the reliability of the measurement and, consequently, of the survey. In addition, no bias was found in the quality of the response over time. In a comparison between respondents and nonrespondents, there was no indication of a significant bias related to nonrespondents.

The results of statistical tests and the evidence presented in this chapter confirm that the survey can be accepted with reasonable confidence. Caution should be taken, however, in the interpretation of the results and in making generalisations from the sample to a wider population, especially because a nonprobability sample was used in the research.

CHAPTER 6

DESCRIPTION OF THE SAMPLE

6.1 Introduction

Chapters 4 and 5 described in detail the sampling process used in this survey. Tests for verifying the reliability and validity of the results were run with success. As an official list of British firms that transfer technology abroad could not be found, efforts were made to contact institutions that use technology transfer, though the attempt was unfruitful in this respect. At last, a contact with the Licensing Executive Society (LES) was very productive and led to access to their mailing list. It was decided to base the present study on a mail questionnaire applied to members of LES despite the possibility of an eventual bias in the responses as a consequence of this membership.

An introductory and broad view of the data will be given in this chapter through descriptive statistics, showing the frequency distribution of each of the variables. The results obtained are compared with the literature on the subject and with the findings of the pilot study, in an attempt to establish tendencies that will be examined more carefully in Chapter 7. Firstly, a description of the sample will be provided, showing characteristics of respondents, and data about ownership, size, and sector of the firms. The background of the firms will be explained, followed by an examination of the way they conduct their R&D activities, which leads to the technology that is transferred. The motivation that leads to technology transfer will be examined, looking for reasons underlying the actions taken by firms.

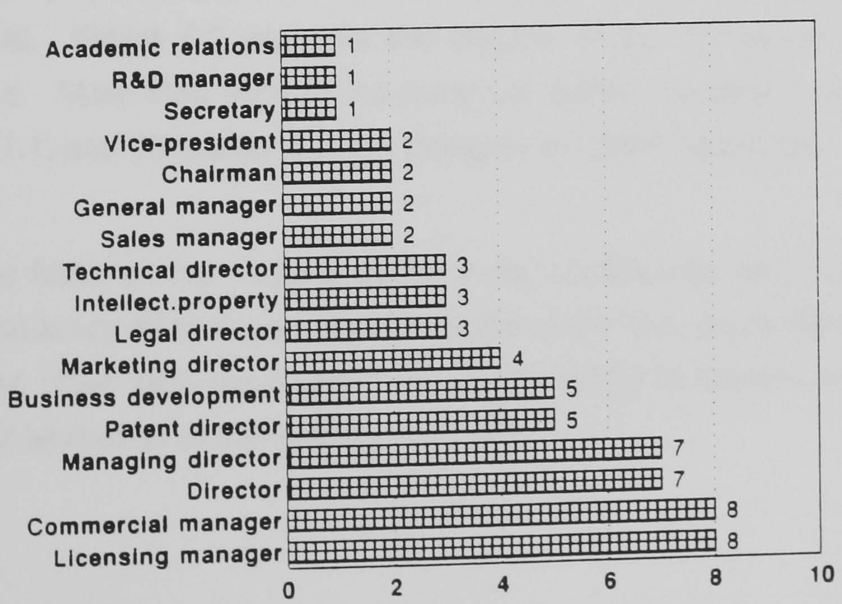
6.2 Outline of respondents and their firms

An overview of the respondents, as well as characteristics of firms related to ownership, size and sector of activities, will help to draw a basic profile of the sample.

6.2.1 Respondents of questionnaire

The target respondent of the survey was the person most closely related to commercialisation of technology in the firms. The problem of identifying the target-person in each organisation was overcome by using the mailing list of LES. As can be seen in Figure 6.1, the respondents do not occupy corresponding positions, owing to a broad range of different organisational structures presented in the firms.

Figure 6.1
Position of respondents in their firms



It should be observed that 67% of the respondents occupy positions at the second level of the hierarchy of firms, such as sectorial managers of R&D, sales.

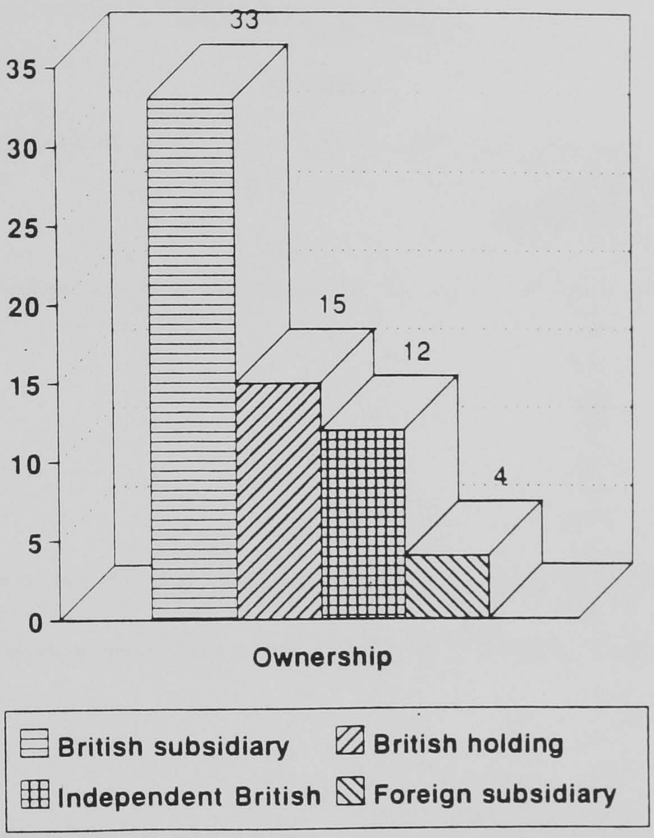
intellectual properties or patents units, marketing, business development, and licensing. More than 30% of the respondents have top positions, such as vice-presidents, chairmen, general managers, directors and managing directors. As was expected, there is a relatively big contingent formed by people that deal with licensing directly (25%), such as intellectual property managers, patent managers and licensing managers; these could lead the responses to represent their daily routine of work and add a licence perspective to the answers. However, 75% of the sample are people of diverse activities inside the firm, in spite of not being concentrated in only one activity.

6.2.2 Ownership of firms

Using the operational definitions presented in Chapter 2, the sample was divided into four categories: (1) independent British firms, whose most important characteristic is that they do not have any branch abroad; (2) holdings of British firms, i.e., headquarters of British transnational corporations; (3) subsidiaries of British firms; and (4) subsidiaries of foreign TNC. Owing to the small number of this last category (only four firms), it became unnecessary to differentiate between subsidiary and affiliate. Figure 6.2 presents the division of the sample in terms of different ownerships. More than 90% of the firms are British, according to the definitions in Appendix 1.1, and 50% belong to the category of British subsidiary.

The fact that the majority of firms are subsidiaries may mean a situation of more dependency on their parents in their decisions, but, as verified in the pilot study, subsidiaries often have the freedom of a wide range of choices of strategy, without the direct intervention of the holding company.

Figure 6.2
Ownership of firms



6.2.3 Size of firms

As stated previously, the size of the company is very important in defining strategies to be followed. For example, small firms usually have a lack of resources and this can restrict the range of options for establishing a presence abroad. It can be verified in Table 6.1, through the turnover of the sample surveyed, that a wide crossection of firms, from micro-firms to the largest corporations in the world, is included in the study. It should be mentioned that 22% of the firms belong to this last category of very large transnational corporations.

As explained in Appendix 1.1, to make a preliminary classification of the size of firms in three categories (small, medium and large), the criterion which was chosen was the number of employees. Figure 6.3 shows how the sample is divided.

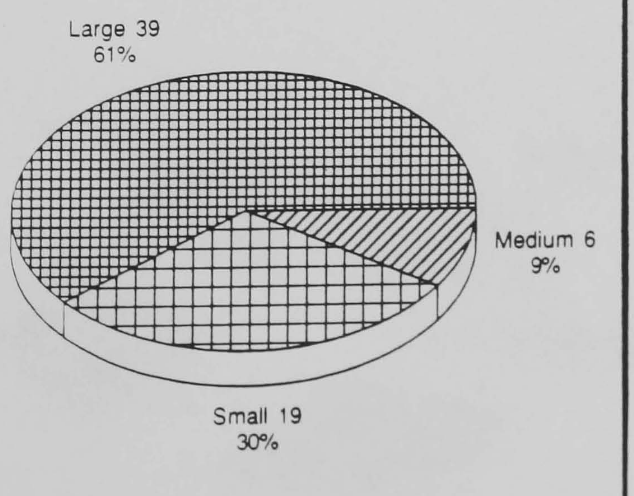
Table 6.1

Turnover of firms

(1989)

Turnover (£ millions)	Frequency Absolute	Relative (%)
Less than 1	9	14.1
1 - 9	11	17.2
10 - 49	9	14.1
50 - 99	3	4.7
100 - 29	10	15.6
250 - 500	8	12.5
Over 500	14	21.9
Total	64	100.0

Figure 6.3
Size of firms studied



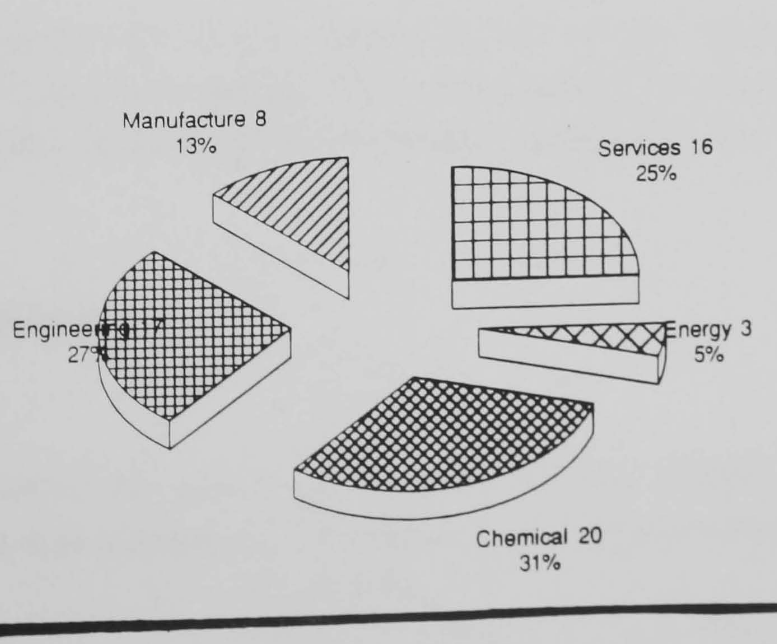
Chemical and engineering firms represent the majority of large size firms, as services represent more than 60% of the small size firms.

With the verification that only six firms were classified as being of medium size, it was decided to create a new category of small/medium size, merging the two categories. Thus, the sample was divided into: (1) 61% of large size firms (39 firms) and (2) 39% of small/medium size firms (25 firms).

6.2.4 Sector of firms

One of the objectives of this research is to examine whether the sector of activities of firms influences the way they transfer technology abroad. Having this in mind, the sample was divided into five sectors, according to the divisions explained in Appendix 1.1. It should be remembered that firms were not found in all categories of sectors established by the UKSIC codes. Figure 6.4 shows the division of firms by sector.

Figure 6.4
Sector of firms studied



Only 5% of the firms belong to the sector of energy and water supply industries. 31% belong to the sector of extraction of minerals and ores other than fuels, manufacture of metals, mineral products and chemicals. 27% are classified in the sector of metal goods, engineering and vehicles industries. 13% are other manufacturing industries. And, finally, 25% are service firms, such as banking, finance, insurance, business services, leasing and others.

6.2.5 Summary

It was observed that firms are structured in very different manners and the persons responsible for dealing with commercialisation of technology are spread throughout different departments. A considerable proportion of respondents (25%) have activities directly related to licensing; this could be a bias resulting from the mailing list used by the research. However, this bias will not damage the overall outcome of the present study.

The majority of the firms studied are British, most of them being in the category of subsidiary, and of large size firm. It should be emphasised that the sample includes some of the largest corporations in the world, with a vast range of subsidiaries and affiliates in several countries and with an important volume of transfer of technology, within the firms as well as at arm's length.

The chemical as well as the engineering and vehicles industries are the sectors most represented in the sample. The consequence of this accumulation may be responsible for other characteristics of the firms explained in the next section.

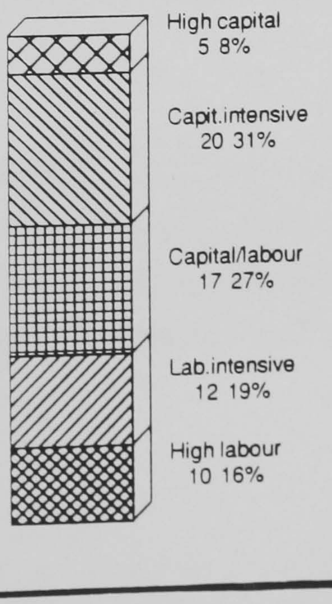
6.3 Background of firms

The first part of the questionnaire applied to firms contains a group of questions related to their background. The objective was to analyse specific aspects of the ways in which firms work and to try to link these findings with the firms' choices of transfer of technology.

6.3.1 Nature of production process\services

Frequently the nature of production process\services of a firm is closely related to the sector of activity. Automatization (or a highly capital intensive characteristic), for example, is characterised by a modern plant, with a small number of employees compared with the volume of output. Capital intensive firms are most common in the chemical and electronic industries. On the other hand, mechanical and textile industries are usually examples of labour intensive activities. The firm's nature of production is supposed to influence its mode of technology transfer. The distribution of the answers of firms surveyed is presented in Figure 6.5.

Figure 6.5
Nature of production process\services



While 37% declared they can be classified as highly labour or labour intensive, 42% declared themselves as being highly capital or capital intensive and 29% identified the firms as being either capital intensive or labour intensive.

There is a slight majority of responses pointing to a tendency to capital intensive. This is probably a reflection of the number of firms belonging to the chemical sector, as shown in the previous section. It was verified in the sample that highly labour intensive activities are present in services firms.

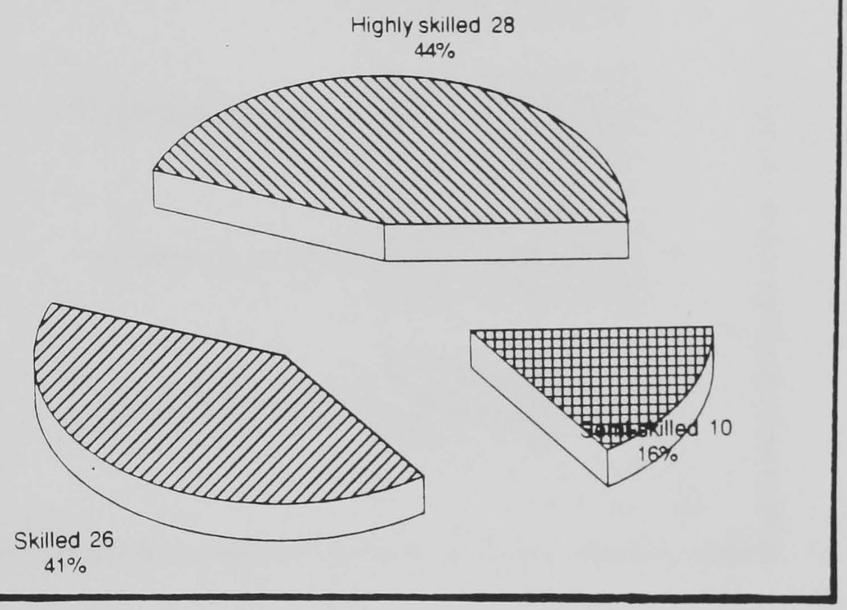
It should be observed that, among the manufacturers, when asked how the type of production procedures of their firms could be best classified, respondents that answered the question (42) informed that 52% were batch, 28% were line and 20% were process.

6.3.2 Classification of labour

The classification of the labour force defines how technologically advanced a firm is. With the constant process of automatization changing significantly the modes of production, firms are supposed to adjust their labour force to the new order. Highly skilled labour means that this working force is prepared to assume the most elaborate functions in opposition to unskilled labour, which is only expected to perform simple tasks, such as assembly operations. The labour force of the firms is presented in Figure 6.6.

In a range that goes from highly skilled labour to unskilled labour, the great majority of respondents declared that their work force is highly trained or skilled trained. This might mean that this work force deals with sophisticated technology and automated activities. Mass assembly operations, which need unskilled labour, can be transferred to another country.

Figure 6.6
Classification of labour force

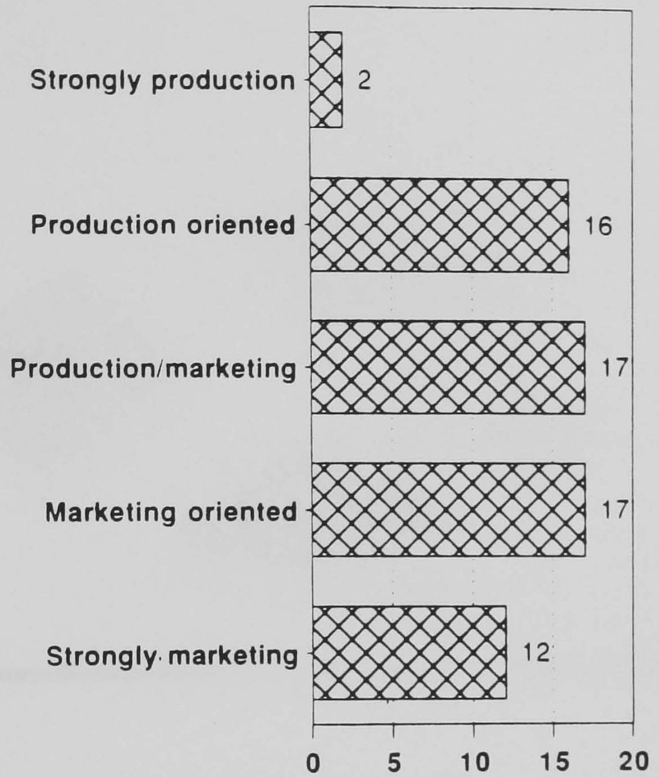


6.3.3 Corporate orientation

When asked about the nature of the corporate orientation of their firms, the respondents answered that they tend to be marketing orientated. Figure 6.7 shows the distribution of the answers.

It should be noted that 18% of the firms declared they are strongly marketing orientated. This might denote a tendency of marketing-push practice in these firms, where needs from the market command the production activities. That is to say, the market has the principal position in the corporate orientation of those firms. In a closer examination of the questionnaires, it became evident that many firms belonging to the chemical sector are production orientated and most of the service sector are strongly market orientated.

Figure 6.7
Nature of corporate orientation

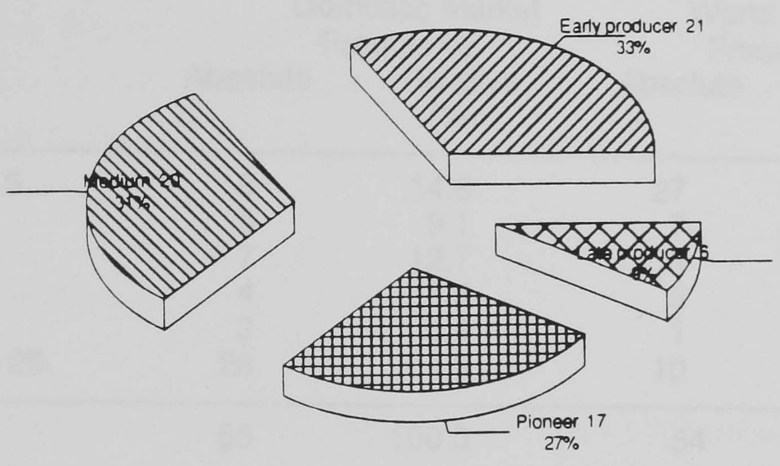


6.3.4 Introducing new products\services

It is supposed that the speed of introduction of new products/services is reflected in the way firms transfer technology abroad. Figure 6.6 shows how the respondents classified their firms in terms of this characteristic. It should be noticed that 60% of respondents classified themselves as pioneer or early producer of the products/services, and only 9% declared that they are late producers. This characteristic also reflects the strategy that firms use to move first to the market and sustain a lead position.

The sector of services classified themselves as pioneer, while chemical and engineering sectors are classified as early producers. Firms from the sector of energy declared they can be classified as late producers.

Figure 6.8
Introduction of new products/services



6.3.5 Market share

Market share is one more data which describes the firms studied. A large percentage share of the market might mean that the firm has an active presence in the market, probably controlling an unique competitive advantage over the competitors and Table 6.2 shows the current market share of the firms, at the domestic as well as the international level. As can be perceived, the great majority of the respondents (50.9%) affirmed that they retain more than 25% of the domestic market and 18.5% of them share 25% of the world market. These are very high percentages. This result is probably a reflection of the pioneer/early producer position in launching a product/service, which could give them leadership in the markets where they operate. It should be said that most of the respondents that claimed they retain over 25% of domestic and world market share belong to the chemical sector.

Table 6.2

Current market share of firms

(1990)

Market Share (%)	Domestic Market Frequency		World Market Frequency	
	Absolute	Relative (%)	Absolute	Relative (%)
Less than 5	8	14.6	27	50.0
6 - 10	5	9.1	7	12.9
11 - 15	7	12.7	4	7.5
16 - 20	4	7.3	5	9.2
21 - 25	3	5.4	1	1.9
More than 25	28	50.9	10	18.5
Total	55	100.0	54	100.0

6.3.6 Summary

There is a preponderance of firms which are capital intensive in the sample. They have a high level of automatization and a highly skilled labour force, dealing with sophisticated technology.

The firms also tend to be market oriented and the marketing-push seems to be the main drive guiding their corporate strategy. They declare themselves to be pioneers in the introduction of new products or services in the market and they retain a large percentage of the domestic market. Moreover, they also have an important participation in the world market.

6.4 R&D activity

R&D activities are closely related to the transfer of technology and the largest R&D investors are also the most active transferors. An evaluation of the R&D performance of the firms may be used to judge their aptitude to deal with technology at international level.

6.4.1 Size of R&D

When asked whether they have a centralised R&D department, most of the respondents (64%) answered affirmatively. This is still a strong tendency in the UK industry, in spite of the process of decentralisation of R&D activities which has been occurring in recent years[1]. It should be emphasised that most of the firms that declared that they have a centralised R&D are among the biggest of the sample.

The number of employees and annual budget were chosen to measure the size of R&D in the firms. Table 6.3 shows the frequencies among the firms that answered the question. It should be observed that 42% have less than 50 employees, which indicates an R&D department of small-medium size. However, other R&D departments have an impressive number of more than three thousand employees in R&D activities alone.

The annual budget of the central R&D departments for the year of 1990 are shown in Tables 6.4 and 6.4a. Among the respondents, more than 50% of the departments have a budget under ten million pounds, which confirms that these departments are small/medium size.

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1 See Whittington (1991b).

Table 6.3

Number of employees in central R&D

(1990)

Number of employees	Frequency Absolute	Relative (%)
Less than 49	14	42.4
50 - 199	6	18.2
299 - 499	6	18.2
500 - 1000	4	12.1
Over 1000	3	9.1
Total	33	100.0

Table 6.4

Current annual budget for R&D

(1990)

Annual budget (£ millions)	Frequency Absolute	Relative (%)
Less than 1	6	28.5
1 - 9	5	23.8
10 - 49	7	33.3
50 - 99	1	4.8
100 - 500	2	9.6
Total	21	100.0

Table 6.4a

Current annual budget for R&D

(1990)

Percentage of turnover (%)	Frequency Absolute	Relative (%)
Less than 1	6	20.7
1 - 5	10	34.6
5 - 10	7	24.1
10 - 30	3	10.3
Over 30	3	10.3
Total	29	100.0

It should be noticed in Table 6.4a that 55% of the firms invest up to 5% of their turnover in R&D activities. It can be observed in Table 6.3 that three firms (that belongs to the chemical sector) have very active R&D with more than one thousand employees, and with a budget bigger than fifty million pounds (Table 6.4). On the other hand, in Table 6.4a it can be seen that six firms invest over 10% of their turnover in R&D, and of these firms three expend more than 30%. They are firms of services, of relatively small size, and specialised in developing technology to be sold to clients in any part of the world.

6.4.2 Funding for R&D

The process of funding R&D is a complex one. R&D departments, in more advanced organisational structures, have become profit centres, competing for contracts through market mechanisms. For example, the firms are free to choose an external R&D centre for developing a new technology if their prices are more competitive than the ones offered by in-house laboratories. This is a general tendency that has become more evident in the last decade[2]. However, what Table 6.5 presents as main sources of funds for R&D reveals a different tendency.

2 See Whittington (1991b).

Table 6.5

Sources of funds for R&D

Sources	Frequency Absolute	Relative (%)
Central budget	30	58.9
Internal customers	10	19.7
External customers	4	7.8
International transfer	2	3.9
Government funds	1	1.9
Other	4	7.8
Total	51	100.0

In the sample examined, the majority of responses pointed out that the main source of funding for R&D activities is the central budget. Internal customers are the second source of funds, followed by external customers. International transfer of technology does not represent a significant source for those firms, in contrast with what is widely reported in the literature; the only two firms that have international customers as the main sources of funds for R&D belong to the service sector and declared themselves strongly market orientated. Venture capital, foreign organisations, and units funding are pointed as 'Other' sources of funds.

6.4.3 Summary

Firms that answered the questionnaire declared that they have their R&D activities centralised in a single department. These departments are usually small size, but a few companies have very impressive R&D activity, recruiting more than three thousand people. The main source of funding of these departments is the central budget of the company. International transfer of technology does not represent a significant source for the maintenance of the departments.

6.5 Technology transfer

The third part of the questionnaire was specifically designed to obtain information related to the transfer of technology in the firms. The number of contracts of transfer a year, the kind of technology transferred, the policy followed by firms, the destination of the technology and the main forms as well as ideal forms of transfer will be examined in this section, among other items.

6.5.1 Contracts

Asked if they have a special department responsible for transferring technology, 42% of the firms answered affirmatively. Of the 58% that do not have a special department, in some firms transfers are dealt with by different departments, such as business development, headquarters, strategic planning, marketing services among others, while in other firms each department approaches the problem on an *ad hoc* basis.

When dealing with technology, the main activities of these bureaucratic departments are seen in Figure 6.9. The negotiation of technology is the main activity of the department, followed by commercialisation of technology, technical assistance and management of projects. 'Other' means strategic planning, development, support for technical and commercial activities, and so on.

Table 6.6 shows the number of technology transfer contracts the firms have on average per year.

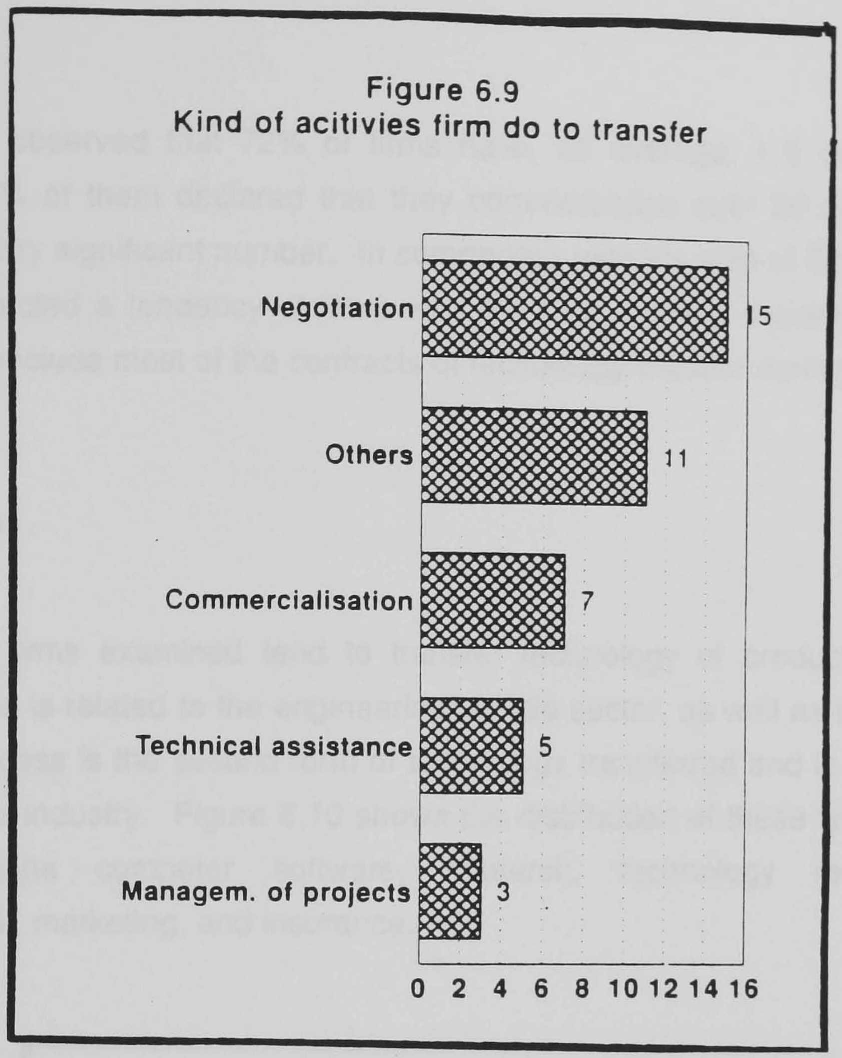


Table 6.6

Contracts of technology transfer per year

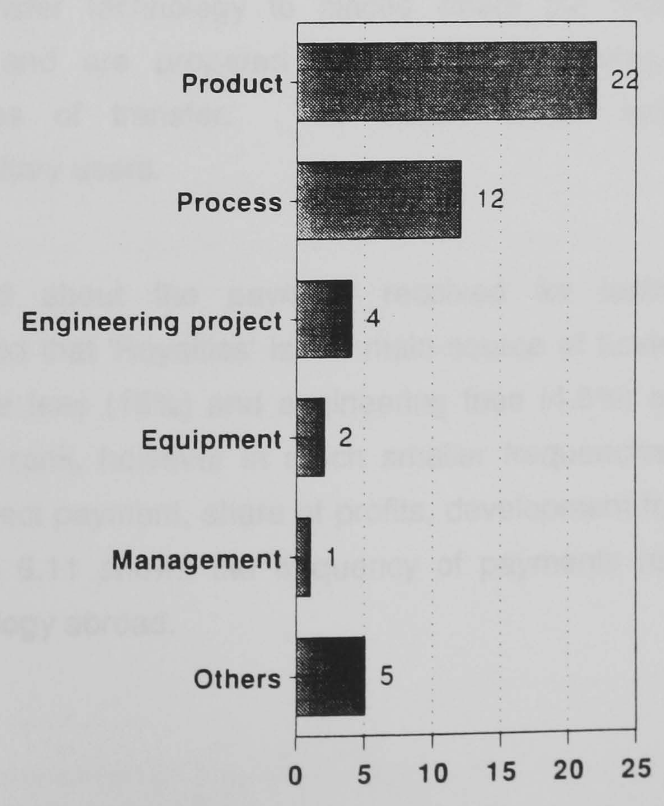
Number of contracts	Frequency Absolute	Frequency Relative (%)
1	16	32.0
2 - 5	20	40.0
6 - 9	3	6.0
10 - 14	3	6.0
15 - 20	4	8.0
Over 20	4	8.0
Total	50	100.0

It is observed that 72% of firms have, on average, 1-5 contracts a year. However, 8% of them declared that they commercialise over 20 contracts a year, which is a very significant number. In comparison with the size of R&D departments, there is detected a tendency of firms with the biggest R&D departments to be the ones that conclude most of the contracts of technology transfer during the year.

6.5.2 Types

The firms examined tend to transfer technology of product as their main activity. This is related to the engineering/vehicle sector, as well as the manufacture sector. Process is the second form of technology transferred and is more related to the chemical industry. Figure 6.10 shows the distribution of these types. The option 'Other' means computer software, research, technology requiring further development, marketing, and insurance.

Figure 6.10
Types of technology transfer



6.5.4 Clients

It was asked who are the main clients when the firms transfer their technology abroad. Table 6.7 presents the list of these main clients.

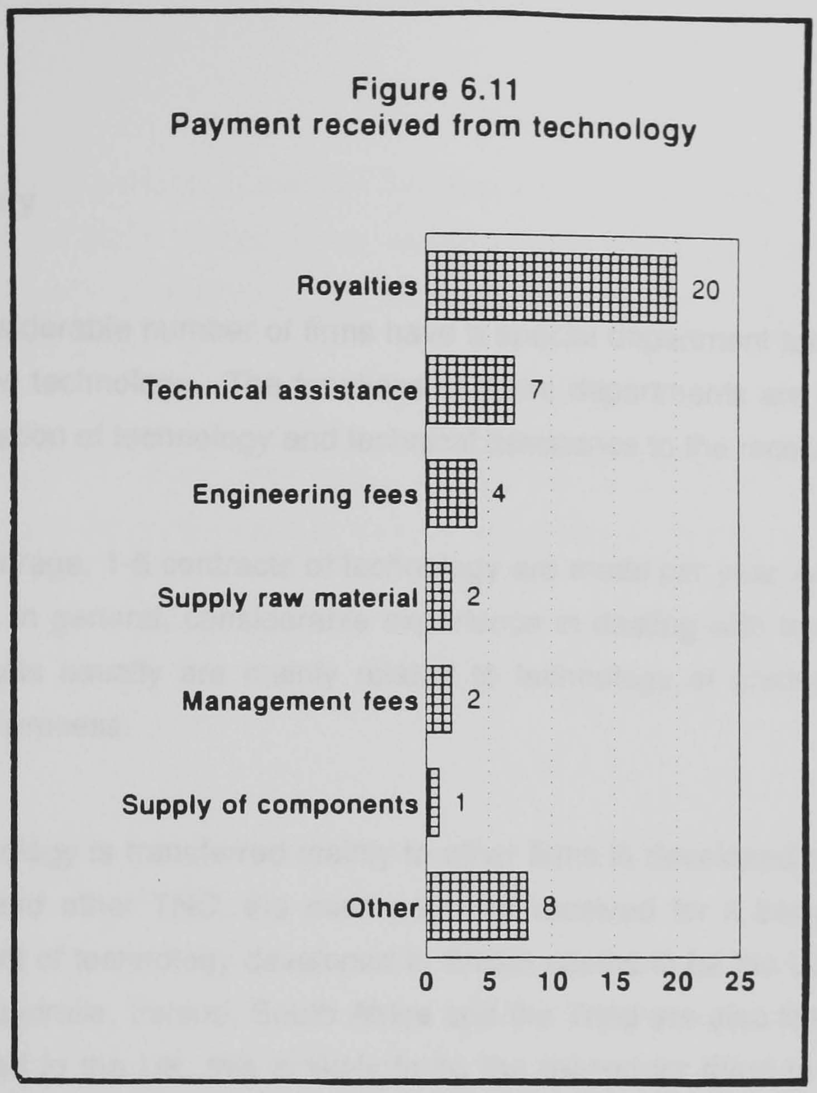
Table 6.7

Main clients for technology

Main clients	Frequency Absolute	Relative (%)
Firms in developed countries	12	26.1
Subsidiaries	11	23.9
Other transnational corporations	10	21.7
Affiliates	4	8.7
Firms in East European countries	4	8.7
Firms in developing countries	1	2.2
Other	4	8.7
Total	46	100.0

Local companies in developed countries are the main clients (26%), followed very closely by subsidiaries (24%) and other TNC (22%). These results mean that firms select to transfer technology to places where the receivers are able to understand better and are prepared to use this technology, without a very complicated process of transfer. The option 'Other' includes government departments and military users.

When asked about the payment received for technology, 45.5% of respondents indicated that 'Royalties' is the main source of funds from the transfer. Technical assistance fees (16%) and engineering fees (4.5%) are the second and third options in the rank, however in much smaller frequencies. 'Other' includes various answers: direct payment, share of profits, development fees, know-how fees and so on. Figure 6.11 shows the frequency of payments received when firms transfer their technology abroad.



It was also asked whether the firms had a particular country that has become their main client of technology in the last few years. With only one response missing, 30% declared they have a particular country as a main client whereas almost 70% said they do not. The United States appears to be the main country to which British firms transfer technology. India is the second country, followed by the USSR[3], Australia, Ireland, South Africa, China, the Triad, the Eastern Bloc and the Far East. When examining which of these countries receive the latest technology and which do not, an interesting finding was that the USA appears on both lists, specially in the list of countries which do not receive the latest technology. At the same time, China, Ireland, India, the Far East and the USSR appear only in the list of countries receiving the latest technology.

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3 The questionnaire was applied in 1990, before the dismantling of the USSR.

6.5.7 Summary

A considerable number of firms have a special department totally responsible for transferring technology. The functions of these departments are negotiation and commercialisation of technology and technical assistance to the receivers.

On average, 1-5 contracts of technology are made per year, which give to the firms studied, in general, considerable experience in dealing with transfer overseas. These contracts usually are mainly related to technology of products followed by technology of process.

Technology is transferred mainly to other firms in developed countries and to subsidiaries and other TNC, the main payment received for it being the royalties. The main client of technology developed in Britain seems to be the USA far ahead of the others. Australia, Ireland, South Africa and the Triad are also listed; as they are culturally linked to the UK, this is likely to be the reason for them to appear among the main clients. However, India, the USSR, China, the Eastern Bloc and the Far East, with whom Britain have little cultural similarities, appear in the list in equal conditions.

6.7 Conclusion

The firms studied are predominantly British[4]. They tend to be large and most of them are manufacturers using batch as a typical production procedure. In general, they have a highly skilled labour force and their methods of production are intensive capital. They are market oriented and pioneers in the launch of a new product into the market. They tend to have a centralised department of R&D, maintained by a central budget and, on average, those departments are small/medium size. The firms are experienced in dealing with transfer of technology abroad because they contract around five transfers a year.

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[4] Chapter 4 compares the sample studied with the general population.

The survey pictured a modern industry, with a high degree of automatization and with a well prepared labour force, answering the demands of the markets. This industry has a wide experience in the international setting and transfer of technology is not a secret for them.

In Chapter 7, these preliminary results will be examined further and other statistical procedures will be used to test the hypotheses of the research.

CHAPTER 7

DISCUSSION OF THE RESULTS

7.1 Introduction

The description of the sample presented in Chapter 6 concentrated on general aspects of the firms, and on the organisation of the production process or services within them. The position of the firms in their market was also discussed, as well as the organisation of their R&D activities and of their process of technology transfer.

Chapter 7 will present the discussion of the results obtained, showing firstly how firms transfer technology abroad, what are the underlying reasons supporting their decisions and what are the main forms of transfer and the ideal ones. The importance of technology transfer for the firms will be indicated, with a description of decisions on the subject, as well as the destination of the technology transferred and the practice carried out by firms.

In the last part of this chapter the tests of the hypotheses will be presented and the results will be discussed, comparing what was obtained in the survey with what is found in the literature.

7.2 Modes of technology transfer

The practice of the firms is often not exactly what they would prefer to do. Plans and strategies sometimes cannot be implemented because of characteristics of a particular circumstance. This section examines the way firms go abroad and why they do so.

7.2.1 Policy of firms

There is an important discussion in the literature on the subject of transferring old or mature technology versus the latest technology as a general practice of firms. The pilot study provided some light on the controversy, as it discloses that firms always tend to transfer their latest technology. To examine this debatable point, the firms were asked whether or not they transfer their latest technology. The result was a balance: 50% declared they transfer their newest technology and 48% indicated the negative.

For those who transfer the latest technology, it was asked what makes the firm follow this pattern. Table 7.1 shows the distribution of the answers of those who responded to the question.

Table 7.1

Reasons for transferring latest technology

Reasons	Frequency Absolute	Frequency Relative (%)
Users are leading edge oriented	8	32.0
Clients only accept latest technology	4	16.0
Buyers are aware of what they want	3	12.0
Other	10	40.0
Total	25	100.0

The respondents ranked the answers in order of importance, according to what their firms practice. There can be observed a tendency toward buyers-demand issues. Thus, 32% of respondents declared that users are leading edge oriented, 16% declared that clients only accept latest technology and one respondent declared that buyers are very much aware of what they want. No respondent chose items related to the technical capacity of the supplier firm, such as non-availability of technical support for old technology and lack of means of training people in old technology. The option 'Other' was the one that received the majority of the answers (40%), but among those who provided ranking it was never ranked as the first option. For these respondents, reasons for transferring technology are: best profits, business opportunities, no market in the UK for the product, competition from other product manufacturers, market penetration and the only technology available.

To the group that declared they do not transfer their latest technology, the reasons they gave for doing so are shown in Table 7.2

Table 7.2

Reasons for NOT transferring latest technology

Reasons	Frequency Absolute	Relative (%)
Unable to exploit at home	7	28.0
Technology is in public domain	6	24.0
Technology is old	3	12.0
Technology is not used commercially at home	1	4.0
Other	8	32.0
Total	25	100.0

Some of these respondents were unable to exploit technology adequately in the domestic market (28%); some felt technology was in public domain (24%); for other respondents technology got old and there was no more market for it at home (12%). The respondents who chose the option 'Other' (32%) answered that technology can be best exploited overseas, technology is not available in the market of the licensee, and technology can be adapted to the new market. Also they declared that if they do not transfer, somebody else will do it and that technology meets local manufacturing conditions. In section 7.4.2 this subject will be re-examined in more detail.

7.2.2 Motivation for producing abroad

The size of the new market is the main reason for a firm to start producing its products/services abroad rather than exporting from home, according to 39% of the respondents. The second option ranked by the respondents was related to the foreign government intervention in the process of internationalisation of the firm, restricting direct sales to their territories. This option was chosen by 24% of the respondents. The third motivation of the firm is the creation of a return stream for the future. The answer 'cost of labour in the home market' is not relevant because only one respondent chose this option. 'Other' includes the answers: cost of establishing a new market including transport costs, importance of local presence in overcoming the resistance of local customers, competitive advantage and no interest in UK market. Table 7.3 presents the distribution of responses.

Table 7.3

Motivation for producing abroad

Motivation	Frequency Absolute	Relative (%)
Size of new market	18	39.2
Foreign government policies	11	23.9
Creation of a return stream	9	19.5
Cost of labour in home market	1	2.2
Other	7	15.2
Total	46	100.0

7.2.3 Forms of transfer

The literature offers many details about forms of technology transfer and reasons for choosing one or another. In the questionnaire for the present study, two questions are included on the main forms in which technology is transferred in the firms and on the ideal form of transfer, according to the firm's policy. Table 7.4 shows the main modes of technology transfer in the firms.

Table 7.4

Main forms of technology transfer

Main modes	Frequency Absolute	Relative (%)
Licence	42	68.9
Joint venture	7	11.5
Foreign direct investment	6	9.8
Management contract	3	4.9
Turnkey project	1	1.6
Other	2	3.3
Total	61	100.0

As can be seen, 69% of respondents declared that licensing is the main form of technology transfer in their firms. Joint ventures and foreign direct investments follow licensing, but in a very low ranking. Direct sales was indicated by two respondents in the option 'Other'.

Table 7.5 shows the most important modes of transferring technology, according to the firm's policy. These modes are the ideal form preferred by the firm when they begin to establish their presence overseas. Again, licensing technology to a non-related company is the preferred option. However, the percentage of respondents choosing this option fell to half in relation to Table 7.4. Now licensing represents 35% of the answers. This is followed very closely by selling products or services directly (33%). Joint venture is the third option in the rank, representing 14% of the responses. FDI is the fourth in the list but only 10% of the respondents chose this option. 'Other' includes direct sale to existing subsidiary, transfer to distributors and 'depend on specific case'. One respondent declared that whatever produces a good return is the preferred mode of transfer of technology.

Table 7.5

Most important modes of technology transfer

Modes of technology transfer	Frequency Absolute	Relative (%)
Licensing to non-related firms	20	35.1
Selling products/services directly	19	33.3
Doing joint venture with affiliates	8	14.0
Opening subsidiary	6	10.5
Other	4	7.1
Total	57	100.0

It must be recognised that these results might be biased by the nature of the specific population from which the sample was drawn in that they were contacted using the LES mailing list. However, comparing tables 7.4 and 7.5, half of the respondents for whom licensing is the main form of transfer technology say that they would prefer to use other modes of transfer. This subject will be discussed in more detail in section 7.4.3.

Finally, when asked why their firms choose to license their technology overseas, instead of other forms of participation in the international market, respondents indicated that the capacity of the recipient company to operate the new technology is the main factor influencing this choice. Shortage of funds for direct investment was also a reason to use licence. Shortage of management for investment abroad and small size of host market were other reasons to license. Pressures of the host government and a politically risky situation for investment were further incentives to take licensing. 'Other' received a long list of options, such as legal restrictions, tax efficiency, business opportunity, market requirements for local production, no bank interest in the long term, sale of products to recipient conditional on licensing part of them for indigenous manufacturers, and so on. One respondent declared that it seemed to be the right thing to do. Table 7.6 shows the frequency of options.

Table 7.6

Reasons for choosing licensing

Reasons	Frequency Absolute	Frequency Relative (%)
Capacity of recipient firm to operate	19	35.2
Shortage of funds for investments	7	13.0
Shortage of management	4	7.4
Host market too small	4	7.4
Pressure of host government	3	5.6
Politically risky situation	1	1.9
Other	16	29.5
Total	54	100.0

7.2.4 Summary

Firms were divided between transferring the latest technology and not doing so. For the ones that transfer the latest technology the key reason is the pressures of the demand, such as users who are leading edge orientated and do not accept old technology. The ones who admit they transfer other technologies offer the reasons that the firm is unable to exploit it adequately in the home market or that the technology is in public domain.

The size of the host market is the main reason for the transfer to other countries, and the restrictions generated by foreign government policies are another important factor.

Firms mainly transfer their technologies through licensing but if they have a choice, they opt to export the goods as well. FDI is the option when the market is already tested and very well known. When firms decide to use licensing for transfer of technology, the capacity of the host firm to operate that technology is the most important factor to be taken into consideration.

7.3 Importance of technology transfer

Based on the literature, on the pilot study and on common sense, several statements were made in the questionnaire and the respondents were asked to indicate the relative importance of each of them, according to the policy and practice of their firms. This was done on a scale of importance, from one (very important) to five (no importance), or on a scale of agreement from one (totally agree) to five (totally disagree). In the next sub-sections the answers to the questions will be analysed.

7.3.1 Decision to transfer

When a firm decides to transfer its technological asset abroad, several factors should be weighed before any resolution is made. A non-exhaustive list of these factors was developed and survey respondents were asked to rate the significance of each of the items listed when their firms decided to transfer their technologies. The results are shown in Table 7.7.

As can be observed, several items are considered to be of no importance: supply of additional technology, reciprocal use of technology, lack of funds for investment, and economies of scale. In relation to the item 'territorial control restrictions', the respondents are divided between no importance (25%) and important (23%). However, when computed together, 42% of the respondents consider this option important or very important and 34% consider it of some importance/no importance.

On the other hand, when judging good opportunities in a new market, comparative advantage of firm and availability of managerial skills, the respondents indicated these items are important or very important.

Table 7.7

Importance of transfer technology abroad

(%)

Reasons	VI	I	N	SI	NI	Miss -ing	Total
Supply of additional technology	4.7	12.5	20.3	21.9	**31.3**	9.4	100.0
Reciprocal use of technology	7.8	12.5	20.3	21.9	**28.1**	9.4	100.0
Territorial control restrictions	18.8	23.4	17.2	9.4	**25.0**	6.3	100.0
Lower labour costs in new country	3.1	20.3	20.3	12.5	**32.8**	10.9	100.0
Lack of funds for investment	9.4	9.4	21.9	18.8	**31.3**	9.4	100.0
Good opportunities in new market	**45.3**	34.4	4.7	0.0	9.4	6.3	100.0
Comparative advantage of firm	25.0	**31.3**	14.1	0.0	18.8	10.9	100.0
Economies of scale	3.1	14.1	25.0	9.4	**35.9**	12.5	100.0
Availability of managerial skills	18.8	**35.9**	18.8	4.7	15.6	6.3	100.0

VI = very important; I = important ; N = neutral; SI = some importance; NI = no importance
Total of respondents = 64

Obs.: Small errors may arise due to rounding.

In a preliminary evaluation of the responses, there is evidence that the market of the host country is considered the most important factor underlying the decision to operate abroad. The results of Table 7.7 are coherent with the ones presented in Table 7.3, where the size of the new market was considered the main motivation for initiating production overseas. Surprisingly, the firms indicate no worries about costs of labour, as much in the home market as in the new country[1]. It seems that this item is not taken into consideration when firms decide to go abroad. Similarly, 'foreign government policies' and 'territorial control restrictions' are important items to the firms, confirming the preponderant position of governments in defining the way firms operate in their territories.

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1 This finding does not confirm Casson's (1988) statements on costs of labour and internationalisation of production.

Another unexpected result in Table 7.7 is that a noticeable proportion of firms consider two items to be of no importance: the exchange of technology and the supply of additional technology when operating in another country. These are new findings that go against prevailing notions in the literature[2].

7.3.2 Destination of technology

There has been ample discussion in the literature about what is considered important to the firms when they examine pros and cons of new locations for their expansion overseas. On a scale of importance from one to five, respondents indicated what their firms consider important or not when they are choosing the destination of the transfer of technology. Table 7.8 presents the results.

Again, some unforeseen results are shown in the table. For example, firms consider it to be of no importance to transfer technologies to countries where they want to block a competitor's entry[3] and where they want to have access to strategic raw materials[4]. A balance occurs for the item of how important it is to transfer to countries where firms already have production facilities: 42% consider this option very important/important while 43% consider it of some importance/no importance. On the other hand, the respondents indicated that they consider it very important/important to transfer to countries where the firms have entered into agreements with other organisations operating within the foreign country (50%), and to transfer to countries where the firms have competitive advantage over other firms (46%)[5].

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2 Bertin & Wyatt (1988), Aggarwal & Agmon (1990), Fatehi-Sedeh & Safizadeh (1989), for example, emphasise the importance of the exchange of technology for maintaining the firm up to date in the world of technology.

3 Porter (1990) is not supported when he recommends the continuous necessity of renewing barriers to protect the firm's competitive advantage.

4 The protection of the supply of raw materials through vertical integration to avoid market uncertainties, as emphasised by internalisation theories, does not seem to worry many of the firms in the sample.

5 This finding is consistent with Hymer's reasons for firms to establish production in a foreign country.

Table 7.8

Destination of technology transferred abroad

(%)

Transfer technology where firm has:	VI	I	N	SI	NI	Missing	Total
Production facilities	25.0	17.2	7.8	7.8	**35.9**	6.3	100.0
Entered agreement with local organisations	20.3	**29.7**	18.8	3.1	18.8	9.4	100.0
Blocked competitor's entry	9.4	20.3	25.0	10.9	**26.6**	7.8	100.0
Access to raw materials	4.7	10.9	4.7	12.5	**57.8**	9.4	100.0
Competitive advantage	21.9	**25.0**	17.2	7.8	21.9	6.3	100.0

VI = very important; I = important ; N = neutral; SI = some importance; NI = no importance
Total of respondents = 64

Obs.: Small errors may arise due to rounding.

The results of this table continue to be surprising in some respects, specially when the firms denied (58%) that having access to strategic raw materials is an important matter when transferring technology abroad. Once more there is evidence of the concerns about a new market and the possibility that agreement with other firms operating in the same country is an ideal situation. However, to arrive at a situation of agreement, the firm must have a competitive advantage which gives it strong bargaining power to negotiate with competitors that are already operating in the new environment. They do not want to block the competitors, but divide a market that seems to be very fruitful.

7.3.3 Firm's practice

Another non-exhaustive list was developed, of nineteen reasons frequently mentioned in the literature for firms to transfer technology overseas. This list covers several factors: home market conditions leading firms to go abroad, qualities of technology, R&D funding, competitive advantage, FDI, licensing and joint venture.

The respondents were asked to rate those statements on a scale of agreement from one (totally agree) to five (totally disagree). The results are presented in Table 7.9.

Responses indicate that characteristics of the home market are not important when firms choose to transfer their technologies overseas. Also, respondents totally disagree that characteristics of the technology, such as 'promotion of standardisation' and 'widely available technology', influence the process of transfer. Characteristics of the R&D funding received opposite responses. The statement concerning transfer of technology to finance home R&D activities was marked with 'totally disagree', whereas the item concerning the increase of the return on investment made in R&D was considered important. Once more the statements related to competitive advantage in the new market were marked with totally agree/agree by the majority.

Statements related to FDI were met with disagreement by the respondents, an exception being the statement that FDI is the choice when the firm knows the environment of the host country well. Statements about licensing received mixed responses. While the majority of respondents agreed that one reason to transfer through licensing is that it minimises management costs, a strong group totally disagrees with this. Once more in consistency with previous responses given in other parts of the questionnaire, the responses indicated that the facility of access to patents and technology of the licensee is not an important influence on the international presence of the firm.

The statement related to the age of technology produced an even proportion of agreement and total disagreement. This can be explained by the even division of the respondents into the ones that transfer latest technology and the ones that do not do so. This result will be explained in more detail in section 7.4.2 .

There was agreement that joint venture speeds the entry in a new market with a small investment. In the same way, respondents were in agreement that firms transfer their technology overseas when they cannot export to one market, owing to restrictions or protection of that market. Finally, the idea that transferring technology to a developed country creates a competitor in the international market received a largely neutral response.

Table 7.9

Firm's practice with technology transfer abroad

Firm chooses to transfer its technology overseas:	TA	A	N	D	TD	Missing	Total
When it is not profitable to produce anymore in the home country	3.1	6.3	7.8	23.4	**53.1**	6.3	100.0
When your home market is saturated	1.6	9.4	21.9	17.2	**46.9**	3.1	100.0
When the competition in your home market is heavy	1.6	7.8	12.5	23.4	**50.0**	4.7	100.0
When it wants to promote its rapid standardisation	7.8	15.6	23.4	12.5	**34.4**	6.3	100.0
Only when this technology is widely available	3.7	7.8	15.6	21.9	**48.4**	3.1	100.0
To finance its home R&D department	4.7	17.2	12.5	21.9	**40.6**	3.1	100.0
To increase the return on investment made in R&D	18.8	**25.0**	17.2	14.1	21.9	3.1	100.0
Where it can create a dominant position in the market	26.6	**26.6**	20.3	4.7	18.8	3.1	100.0
To maintain its leading position in the international market	21.9	**46.9**	14.1	3.3	9.4	4.7	100.0
Through FDI to control firms in different countries	7.8	10.9	6.3	17.2	**53.1**	4.7	100.0
Through FDI to reduce the risk of loss to potential competitors	4.7	10.9	26.6	21.9	**31.3**	4.7	100.0
Through FDI to countries that have a large market	12.5	18.8	15.6	12.5	**37.5**	3.1	100.0
Through FDI when it knows well the local environment of host country	17.2	**26.6**	18.3	6.3	25.0	6.3	100.0
Through licensing to minimise management costs	12.5	**26.6**	15.6	15.6	**26.6**	3.1	100.0
Through licensing in order to facilitate access to patents and technologies of the licensee	1.6	9.4	23.4	23.4	**37.5**	4.7	100.0
When technology gets mature, licensing and JV become more important channels	12.5	**31.3**	14.1	6.3	**31.3**	4.7	100.0
Through JV to speed the entry in a new market with small investment	14.1	**32.8**	17.2	7.8	23.4	4.7	100.0
When there are import restrictions or protection of domestic market	21.9	**28.1**	10.9	18.8	15.6	4.7	100.0
Transfer technology to developed country creates competition in international market	6.3	12.5	**35.9**	15.6	26.6	3.1	100.0

TA = totally agree; A = agree ; N = neutral; D = disagree; TD = totally disagree
Total of respondents = 64

Obs.: Small errors may arise due to rounding.

Once again some results were unexpected. Firms are not concerned about the home market when they decide to transfer technology abroad[6]. The foreign market is the main object of concern for them, and the possibility of having a monopolistic/oligopolistic position in the new market and maintaining a leading position internationally is a strong enough reason for the firm to decide to move abroad. Still related to concerns with host markets, restrictions on exports to them account for a good part of the decision of going overseas.

FDI is considered a path to be taken after the new market is thoroughly known by investors and there are no more doubts about what to expect from it. Once more, firms demonstrated that they do not want to go international to fight with competitors but instead to be in a position to collude with them. A large market is a priority concern for the firm when transferring technology, but not when investing in a subsidiary. There are other ways of exploiting this large market without a serious involvement in it. This is particularly true when the firm does not have very good knowledge of the market and will not invest a large amount of resources in it without being sure that this investment will have a return. In this phase of knowledge of the market, licensing and, in a second stage, joint venture work as preliminary steps to a more definitive presence through direct investment.

7.3.4 Summary

The unexpected results do not confirm what is widely argued in the literature. For example, costs related to home market and foreign market do not seem to be an object of special concern when firms decide to go abroad. Additionally, the position of the firms in the home market and the pressures that they suffer domestically are not important factors in their decision to go overseas. Exchange of technology also does not worry firms which go abroad, for several reasons: first, and primarily, because of the good opportunity in the new location; because of the monopolistic/oligopolistic position that will be held; and in addition because of the possibility of agreement with firms already positioned in that location, as a fight with competitors is not desired by the firm.

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6 Solocha et al (1990), among others, found that the decision of exploiting foreign markets happens when the growth of the firm in the home market is frustrated by the heavy competition.

FDI seems to be the last step in the establishment of the international presence of the firm and it is taken only when the market no longer unknown.

7.4 Test of hypotheses

In Chapter 3 contained the research hypotheses, which were developed after the review of literature and the pilot study. These hypotheses aim to test through statistical analyses, the strength of the relationships presented in the analytical framework of transfer of technology. It should be clarified that the present research is testing only a few relationships described in the model owing to limitations of time and costs. This section will show how they were tested and the results obtained with their tests.

7.4.1 Relationship with home market

Only one hypothesis was developed about the relationship between transfer of technology and home market. The following hypothesis was:

a.1 **Firms tend to transfer their technologies abroad when their home market is saturated and the competition is heavy.**

To test this hypothesis, it was decided to ask the respondents to mark, in a scale from 1 (totally agree) to 5 (totally disagree), the appropriateness of three statements about the subject. The results are presented in Table 7.10

Table 7.10

Relationship with home market

Scale	Not profitable to produce at home market Frequency Absolute	Relative (%)	Home market is saturated Frequency Absolute	Relative (%)	Competition in home market is heavy Frequency Absolute	Relative (%)
TA/A	6	10.0	7	11.3	6	9.8
N	5	8.3	14	22.6	8	13.1
D/TD	49	81.7	41	66.1	47	77.4
Total	60	100.0	62	100.0	61	100.0

TA/A = totally agree/agree; N = neutral; D/TD = disagree/totally disagree

As can be observed, the respondents disagree with the statements, so that this hypothesis cannot be accepted. Saturation of the domestic market and heavy competition at home do not influence the decision of the firm to initiate production overseas.

7.4.2 Relationship with technology

The hypothesis developed to test the relationship with technology is the following:

b.1 Firms transfer abroad their mature technologies which are no longer considered essential to their home business.

As explained in section 7.2.1, 50% of the respondents attested that their firms transfer their latest technology. However, 48% responded negatively to this possibility. In view of this, other statistical procedures were used to investigate the point further. Aiming to discover whether there was any relationship between variables explaining differences in behaviour between groups, the sample was divided into two groups, the transferors of latest technology and the transferors of no latest technology and a discriminant analysis[7] test was run, using the interval variables of the questionnaire as independent variables.

The final result obtained with discriminant analysis using the Wilks methods (stepwise) is shown in Table 7.11. Only five variables produced significant separation between the two groups.

Table 7.11

Discriminant analysis of policy of transferring technology

Variables(1)	Means(2) Latest technology	Not latest technology	Discriminant Coefficient
RECIPR	3.312	3.096	-0.568
FACIL	2.843	3.064	0.392
FDI	4.000	3.612	-0.918
INVEST	2.375	3.290	0.698
CREATE	2.187	2.870	0.742
Number of cases:	32 for latest technology 31 for not latest technology		
Wilks' lambda= 0.751; Chi-squared = 16.724; D.F.=5; Significance = 0.005			

(1) RECIPR = reciprocal use of technology
FACIL = transfer to place where firm has production facilities
FDI = control of firms in different countries through FDI
INVEST = increase of return on investment in R&D
CREATE = creation of dominant position in the market

(2) Scale = **1** (totally agree) to **5** (totally disagree)

As can be observed, those who transfer latest technology also agree more strongly that the issue of production facilities, return on R&D and dominant position in the market matter whereas those who do not transfer the latest technology agree more with reciprocal use of technology and the use of FDI to control firm in different countries. As the level of significance of the test is 0.005, this means that there are two different populations with distinct behaviours.

The first population, firms that transfer the latest technology, can be described as market/investment led. Their purpose of going abroad is to strength their dominant position in a known market, where they have previously had production facilities and where they can increase the return on investments made in R&D. It is

[7] Appendix 7.1 gives an explanation about this statistical technique.

reasonable to assume that they take decisions with more confidence. This has probably originated in their more aggressive attitude towards transferring technology overseas.

The second population, firms that do not transfer the latest technology, can be described as control/relationship led. These firms seems to agree with the statement that they operate abroad through FDI to control enterprises in different countries. Also, agreeing with the importance of the reciprocal use of technology, they match what is stated in the literature[8]. They appear to have a more conservative approach toward a foreign market; this incremental form of internationalisation of the firm is confirmed by the results in Table 7.12.

The fact that they do or do not transfer the latest technology does not appear to be the most important issue in the problem. Firms respond to opportunities of the markets as they occur and considerations about strategies to be followed when going abroad are of secondary importance. As stated before, the firms agreed totally that good opportunities in the new market are an important influence on the decision of transfer technology overseas. Furthermore, it seems that buyer demand issues contribute a great deal to imposing the kind of technology to be transferred. This is corroborated by the pilot study previously made, when interviewed firms agreed unanimously that the buyers are very much aware of what they want.

One item that demonstrated a certain degree of differentiation was related to the ideal modes of transferring technology. Table 7.12 presents the results. The first group that transfer latest technology tend to prefer licensing followed by exporting, and the second group that do not transfer latest technology prefer, first, exporting and, second, licensing. While firms in the first group show a bias towards opening a subsidiary abroad, firms in the second group tend to prefer joint ventures as a first step to a more complete involvement in the new market.

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8 Prasad (1981), Telesio (1984) and Cantwell (1991), among others, treat the subject of reciprocal use of technology with special attention as part of the overall strategy of the firms.

Table 7.12

Ideal modes of technology transfer

(Latest *versus* no latest technology)

Items	Transfer latest technology Frequency Absolute	Relative (%)	Do not transfer latest technology Frequency Absolute	Relative (%)
Opening a subsidiary	4	12.9	2	7.7
Joint venture with affiliate	2	6.5	6	23.1
Licensing to non-related firm	13	41.9	7	26.9
Selling products/services	11	35.5	8	30.8
Others	1	3.2	3	11.5
Total	31	100.0	26	100.0

It seems that firms transferring latest technology prefer doing it to subsidiaries, and the others prefer the use of joint venture. This result agrees with the findings of Mansfield & Romeo (1980), that there is a tendency of TNCs to transfer their latest technology to foreign subsidiaries and their mature technology to affiliates through joint ventures and licensing.

As the results are not conclusive, it is not possible to either accept or not accept this hypothesis.

7.4.3 Relationship with government barriers

In this section, two hypotheses were developed. The first is based on the fact that there are ideal modes of international operation, which sometimes cannot be followed because of circumstances, including the barriers created by foreign governments. The second hypothesis relates directly to the strong presence of governments, determining the rules of the game in the technology transfer matter.

The first hypothesis of this section is the following:

c.1 There is a sequence of modes of international operation, where exporting is the first preferred choice.

To test this hypothesis two questions from the questionnaire were used:

(25) how does your company mainly (not ideally) transfer its technology?

(28) regarding your company's policy, what are the most important modes of transferring technology? Please rank all the items below as to the degree of importance.

As described in section 7.2.3, 69% of respondents declared that their firms mainly use licensing when transferring technology abroad. However, 35% declared that their first option in transferring technology abroad is licensing. Table 7.12, presenting the division of the sample into two groups, shows that firms that do not transfer the latest technology appear to follow the standards of the incremental process of internationalisation of the firms found in the literature[9], where the first international step of the firm would be exporting, followed by licensing and foreign direct investment. The occurrence of joint venture in third position means that this is one more step in the direction of a more solid and permanent presence overseas, through a foreign direct investment. However, firms that transfer the latest technology declared that licensing is their ideal form of international operation.

It seems that firms that do not transfer latest technology have a more traditional approach to the problem. They tend to export first. When the market starts getting more interesting or when host governments begin to make pressure against exporting, they take the second step, i.e., licensing. If the market is a good opportunity, but the firm is still in doubt about the market, they look for an affiliate in the local market to share the risks; thus, if there is a loss, it will not be very severe. Finally, when the market is well known, when the local environment and economy do not present any more surprise for the firm, they go ahead with FDI. Nevertheless, firms that transfer latest technology seem to be more impulsive, reacting quickly to changes in the market and taking the decision that appears to be the best for each situation, and not following a pattern.

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9 See Johanson & Vahlne (1977) and Buckley & Casson (1981) among others.

In an attempt to clarify these results, the two variables were statistically analysed using crosstabulations, and the results are shown in Table 7.13.

Table 7.13

Crosstab between main modes and ideal modes of transfer technology

Main modes	Ideal modes FDI	JV	Licen-sing	Export-ing	Others (*)	Total Absolute	Relative(%)
FDI	3	-	-	3		6	10.9
JV	1	2	1	2		6	10.9
Licensing	2	5	17	10	3	37	67.3
Others(*)	-	-	2	3	1	6	10.9
Total Abs.	6	7	20	18	4	55	
Rel(%)	10.9	12.7	36.4	32.7	7.3		100.0

Chi-square	Value	DF	Significance
Pearson	28.12054	20	0.10658
Likelihood ratio	26.85603	20	0.13936
Mantel-Haenszel	3.38416	1	0.06583

(*)Others: turnkey projects, management contracts, etc

It can be verified by the level of significance (>0.05) that there is no systematic relationship between the two variables. This means that the variables are statistically independent and it is not advisable to make inferences from the sample data to conditions existing in the population. However, the distribution can bring some light to the specific problem and it is being used with this purpose. For example, 10 respondents that mainly transfer technology through licensing would prefer to export their goods, 5 would like to do joint venture and 2 would use FDI. Once more, the data seems broadly to corroborate that firms are responding to opportunities.

On a further examination of whether there are specific characteristics of firms that license and firms that operate abroad through a more formal investment, i.e., FDI and joint venture, a discriminant analysis was run, dividing the sample into these two groups and using the method stepwise. The results are shown in Table 7.14.

Table 7.14

Discriminant analysis of modes of transfer technology

Variables(1)	Means(2) FDI/JV	Licensing	Discriminant Coefficient
RECIPR	2.714	3.800	0.599
COMPARA	1.785	2.950	1.431
ECONOMY	3.285	3.550	-1.549
FDI	2.571	4.550	1.208
FINANCE	4.000	3.150	-0.464
HEAVY	4.428	3.850	-0.511
Number of cases:	14 for FDI/JV 20 for Licensing		
Wilks' lambda= 0.229; Chi-squared = 42.644; D.F.=6; Significance = 0.000			

(1) RECIPR = reciprocal use of technology
COMPARA = comparative advantage in manufacturing the product
ECONOMY = economies of scale of the new plant
FDI = control of firms in different countries through FDI
FINANCE = finance home R&D
HEAVY = competition in home market is heavy

(2) Scale = **1** (totally agree) to **5** (totally disagree)

The table shows that firms that chose FDI/joint venture as ideal forms of technology transfer are the ones who agree more strongly that what matters are reciprocal use of technology, comparative advantage in manufacturing the product, controlling firms in other countries through FDI and achieving economy of scale with new plants. On the other hand, financing the home R&D and looking for new markets to expand activities because of the heavy competition at home are issues that firms which prefer licensing agree upon more strongly. The level of significance of 0.000 confirms that there certainly are two distinct populations.

The first population, who prefers FDI/joint venture, is again control/relationship led. These firms, holding a safe comparative advantage over competitors, think of going abroad through FDI. They also have the objective of improving their technology through exchanges with foreign partners. It is possible to assume that this is a more conservative approach.

The second population can be defined as market/investment led as well. They look at the foreign market as a form of getting funds to finance their home R&D programs and as an opportunity of expanding, since this is no longer feasible in the home market. Licensing is a means to get more funds for their home activities and overcome competition at home.

Owing to similarities observed between the group that transfer the latest technology and the group that prefers licensing, and between the group that do not transfer the latest technology and the group that prefers FDI/joint venture, it was decided to compare the four groups through a crosstabulation, using the results obtained directly from the two discriminant analysis tests (Tables 7.11 and 7.14)[10].

Table 7.15

Crosstab between policy and modes of transferring technology

Policy	Modes			
	FDI	Licensing	Total Absolute	Total Relative (%)
Latest technology	9	25	34	53.1
Not latest technology	16	14	30	46.9
Total Abs.	25	39	64	
Rel(%)	39.1	60.9		100.0
Chi-square	Value	DF	Significance	
Pearson	4.83144	1	0.02795	
Likelihood ratio	4.88134	1	0.02715	
Mantel-Haenszel	4.75595	1	0.02920	

As can be observed in Table 7.15, characteristics of firms which transfer the latest technology seem to mirror those for the licensing group and characteristics of firms which do not transfer the latest technology are similar to those for the FDI/joint venture group. There is a systematic relationship between the two variables and this relationship is borne out by the level of significance of the test. Based on the results, it is possible to conclude that there are two very distinct groups.

On careful examination of the ideal modes of transfer technology, the sequence cannot be proved but the answers of the firms indicate important differences of behaviour. For example, if the sample is split in different groups, such as firms that transfer latest technology and others that do not do it, sector of

10 Appendix 7.2 shows the program used for these statistical tests.

activities, size, the results are different and the existence of an incremental form of international presence of the firm can be confirmed.

The second hypothesis is related strictly to the role of the foreign government intervening in the transactions with technology. The hypothesis is the following:

c.2 Foreign government's policy, restricting the direct sales to its territory, is one of the main incentives for a company to start producing its products/services abroad.

To test this hypothesis, two questions were asked to the respondent, in a direct form. The results are shown in Table 7.16.

Table 7.16

Relationship with foreign governments

Scale	Territorial control restrictions		Import restrictions/ protection of market	
	Frequency		Frequency	
	Absolute	Relative (%)	Absolute	Relative (%)
TA/A	27	45.0	32	52.5
N	11	18.3	7	11.5
D/TD	22	36.7	22	36.0
Total	60	100.0	61	100.0

TA/A = totally agree/agree; N = neutral; D/TD = disagree/totally disagree

As can be noticed, the majority of the respondents declared that there are important territorial control restrictions on local imports and they transfer technology to overcome import restrictions or protection of the domestic market in the host country. Governments of receiving countries are much more active in the process of negotiating technology. They create artificial barriers to their markets and establish the way firms can enter their boundaries. Firms recognise the importance of the role of governments in regulating the mode in which technology can be transferred to their markets. In subsequents crosstabulations, it was evidenced that firms that denied the importance of territorial control restrictions are, in their majority, small size service firms. These firms, traditionally, prefer licensing to transfer their technologies, and with or without restrictions in the new territories against direct sales, they are indifferent to them.

In view of the results of the frequencies the present hypothesis is accepted.

7.4.4 Relationship with firm's attributes

Several attributes of the firm are tested in this section. First R&D activities are examined, presupposing their importance in the process of creation of new technology. Sector, size, ownership and organisation of the firms are equally examined, in an attempt to trace a relationship between these attributes and the way firms transfer technology.

The first hypothesis is related to size of R&D departments:

d.1 Firms with the most sizeable R&D departments are more active in the transfer of technology abroad.

Two questions are used to test this hypothesis. One is related to the number of employees working in the central R&D department and the second is about the number of contracts transferred abroad per year by the firm. The results are shown in Table 7.17

Table 7.17

Size of R&D departments

Number of employees	1 to 5	6 to 20	Over 20	Total Absol.	Total Relat.(%)
	Number of contracts per year				
Less than 200	13	2	-	15	60.0
200 to 1000	5	2	1	8	32.0
Over 1000	-	1	1	2	8.00
Total Abs.	18	5	2	25	
Rel(%)	72.0	20.0	8.0		100.0

Chi-square	Value	DF	Significance
Pearson	9.13426	4	0.05783
Likelihood ratio	9.06650	4	0.05946
Mantel-Haenszel	7.74744	1	0.00538

As can be observed, firms with more than 200 employees in their R&D departments are the ones that most transfer technology abroad. It should be noted that two firms, with giant R&D departments, have a very high number of transfers a year, and two of them declared that they have more than 20 contracts of technology transfer a year. Also, these firms are the biggest in the sample, which corroborates Stoneman's (1988) evidence that the bigger the company the bigger the R&D programme. Stoneman (1988) also explains that high industry R&D is not always a sign of high rates of output because a great amount of inefficiency and repetition may result. Table 7.18 compares the number of employees in R&D department with a ratio composed by the number of contracts divided by the number of employees, i.e., number of contracts per employee per year. The results confirm Stoneman's finding, that the biggest R&D departments do not appear to be the most efficient.

It can be observed that 5 firms with less than 200 employees in R&D have a ratio of up to 4 contracts per employee per year and no one of the biggest departments do not get more than 1.5 contract per employee.

Table 7.18

Ratio of efficiency in transferring technology

Number of employees	Ratio of contracts per employee per year 0.33 to 0.67	0.68 to 1.50	1.51 to 4.0	Total Absol.	Relat.(%)
Less than 200	2	8	5	15	60.0
200 to 1000	5	1	2	8	32.0
Over 1000	-	2	-	2	8.00
Total Abs.	7	11	7	25	
Rel(%)	28.0	44.0	28.0		100.0

Chi-square	Value	DF	Significance
Pearson	9.37770	4	0.05232
Likelihood ratio	10.19703	4	0.03724
Mantel-Haenszel	1.50670	1	0.21964

The analysis of Table 7.17 supports the hypothesis but Table 7.18 suggests that this might be mainly a size effect. In view of the evidence, the present hypothesis is accepted.

It is also widely recognised in the literature[11] that costs of R&D have been increasing considerably in the past few years, and firms should arrange supplementary sources for funding their R&D activities. Transfer of technology is one of the forms of increasing the budget of the R&D departments. A hypothesis was constructed on this matter:

d.2 Firms transfer technology abroad to support their R&D activities.

To test this hypothesis, two statements were presented to respondents for them to mark what would be the position of their firms to those questions. The results are shown in table 7.19 below.

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11 See Prasad (1981), Bertin & Wyatt (1988) among others.

Table 7.19

Support of R&D activities

Scale	Transfer to finance home R&D		Transfer to increase return on investments in R&D	
	Frequency		Frequency	
	Absolute	Relative (%)	Absolute	Relative (%)
TA/A	14	22.5	28	45.2
N	8	12.9	11	17.7
D/TD	40	64.6	23	37.1
Total	62	100.0	62	100.0

TA/A = totally agree/agree; N = neutral; D/TD = disagree/totally disagree

In this table opposite directions in the answers are detected. At the same time, the respondents denied totally that the transfer is responsible for financing R&D at home, and they think it is important to increase return on investments in R&D. The pilot study disclosed the fact that firms do not subsidise their R&D activities with funds raised from selling technology, because, as they explained, the funds are not sufficient to finance those R&D departments, despite being of a considerable amount. To detect which firms agree or disagree with the statement that the sale of technology overseas finances R&D at home, crosstabulations were run, and the results are shown in Tables 7.20 and 7.21 It is demonstrated that the great majority of the firms that disagree with this statement are large size ones, especially from the chemical and engineering sectors. This means that the profits they obtain from selling technology, in spite of being of a significant amount, are little compared to the total budget of the R&D department, usually a large one. This corroborates the results of the pilot study, when the interviewed firms were six large size TNCs. On the other hand, the majority of the firms that agree with the statement belong to the service sector and are small size. For those that have small R&D departments, with a limited budget, each new source of funds for these activities is welcomed.

Table 7.20

Crosstab between finance of home R&D and size

Finance home R&D	Size Small	Medium	Large	Absolute	Relative (%)
TA/A	6	4	4	14	22.6
N	2	1	5	8	12.9
D/TD	10	1	29	40	64.5
Total Abs.	18	6	38	62	
Rel(%)	29.0	9.7	61.3		100.0

Chi-square	Value	DF	Significance
Pearson	11.81729	4	0.01876
Likelihood ratio	11.38223	4	0.02259
Mantel-Haenszel	4.54450	1	0.03302

TA/A = totally agree/agree; N = neutral; D/TD = disagree/totally disagree

Table 7.21

Crosstab between finance of home R&D and sector

Ideal modes	Sector Energy	Chem-ical	Engine-ering	Manuf-acture	Services	Total Abs.	Rel(%)
TA/A	-	5	1	-	8	14	22.6
N	3	-	2	2	1	8	12.9
D/TD	-	15	13	6	6	40	64.5
Total Abs.	3	20	16	8	15	62	
Rel(%)	4.8	32.3	25.8	12.9	24.2		100.0

Chi-square	Value	DF	Significance
Pearson	36.79126	8	0.00001
Likelihood ratio	32.26793	8	0.00008
Mantel-Haenszel	6.08453	1	0.01364

TA/A = totally agree/agree; N = neutral; D/TD = disagree/totally disagree

Comparing the answers to these two questions, it seems that the respondent understood them as being different questions. To finance R&D is not the main reason for transferring technology, but gaining some return from investment made in R&D is important. The R&D centres of the firms studied, specially in the large ones, develop technology primarily for their internal use. Their main activity is to manufacture, not to provide technology to other firms. The transfer of technology is incidental, and occurs within other transactions or as a result of a surplus in the departments. This, on the other hand, does not happen with firms whose main objective is the development of technology for other firms and whose main concerns are to obtain their turnover from the sale of technology. For them the financing of home R&D is very important as well as the increased return on investment on these activities.

It cannot be proved that foreign production is linked to a search for new sources of income for funding home R&D, but, on the other hand, firms recognise that they transfer technology overseas to increase return on investment made in R&D. However, the contradictory results do not present sufficient evidence to support the hypothesis.

The third hypothesis in this section concerns particular characteristics of the firms, relating them to the way technology is transferred. This hypothesis is the following:

d.3 The manner of transfer of technology abroad depends on one or more of the following factors:

a) sector of activities;
b) ownership;
c) nature of production process;
d) qualification of the labour force;
e) nature of corporate orientation;
f) speed of introduction of new products/services into the market.

To test this set of hypotheses, a series of crosstabulations was run, and the results are shown in the following tables.

a) sector of activities

To verify whether the sector of activities has any influence on the way firms transfer technology abroad, a crosstabulation was run with sector of activities and the main form of the transfer of technology. The results are shown in Table 7.22.

Table 7.22

Crosstab between main modes and sector of activities

Main modes	Energy	Chem-ical	Sector Engine-ering	Manuf-acture	Services	Total Absolute	Relative(%)
FDI	-	5	-	1	-	6	9.8
JV	1	2	3	-	1	7	11.5
Licensing	2	10	13	6	11	42	68.9
Others(*)	-	2	1	1	2	6	9.8
Total Abs.	3	19	17	8	14	61	
Rel(%)	4.9	31.1	27.9	13.1	23.0		100.0

Chi-square	Value	DF	Significance
Pearson	13.64468	12	0.32397
Likelihood ratio	16.11469	12	0.18604
Mantel-Haenszel	0.70306	1	0.40176

(*) Others: turnkey project, management contract, exporting.

As expected, licensing continues to be the main mode used by the firms of all the sectors to transfer technology, specially firms of the service sector. FDI is most used by the chemical sector, while energy, engineering and services firms do not utilise this kind of investment, preferring joint ventures instead.

In comparing the ideal forms of transfer technology, some differences appear. Table 7.23 shows the results.

Table 7.23

Crosstab between ideal modes and sector of activities

Ideal modes	Sector Energy	Chem-ical	Engine-ering	Manuf acture	Services	Total Absolute	Relative(%)
FDI	1	4	-	-	1	6	10.6
JV	-	3	3	1	1	8	14.0
Licensing	1	4	5	2	8	20	35.1
Exporting	1	7	5	2	4	19	33.3
Others(*)	-	1	-	2	1	4	7.0
Total Abs.	3	19	17	7	15	57	
Rel(%)	5.3	33.3	22.8	12.3	26.3		100.0

Chi-square	Value	DF	Significance
Pearson	16.48310	16	0.41978
Likelihood ratio	17.14878	16	0.37603
Mantel-Haenszel	0.57316	1	0.44901

(*) Others: turnkey project, management contract.

Exporting becomes an important activity for all the sectors, except for the sector of services. This last sector has a very characteristic behaviour, different from the rest of the sample. As they are a relatively large number (15, 26%), compared with the size of the sample (57), they have a heavy influence on the final results.

The level of significance of the two tests means that the results obtained are peculiar to the firms examined and cannot be extrapolated to the universe. From the scrutiny of the two tables, there cannot be detected a tendency from a sector to take a specific form of internationalisation, with the exception of the sector of services. Then, this sub-hypothesis cannot be accepted.

b) ownership

In the same way, two crosstabulations were run to verify tendencies towards one or another form of transfer technology from firms of different ownership. First, the main modes of transfer are crossed with ownership, as shown in Table 7.24.

Table 7.24

Crosstab between main modes and ownership of firms

Main modes	Ownership Indep-endent	Brit. TNC	Brit. subsid	Foreign TNC	Total Absol.	Relat.(%)
FDI	1	2	2	1	6	9.8
JV	3	2	1	1	7	11.5
Licensing	5	9	26	2	42	68.9
Others(*)	2	2	2	-	6	9.8
Total Abs.	11	15	31	4	61	
Rel(%)	18.0	24.6	50.8	6.6		100.0

Chi-square	Value	DF	Significance
Pearson	10.38950	9	0.31988
Likelihood ratio	10.38989	9	0.31985
Mantel-Haenszel	3.38416	1	0.07724

(*) Others: turnkey project, management contract, exporting.

It is not possible to notice an inclination to a particular mode of transfer of technology by firms with different ownership. All of them do licensing as the main form of commercialising their technology.

Examining the ideal mode of technology transfer, which is shown in Table 7.25, the same scenario is presented. There is no tendency towards specific forms of transfer deriving from ownership. One noticeable difference between the two tables is that British subsidiaries do licensing but they prefer exporting.

The significance level of the two tables leads to the conclusion that the variables are independent. Once again, there is insufficient evidence to support this sub-hypothesis.

Table 7.25

Crosstab between ideal modes and ownership of firms

Ideal modes	Ownership: Independent	Brit. TNC	Brit. subsid	Foreign	Total Absol.	Total Relative(%)
FDI	-	4	1	1	6	10.5
JV	2	1	4	1	8	14.0
Licensing	5	5	9	1	20	35.1
Exporting	4	2	13	2	19	33.3
Others(*)	-	1	3	-	4	7.0
Total Abs.	11	13	30	3	57	
Rel(%)	19.3	22.8	52.6	5.3		100.0

Chi-square	Value	DF	Significance
Pearson	15.65054	12	0.20777
Likelihood ratio	17.05681	12	0.14747
Mantel-Haenszel	0.07501	1	0.78417

(*) Others: turnkey project, management contract.

c) nature of production process;

The nature of the production process was examined through two crosstabulations. The first table, table 7.26, shows the main mode of transfer technology.

There is no peculiarity that could be identified with any characteristic of the production process. In the same manner, firms mainly transfer technology through licensing. Table 7.27 shows the ideal modes of transfer. Once more, the firms are divided between exporting and licensing, when they have an option to choose the process of internationalisation.

Table 7.26

Crosstab between main modes and nature of production process

Main modes	Nature of production: Capital intensive	Nor capital or labour	Labour intensive	Total: Absolute	Relative(%)
FDI	3	2	1	6	9.8
JV	3	3	1	7	11.5
Licensing	16	11	15	42	68.9
Others(*)	2	1	3	6	9.8
Total Abs.	24	17	20	61	
Rel(%)	39.3	27.9	32.8		100.0

Chi-square	Value	DF	Significance
Pearson	3.06637	6	0.80047
Likelihood ratio	3.24217	6	0.77790
Mantel-Haenszel	0.32609	1	0.56797

(*) Others: turnkey project, management contract, exporting.

Table 7.27

Crosstab between ideal modes and nature of production process

Ideal modes	Nature of production: Capital intensive	Nor capital or labour	Labour intensive	Total: Absolute	Relative(%)
FDI	-	2	4	6	10.5
JV	3	3	2	8	14.0
Licensing	9	2	9	20	35.1
Exporting	8	5	6	19	33.3
Others(*)	2	1	1	4	7.0
Total Abs.	22	13	22	57	
Rel(%)	38.6	22.8	38.6		100.0

Chi-square	Value	DF	Significance
Pearson	7.57876	8	0.47566
Likelihood ratio	9.95760	8	0.26801
Mantel-Haenszel	2.32838	1	0.12703

(*) Others: turnkey project, management contract.

The levels of significance show that there is no systematic pattern between the variables, and the existing relationship seems to be random. This sub-hypothesis cannot be accepted because of lack of evidence, since there is no apparent tendency driving firms to react in a particular way, considering their specific production process.

d) qualification of labour force;

Crosstabulations were used to test whether the qualification of the labour force in the firms influences the way they transfer technology abroad. Table 7.28 shows the results of the first test. There can be detected a tendency of firms with a highly skilled labour force to use licence more commonly than other kinds of firms. It should be remembered that most service firms perceived themselves as having a highly skilled labour force. At the same time, it was observed that such firms have been using licensing as virtually their only form of technology transfer. With this exception, no further tendency can be perceived in the table.

In the same way, no tendency can be noticed in the ideal modes of technology transfer, as shown in Table 7.29 Firms tend to change licensing to exporting, when they have the option, and this is a general inclination.

The levels of significance imply that the variables are independent of each other and the relationships shown are random. But the results can describe the sample and explain the behaviour of the firms. In view of the fact that there is insufficient evidence to support this sub-hypothesis, it is rejected.

Table 7.28

Crosstab between main modes and qualification of labour force

Main modes	Labour force: Highly skilled	Skilled	Semi-skilled	Total: Absolute	Relative(%)
FDI	-	5	1	6	10.0
JV	2	3	1	6	10.0
Licensing	21	15	6	42	70.0
Others(*)	3	3	-	6	10.0
Total Abs.	26	26	8	60	
Rel(%)	43.3	43.3	13.3		100.0

Chi-square	Value	DF	Significance
Pearson	7.06044	6	0.31529
Likelihood ratio	9.99518	6	0.12485
Mantel-Haenszel	1.18864	1	0.27560

(*) Others: turnkey project, management contract, exporting.

Table 7.29

Crosstab between ideal modes and qualification of labour force

Ideal modes	Labour force: Highly skilled	Skilled	Semi-skilled	Total: Absolute	Relative(%)
FDI	1	3	1	5	8.9
JV	3	3	2	8	14.3
Licensing	12	6	2	20	35.7
Exporting	8	9	2	19	33.9
Others(*)	2	1	1	4	7.1
Total Abs.	26	22	8	56	
Rel(%)	46.4	39.3	14.3		100.0

Chi-square	Value	DF	Significance
Pearson	4.80944	8	0.77774
Likelihood ratio	4.79300	8	0.77945
Mantel-Haenszel	0.53422	1	0.46484

(*) Others: turnkey project, management contract.

e) **nature of corporate orientation;**

Another characteristic of the firm was examined to determine whether it influences the process of transfer of technology. Table 7.30 shows the results of the first crosstabulation. Firms that are marketing orientated prefer licensing their products.

Table 7.30

Crosstab between main modes and nature of corporate orientation

Main modes	Corporate orientation: Production orientated	Nor production or marketing	Marketing orientated	Total: Absolute	Relative(%)
FDI	3	1	2	6	9.8
JV	1	4	2	7	11.5
Licensing	13	10	19	42	68.9
Others(*)	1	1	4	6	9.8
Total Abs.	18	16	27	61	
Rel(%)	29.5	26.2	44.3		100.0

Chi-square	Value	DF	Significance
Pearson	6.07176	6	0.41520
Likelihood ratio	5.51261	6	0.47993
Mantel-Haenszel	1.48469	1	0.22304

(*) Others: turnkey project, management contract, exporting.

Previous results disclosed that service firms declared they are market orientated. This view on the part of firms can explain the result, since those firms are the ones that use licensing most of the time. In comparing this factor with the ideal mode of technology transfer, as shown in Table 7.31, little difference can be observed, i.e., it is not possible to notice tendencies towards any form of internationalisation of the firms in function of their corporate orientation. Selling products or services directly is an important form of marking the international presence of the firm, but licensing is still the favourite one.

Table 7.31

Crosstab between ideal modes and nature of corporate orientation

Ideal modes	Corporate orientation: Production orientated	Nor production or marketing	Marketing orientated	Total Absolute	Total Relative(%)
FDI	-	3	3	6	10.5
JV	2	1	5	8	14.0
Licensing	7	4	9	20	35.1
Exporting	6	6	7	19	33.3
Others(*)	2	-	2	4	7.0
Total Abs.	17	14	26	57	
Rel(%)	29.8	24.6	45.6		100.0

Chi-square	Value	DF	Significance
Pearson	7.04898	8	0.53136
Likelihood ratio	9.40705	8	0.30913
Mantel-Haenszel	1.68824	1	0.19383

(*) Others: turnkey project, management contract.

The statistical results do not reject the null hypothesis that they are independent variables and the evidences does not support this sub-hypothesis.

f) speed of introduction of new products/services into the market.

Finally, the sub-hypothesis about the speed at which firms introduce products/services into the market was tested, using the same statistical procedures. Table 7.32 shows the first crosstabulation.

Table 7.32

Crosstab between main modes and speed of introduction of new product/service

Main modes	Introduction of new product/service				
	Pioneer producer	Nor pioneer or late	Late producer	Total Absolute	Total Relative(%)
FDI	3	2	1	6	9.8
JV	5	1	1	7	11.5
Licensing	24	14	4	42	68.9
Others(*)	5	1	-	6	9.8
Total Abs.	37	18	6	61	
Rel(%)	60.7	29.5	9.8		100.0

Chi-square	Value	DF	Significance
Pearson	2.98327	6	0.81094
Likelihood ratio	3.63852	6	0.72546
Mantel-Haenszel	1.87146	1	0.17131

(*) Others: turnkey project, management contract, exporting.

There are a considerable number of pioneer firms which declare they do mainly licensing and, one more time, this is explained by the presence of the service firms, which consider themselves pioneer in their majority. No additional tendencies are detected in the table.

Table 7.33 shows the result of the ideal modes of transfer technology and the introduction of new products/services. As can be observed, exporting is again an important option for all the firms, and licensing is the choice of the majority of respondents, but with a very little difference.

Table 7.33

Crosstab between ideal modes and speed of introduction of new product/service

Ideal modes	Introduction of new product/service				
	Pioneer producer	Nor pioneer or late	Late producer	Total Absolute	Total Relative(%)
FDI	4	2	-	6	10.5
JV	5	2	1	8	14.0
Licensing	12	7	1	20	35.1
Exporting	9	7	3	19	33.3
Others(*)	3	1	-	4	7.0
Total Abs.	33	19	5	57	
Rel(%)	57.9	33.3	8.8		100.0

Chi-square	Value	DF	Significance
Pearson	3.42199	8	0.90516
Likelihood ratio	4.16130	8	0.84228
Mantel-Haenszel	0.41291	1	0.52050

(*) Others: turnkey project, management contract.

The levels of significance of the tests are big enough to make acceptable the null hypothesis that the variables are independent and the lack of evidence forces rejection of this sub-hypothesis.

The fourth hypothesis of this section concerns size of firms and is the following:

d.4 Small and medium size firms, which lack sufficient available human and financial resources, tend to utilise licensing to transfer their technologies abroad.

A large number of articles[12] were written on the influence of the size of the firms in the way they transfer technology abroad. The main proposition is that small firms do not do FDI because they usually lack financial and managerial resources to

12 See Solocha et al (1990), Teece (1987), Stobaugh (1984), Buckley & Davies (1981), among others.

invest abroad. Large firms, on the other hand, tend to internalise their markets. To test this hypothesis two crosstabulations were used, in the same way as with the previous hypotheses. The first crosstabulation crossed the main modes of technology transfer with size. The results are shown in Table 7.34.

Table 7.34

Crosstab between main modes and size of firms

Main modes	Size: Small /Medium	Large	Total: Absolute	Relative(%)
FDI	-	6	6	9.8
JV	4	3	7	11.5
Licensing	15	27	42	68.9
Others(*)	3	3	6	9.8
Total Abs.	22	39	61	
Rel(%)	36.1	63.9		100.0

Chi-square	Value	DF	Significance
Pearson	5.24076	3	0.15499
Likelihood ratio	7.13688	3	0.06766
Mantel-Haenszel	3.51579	1	0.06079

(*) Others: turnkey project, management contract, exporting.

From what can be observed in the table, it is reasonable to assume that small size firms do not do FDI. They license most of the time, do joint venture and exporting. But it seems that they do not go abroad through a total investment. On the other hand, large size firms do FDI, despite the fact that their main international activity is through licensing.

Table 7.35 shows the results of the second crosstabulation, when the ideal form of transfer technology was crossed with the size of the firms.

Table 7.35

Crosstab between ideal modes and size of firms

Ideal modes	Size Small /Medium	Large	Total Absolute	Relative(%)
FDI	1	5	6	10.5
JV	5	3	8	14.0
Licensing	9	11	20	35.1
Exporting	7	12	19	33.3
Other (*)	2	2	4	7.0
Total Abs.	24	33	57	
Rel(%)	42.1	57.9		100.0

Chi-square	Value	DF	Significance
Pearson	3.34479	4	0.50187
Likelihood ratio	3.52110	4	0.47468
Mantel-Haenszel	0.06752	1	0.79498

(*) Others: turnkey project, management contract.

It can be observed that the large firms of this sample prefer exporting in the first instance, followed by licensing and FDI. Large firms have a different standard of behaviour from the small ones. Their main stimulus is to sell their product abroad. If they have impediments to do this, they try licensing to get to know the new market better. After the market becomes well known, they do FDI. This finding does not match what was disclosed in the pilot study, when the large TNCs interviewed declared they prefer exporting, followed by FDI, joint venture and, as a last option, licensing.

This sequence of modes of internationalisation, however, does not happen with the small size firms, which chose licensing as the first option. It seems that these firms follow the standard found in the literature[13] that predicts that, owing to lack of resources, they tend to use licensing more frequently. Most of them being service firms, they do not have products to sell abroad and as the exporting of services involves availability of managerial resources in good number, they tend to

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[13] See Buckley & Davies (1981).

prefer licensing to avoid this problem. In the same way, FDI is a distant future for those small firms - only one respondent opted for the choice.

The levels of significance of the two tables do not reveal a systematic pattern. It is clear that small firms tend to prefer licensing to transfer their technologies, but the large firms of the sample also act in the same way. As the results are not conclusive it is not possible either to accept or not accept this hypothesis.

7.4.5 Relationship with foreign market

To examine the relationship between transfer of technology and characteristics of the foreign market, two hypotheses were developed. The first hypothesis is related to the size of the market and a specific form of transfer - FDI. The literature explains that when the market has a large size, there is an incentive for firms to establish foreign production, through FDI [14]. The following hypothesis was tested:

e.1 Firms transfer technology through foreign direct investment to countries that have a large market.

To test the hypothesis, the respondents were asked to circle, on a scale of 1 (totally agree) to 5 (totally disagree), with their firms' practice in mind, the following statement: your company chooses to transfer its technology overseas through FDI to countries that have a large market. Table 7.36 shows the results.

Almost 52% of the respondents declared that they disagree with the statement that the best way to transfer technology to a large market is through FDI. When the respondents were asked what motivates their firms to start producing abroad, the majority of the responses pointed out that the size of the new market was the first reason, as shown in Table 7.3.

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[14] See Erramilli & Rao (1990) and Buckley & Casson (1981), among others.

Table 7.36

FDI and large market

Scale	Transfer through FDI to countries with large market Frequency Absolute	Relative (%)
TA/A	20	32.3
N	10	16.1
D/TD	32	51.6
Total	62	100.0

TA/A = totally agree/agree; N = neutral; D/TD = disagree/totally disagree

The results from the two variables explain that the respondents think the large market is very important, but they do not think that FDI would be the best option. As explained previously in Table 7.9, they consider it important to adopt FDI only when the firm already has ėstablish knowledge of the local environment, economy and market of the host country. It seems that FDI is a well planned decision to be taken when the degree of uncertainty of the new location is near null.

In view of the results of the frequencies, the hypothesis is not accepted.

The second hypothesis in this section is related to the monopolistic or oligopolistic position of the firm in the new market. This refers to several articles in the literature[15] explaining that this is a preferred situation for large firms. The hypothesis in question is:

e.2 Firms transfer technology to markets where they can maintain a monopolistic or oligopolistic position.

To test this hypothesis, the respondents were asked to circle, on a scale of 1 (totally agree) to 5 (totally disagree), with their firms' practice in mind, the following statements:

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15 See Yamin (1991), Bertin & Wyatt (1988), Dunning (1988a), Gilpin (1987), among others.

a) your company chooses to transfer its technology overseas to countries where it can create a dominant position in the market or where there are only a few competitors.

b) your company chooses to transfer its technology overseas to maintin its leading position in the international market.

Table 7.37 above shows the results.

Table 7.37

Dominant position in new market

Scale	Transfer to countries where it can create diminant position Frequency		Transfer to maintain its leading position in international market Frequency	
	Absolute	Relative (%)	Absolute	Relative (%)
TA/A	34	54.8	44	72.1
N	13	21.0	9	14.8
D/TD	15	24.2	8	13.1
Total	62	100.0	61	100.0

TA/A = totally agree/agree; N = neutral; D/TD = disagree/totally disagree

It can be observed that the great majority of the respondents agree with the statements. A monopolistic/oligopolistic position means increase of profits, control of the market, and power to establish the rules of the game when there is opportunity for collusion with another firm. At the same time, maintaining this position is a hard task that only very experienced firms can handle. The competition is usually heavy and the protection of the advantageous position demands a continuous process of renewing, in order to create barriers to new entrants in the market.

As firms agree in both questions that it is important to have a monopolistic/oligopolistic position in the new market, at international level, it seems that this is sufficient evidence to support the hypothesis.

7.5 Conclusion

The analysis of the field work revealed some results that were unexpected. It is likely that the relationships examined are much more complex than the simple interactions explained in the literature. Some points which are widely discussed in several articles do not seem to represent important factors when firms decide to transfer technology abroad. For example, ownership and sector (with exception of the service sector, that will be discussed later) do not seem to be of sufficient importance to discriminate the actions of the firms[16].

The state of the home market does not seem to concern the firms when they decide to go abroad and it is plausible that the goal of internalising the market is more important than worries with domestic competition, when firms attempt to expand their activities. This finding suggests that the process of establishing a presence abroad is basically a strategic decision more concerned about expanding the area of activity rather than compensating for potential loss of demand[17].

Age of technology does not appear to be the most important issue in the matter of transfer[18]. Half of the respondents declared their firms transfer the latest technology and half declared they do not do this. But statistical tests proved that there are two different populations among the transferors of technology: one who transfer the latest technology is market/investment orientated, prefers licensing and is more dynamic and impulsive and the other who do not transfer the latest technology, is control/relationship led, prefers FDI/joint venture, and is more conservative. These two populations present their own characteristics which define the way they deal with technology.

The finding that firms mainly use licensing to transfer their technologies might be related to the mailing list used for the survey. However, in their own ranking of

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16 For example, Dunning (1988b) and Stobaugh (1984), among others, found analogy among ownership and sector and the way firms transfer technology.

17 This is equivalent to the argument proposed by Buckley & Casson (1976) that a key motivating factor to explain the growth of the firms is the internalisation of production.

18 This is one of the main points in Vernon's (1966, 1979) theory about product cycle life.

ideal modes of technology transfer, licensing and exporting appear in first place, followed by joint venture and FDI. This finding more or less confirms the incremental view of the internationalisation of the firm, when the first step is exporting, followed by licensing and FDI. FDI is a path to be taken towards gaining a permanent position in a new market, after it is well known. It seems that while there remains significant uncertainty, licensing is the most used option.

There is evidence that firms with bigger R&D departments are the ones that transfer most technology, but they are not the most efficient ones. Financing home R&D is not a sufficient reason on which to base the decision of transfer technology, but return on investment made in those activities is very much appreciated.

The service firms were the only ones with a specific personality. They have a peculiar behaviour, resulting from their small size, highly skilled labour force, high marketing orientation and their pioneer position in launching new services in the market. They appear to license their technologies more than other firms examined by the survey. Their interest in exporting is relative because they do not have a critical mass of technical personnel available to send abroad on a permanent basis. In addition, they do not intend to use FDI for establishing their presence abroad.

The buyers of technology have an important role in the process of transfer because they can determine the specification of what they are going to receive, specially in relation to age of technology, quality of the desired output, and terms of contracts. Backing their decisions, there is the presence of the host governments. They support their 'buyers' mainly creating artificial barriers to foreigners and approving policies accepting the alien technology in a particular way. Firms recognise their importance in the process of technology transfer and try to adapt to the rules of the game, if the market offers a good degree of attractiveness.

It seems that the decision of firms to go abroad is independent of concerns about consequences of this decision. No worries were expressed about cost of labour, nor about access to strategic raw materials. What matters is not blocking competitors' entry into a good market but dividing this market through collusion and seeking to create and maintain the leading position.

Finally, it should be stressed that the process of going abroad is very complex and cannot be explained by particular reasons. The lack of relationship present in the crosstabulations demonstrated that the reality is very complex and relationships cannot be justified by simple interactions between modes of transfer technology and size, sector, ownership, and so on. The managers respond to opportunities in the market and many times the rationale for the decision taken is not very clear to outsiders because they seem to be the product of the circumstances instead of corporate planning.

In light of the unexpected results obtained in the present survey, the researcher is aware that the present survey only examines a micro-universe of the British industry. Thus, the extrapolation of these results to the whole population must be treated carefully.

CHAPTER 8

CONCLUSIONS AND FUTURE RESEARCH

8.1 Introduction

The mode by which British firms transfer technology abroad and how this is done is the focus of this research. With a long industrial tradition and with several of its firms standing among the biggest and the most successful in the world, British industry offers a good example of behaviour and environment on which such research can be based. The research was carried out having the firm as the unit of analysis. The findings brought out by the survey are significant, as they reveal how and why firms look for new markets overseas. They also contribute to the understanding of the whole process of technology transfer.

This chapter presents a summary of the findings obtained by the research, and develops the implications of these findings at different levels. The limitations of the research are discussed, showing that the results must be treated cautiously. Far from exhausting the subject, this research brings up points which can be explored in future research.

8.2 Summary of findings

The review of the literature indicated little available work in the form of a survey on the process of technology transfer at firm-level in the British industry. A number of articles on the process of internationalisation of American firms can be found, but many of them used available data from indirect sources, such as the US Department of Commerce publications, instead of a direct enquiry. Thus, the contribution of this research is the perspective gained from a survey of firms.

A model was developed, aggregating dimensions that were found dispersed throughout the vast literature on the subject. The dimensions were put in a flow chart, indicating areas where they are supposed to have some influence and how these dimensions are linked. Some of the relationships specified by the model were tested through the survey and the results pointed out that the firms weight these relationships differently.

An unforeseeable finding to emerge from the results was that the state of the home market does not seem to influence firms strongly when making decisions about transferring technology abroad. Saturation of the domestic market and heavy competition at home do not influence the decision to get involved in production overseas. It seems that the process of internationalisation of the firms is more related to expansion of overall area of activity rather than compensation for potential loss of demand in the home market. This finding, however, is consistent with the expected behaviour discussed in the theories of internalisation of production. When the main objective of the firm is to internalise the market, the decision to go international is more important than considerations of the home market.

Much international trade theory has focussed on the issue of the age of technology involved in the transfer process. The results give clear evidence that there are characteristics that discriminate between firms which transfer the latest technology and the ones which do not transfer the latest technology. The firms in the first group are characterised as market/investment led, and have a more aggressive attitude towards transferring technology overseas. The issue of strengthening their dominant position in a market is very important and they transfer technology to have return on their investment in R&D. These firms tend to confirm the findings of Erramilli & Rao (1990) that the experiential knowledge, which is acquired only through operational experience abroad, influences the decision-makers in their commitments of resources to foreign markets. The firms in the second group can be classified as control/relationship led; these tend to control firms in different countries through FDI, agree with the importance of reciprocal use of technology and seem to have a more conservative approach towards foreign markets.

Buyer demand issues are important matters in the process of technology transfer. Buyers are leading edge oriented and can determine the age of technology, the specification of the product/service, and terms of contract. In many countries they have the support of their governments and foreign government policy can influence the way technology is transferred. In spite of transactions being agreements at firm-level, foreign governments have the power to interfere in any movement of technology in their territories and to restrict access to their markets. If governments decide to protect their national industry, as in the case of the infant industry argument, they are able to create for the foreign firm insurmountable barriers, from prohibition of imports to controlled admission to the market only through licensing. Irrespective of the firm's choice of form of technology transfer, the foreign government may override it and impose its own decision concerning the mode of transfer to be adopted: the firm can then decide whether to accept this imposition or abandon the particular market opportunity.

The characteristics of foreign markets strongly influence the firm's decision to transfer technology overseas. The specific market is the main object of concern for them. If firms foresee a good opportunity in a new market, with a high rate of profit, for example, they will take advantage of it. Even if there is a strong presence of a host governments, they will try to deal with its demands and will be able to accept a large number of restrictions to establish themselves in this good new market. The monopolistic/oligopolistic position is often the ideal one in the new market. In addition, maintaining a leading position internationally is a very important reason for deciding to move abroad. These facts concur with Dunning (1991a), in that a firm goes abroad in response to a threat to their ownership advantage or in order to protect their advantages if they do not participate in the foreign market, and that internalisation of production happens when firms decide to exploit a monopolistic situation (Dunning, 1988a).

The results disclosed that the firms which have the most sizeable R&D departments, in spite of being the ones that most transfer technology, are not the most efficient in terms of these activities. In comparing the number of contracts of technology they commercialise per year with the number of employees in their departments, using the admittedly rather crude employee/contract ratio, there appear to be no economies of scale but rather inefficiencies in the system. Large firms do not think that the reason for transferring technology is to finance home R&D, but to have return on investment made in those R&D activities. This is explained by the amount of resources they invest in R&D, which make the profits from these transactions insufficient to maintain the whole department.

When firms decide to go abroad, their attributes (as discussed in Chapter 3) do not seem to be of sufficient importance to discriminate their actions. For example, sector of activities, ownership, nature of production process, qualification of the labour force and so on, do not seem to influence the way firms transfer technology. There is one exception, which is the service sector. Firms belonging to this sector have a distinct behaviour, which is probably influenced by their small size, highly skilled labour force, high marketing orientation and their pioneer position in launching new services in the market. They tend to prefer licensing more than other firms and this can be explained by the fact that they do not have enough resources, human and financial, to invest in other markets on a permanent basis. It may also be related to the speed of market change; this is especially true in the software industry, for example, which has a very fast rate of change.

Another finding of the research is that the new market position is not intended to block competitor entry, but to divide it through an agreement . Firms emphasise the possibility of accord, when they admit that enter into agreements with other firms operating within the foreign country is very important. But they can only get to a position of collusion if they have a competitive advantage supporting their negotiations with competitors who are already established in the new market. This finding seem to be consistent with Hymer (1960/1976), when he says that the two principal reasons for companies to invest abroad are the removal of competition through collusion and the use of the unique advantage of the firm.

In spite of the issue cultural distance not being measured directly, this does not appear to influence the way firms transfer technology. There is no particular form of technology transfer to countries with similar cultural characteristics of Britain. Even the kind of technology transferred are not distinct and indeed any observed difference is mixed. For example, the United States received both the latest and not latest technology from British firms. On the other hand, India, that firms pointed out as the second best commercial partner, only receives the latest technology.

Knowledge of the market matter, when firms decide to go abroad. FDI follows after the market becomes well known. Firms gave evidence that they go international to take advantage of a large market; however, they will only invest in a subsidiary when the new large market has been fully explored and only after there are no more doubts about this new location. There are other ways of exploiting the large market until it becomes completely understood. In the phase of knowledge of the market, licensing seems to be the first choice, followed by joint venture, as preliminary steps to a more definitive presence through FDI. This finding agrees with Buckley & Davies (1981) in that the lack of knowledge of the market explains licensing as a short-term venture to be deserted or substituted by FDI as soon as the necessary information is obtained.

The main mode of transfer of technology is through licensing. Export of goods is the second option of firms, followed by joint venture, and, finally, foreign direct investment. It was not possible to support the incremental mode of internationalisation of the firm, when exporting is the first option, followed by licensing and FDI. However, the division of the sample in sub-groups shows that they behave in different ways and often they support the incremental view. For example, firms that do not transfer the latest technology accept that exporting would ideally be the best option to expand the market of the firm overseas. The same happens when the firms are examined by their sectors, ownership and size: chemical sector, British subsidiaries and large size firms adopt the identical posture.

It is possible to discriminate between firms that prefer FDI/joint venture and firms that prefer licensing to transfer technology abroad. They constitute two distinct groups with different characteristics. For example, the first group, that prefers FDI/joint venture, are control/relationship led. The firms have comparative advantage over competitors, which support their intention of total investment abroad. And the second group, that prefers licensing, is market/investment led. The foreign market is a mean of expanding its activities and getting funds for finance its home R&D programs. Comparing these two groups with the ones who transfer the latest technology or not, it was observed in Chapter 7 that they are the same. The firms that are described as market/investment led transfer their latest technology, prefer licensing as the main form of projecting themselves internationally and are more aggressive, impulsive and dynamic; it is possible also to assume that they go abroad independent of their concerns about the consequences that it may bring to them. The firms that are described as control/relationship oriented are more conservative, follow an incremental mode of internationalisation, do not transfer their latest technology and tend to collude with other firms in foreign markets. These findings suggest an analogy between the present research and the ongoing debate of strategy[1], where two tendencies are discussed: one sees the strategy formation as an emergent and informal approach, responding to unpredictabilities, taking advantages of the learning process (similar to market/investment group); the other, which sees the development of strategy as a process of conceptual design, is more formal, favouring the organisation more than the environment, choosing universal measures to all situations and emphasising one best way to create strategy (similar to control/relationship group).

It should be emphasised that there is no form of technology transfer which appears best in all cases. The environment and the prevailing circumstances will determine the best option for the moment. The process of internationalisation is somewhat context dependent and therefore lead to different behaviours for different firms. The lack of a simple relationship in most of the analyses also implies that subsequent relationships will not be substantially explained by further interactions between, say, size, sector and capital intensity. At the firm-level, it appears to have a

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1 See, for example, Mintzberg's (1990,1991) criticisms to the design school of strategic management, and Ansoff's (1991) reply..

number of distinct sub-groups behaving in different ways reflecting the range of distinct situations for individual firms. However, opportunities in the market are the major influence in the decisions of the managers to seek markets abroad. These decisions often need to be understood as the consequence of a particular moment or circumstance rather than of corporate planning of the firm.

The test of the model of technology transfer demonstrated that the decision of the firms on international operations is not influenced by characteristics of the home market and the age of technology. Similarly, attributes of the firms do not appear to have a major influence. Two dimensions do seem to contribute to the process of technology transfer. Foreign government policy is recognised as very important in defining the process and the attributes of foreign markets are important enough to motivate firms to go abroad.

8.3 Implications of the research

From this research on firm-level transfer of technology, several levels of implications can be drawn. It is hoped that the present research can make a contribution to the understanding of the process. The implications generated by this study are bigger than the micro-level of its universe. Beyond the supplier firms, there are implications for the receivers, the industrial policy-makers as well as foreign governments. The following sub-sections explain the implications of the research for those who are involved in the transfer of technology.

8.3.1 Implications for suppliers

At the level of the supplier firm, the model developed in this research (Figure 3.2) can help managers to decide about the best strategy to use for starting the process of internationalisation. It is reasonable to assume that firms do not usually follow a formal corporate planning procedure for technology strategy formulation. This may be appropriate for many firms that have a good understanding of the process of technology transfer. However, this may not be the most appropriate situation for most of them, who would do better if they had a more formal procedure. If they do so, the model will be useful for helping manager to define a policy of technology transfer, with its viable alternatives and their pros and cons. When establishing a corporate strategy for the internationalisation process, managers have to take into consideration the limitations and the strengths of the firm, according to the factors revealed. So the model can contribute to the planning and decision processes offering a body of references for guiding the decision-makers on choices of technology transfer.

8.3.2 Implications for receivers

When receivers think about transfer of technology as an alternative to investments in domestic R&D, the model can contribute to a framework on which to base decisions on the form of acquiring technology abroad.

The model provides a form of analysing the characteristics of the flow, and it alerts the receivers to the opportunities of engaging in the process of acquiring technology abroad. For example, the model helps verify the importance of government support when it is time to negotiate transfer of technology with a foreign firm.

The research pointed out the important role played by the receivers in the process of negotiation of technology. The receivers have a strong position to influence the whole process and must be aware of it.

8.3.3 Implications for UK industrial policy

It was clearly demonstrated in the research that the action of the home and host governments is very powerful. They can interfere in the process of technology transfer and determine what is possible and what is prohibited. They can establish the partners and all the rules of the game. They can create barriers to the free trade of goods and technology. People responsible for industrial policy must be aware of the power they handle and look for better ways of taking advantage of the situation when forging decisions. They must also be aware of the existence of different groups, with characteristic behaviours, among the firms that transfer technology. These differences are particularly important when decisions on industrial policy must be taken. For example, they should focus more attention on supporting small organisations. These are market led and, most of the time, do not have experience in technology transfer. As licensors of the latest technology, these firms need to act quickly so as not to lose market share to competitors. At such times, they demand all possible support from the authorities.

The generation of technology is strictly related to competitive advantage and only the continuous generation of original technology can maintain this advantage. As reported in the literature, British technological activities continue to be poor in many sectors, when compared with other countries. The country possesses an availability of highly skilled labour, an university system with dynamic characteristics and a long tradition of technological research and development. Industrial policy makers should study new forms of stimuli to R&D in order to improve British technological activity as a whole. For example, the study of the Japanese model of support for R&D activities can bring some new ideas that may help to assure the competitive position of the British industry in the world rankings.

8.3.4 Implications for foreign governments

Although the main objective of this research was to examine the phenomenon of technology transfer at the level of the firm, the results can also have implications on the macro-level. For example, the model formulated can be useful as a guide to the policy makers of foreign countries that are involved with programs of technological development. With the model, presenting the flow of technology from the supplier to the receiver, and with the available alternatives and factors influencing the process, a complete scenario can be constructed, and a more solid base can support discussions on the matter.

At the same time, through the model, the policy-makers can identify the inclination of firms to use one mode of transfer or another, as well as the strengths and weaknesses of their markets. Taking these points into account, a better policy could be designed to encourage the most convenient form of technology transfer, according to their interests.

The world is still in the middle of a huge economic recession. This recession is promoting a shortage of funds for development of new technology or even maintaining the levels of current technologies, when other more basic issues deserve a prioritary attention from the governments, which struggle to balance a small amount of resources with a large amount of necessities for their countries. This is specially true in countries of the Third World. One reliable form of acquiring technological development without intensifying the existing gap, or increasing the list of government's payment, is through the TNCs. Governments must improve relationships with TNCs in order to attract new sources of technology, to have access to foreign technology or even to increase domestic competition. Firms are willing to accept a wide range of restrictions if the new market seems interesting for them, with prospects of good profits. Those firms recognise, for example, that, nowadays, it is difficult to have a share in a foreign market without a local manufacturing presence. They recognise, also, the importance of the presence of the government as an active participant in the negotiation of technology. The foreign governments must also be aware of the role they represent in the process of technology transfer and bargaining power they have to negotiate better dealings with those firms.

8.4 Limitations of the research

This research, as any other, has its limitations, but in recognising them, we can take account of them and remove much of the bias that they can create.

One observation concerns the care that is necessary for the interpretation of the outcome. Although the results are valid for the firms studied by the survey, the sample was a convenience sampling, and so caution is recommended in extrapolating the conclusions of the present research to the whole population. Another problem is the small size of the sample. In addition, the fact that the research used a mailing list of the Licensing Executives Society (LES), a society that includes executives engaged in licensing and other forms of transfer of technology and intellectual property rights, could create a bias in favour of licensing and skew the whole survey. Nevertheless, the LES mailing list is very representative of the British industry as a whole, as explained previously in Chapter 4.

Another limitation of the research concerns the questionnaire. Some questions on the instrument of data collection did not receive any answer from many of the firms. Some of them alleged they could not disclose the data because of confidentiality. As a result of this, some questions had to be omitted, but this fact did not interfere seriously in the results.

There is always a possibility that problems with measurement might be present in the questionnaire; however, tests for validity and reliability of the instrument were run and revealed no bias, as explained in Chapter 5. Any problem with measurement is not large enough to affect the final results.

It is clear from the statistical analysis that a limited number of relationships are significant. Given the size of the sample, this does not invalidate the model as a whole, but rather it opens the way for further study. On the other hand, despite the small size and aggregate nature of the sample, a limited number of relationship were significant, and strongly suggest that various sub-parts of the model may be more dominant than others.

One final comment to be made about the results is that they may only have validity within a particular historical moment. It is reasonable to assume that the same survey being carried out in another economic environment, for example, could generate different results. In the same way, one would expect different results in cross-sectorial or longitudinal studies.

8.5 Future research

The model developed by the present research seems to be valid from the results obtained. However, as several relationships could not be tested owing to lack of time and resources, the tests could become a starting point for future research. One topic which merits a more refined analysis is how British firms which possess products with a high rate of change transfer technology abroad. Is there a tendency for licensing technology instead of investing in a subsidiary abroad still persistent?

One question that should be answered is why so many British firms prefer licensing as the first option? Is it a consequence of a bias caused by the mailing list used by this research or there exist a real tendency towards this form of technology transfer?

A third area of research that should be explored is the behaviour of British firms towards competition. The research suggests the tendency for British firms to collude with competitors in technology transfer in a new market. Is this a British phenomenon or is it a response by firms under specific conditions?

Another fertile area of research should be the examination of changes in the standards of technology transfer from British firms to firms in Western Europe 1992. Will it mean a stronger cooperation between firms and an increase in the number of cross-licensing agreements?

Transfer of technology to firms in Eastern Europe also deserves a special study. Until recently joint ventures and licensing were the main modes of transfer of technology to those countries. With the ongoing process of mass privatisation in that part of the world, it would be interesting to know whether the number of British FDI, for example, has increased there.

Further research could examine whether, with the rise of TNCs from NICs of very different parts of the world, such as Singapore, Korea, Mexico, Brazil, the cultural distance is an important influence on the way firms transfer technology.

And finally, in order to obtain further empirical evidence to test the model, intensive case studies, involving two or three firms, preferably of different sizes, could be developed. In such case studies, the mode of internationalisation chosen by the firms would be measured, having in mind the dimensions shown in Table 3.2.

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APPENDICES

APPENDIX 1.1

OPERATIONAL DEFINITIONS

OPERATIONAL DEFINITIONS

To limit the range of the research, a series of operational definitions are made, based on the literature and on the study of the process of technology transfer.

1. Technology

In the present research the following definitions will be used[1]:

a) Technology

Technology is the knowledge of transforming inputs into outputs.

b) Transfer of technology

Technology transfer is a process by which knowledge and other items related to technology are transferred from one economic agent to another[2].

c) International transfer of technology

International technology transfer is any kind of transaction involving the transfer of knowledge and other items related to technology from one country (supplier) to another (receiver).

2. Ownership of firms

The firms participating in the survey were divided into five categories:

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1 In Chapter 2 it is found a discussion about the subject.

2 Professor Paul Stoneman is acknowledged for his helpful comments on the definitions of technology and transfer of technology.

a) British company

For the purpose of this research, a British company is considered to be a firm whose stocks are owned by British people, and which has its headquarters in Britain and is free of outside control in taking decisions. In practice, in the case of public companies, the specific ownership criterion is actually that the stocks are only quoted on UK exchanges.

b) Transnational company

A transnational company[3] is the company which owns one or more subsidiaries in different countries, and whose production/services are being performed in more than one country.

c) British transnational corporation

A British transnational corporation is the British firm that has its headquarters in Britain, the majority of its stock controlled by British people, and has subsidiaries and/or affiliates in other countries.

d) Subsidiary

A subsidiary is a business firm that is controlled by another company, called the parent company, which owns most or all of its stock[4]. For the purpose of this research, only the wholly owned subsidiary will be considered as such.

e) Affiliate

An affiliate is a business firm that has part of its stock controlled by another company[5].

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3 The term transnational corporation was chosen instead of multinational enterprise, according to Dunning (1988) and Buckley & Casson (1987) among others, or multinational corporation, according to Mansfield & Romeo (1980) and Cantwell (1989) among others, to follow the official choice of the United Nations Centre on Transnational Corporations. This definition is also adopted by Jenkins (1987) and Stoneman (1991), among others.

4 Definition from Ammer & Ammer (1984).

5 This definition finds support in Stopford (1982).

3. Size of firms

A considerable controversy exists in this area. One criterion for size is the turnover of the firm in relation to other firms in the sector; another criterion is the final production; there are still other criteria, such as shares of its market, or ownership[6]. For the purpose of this research, the definition adopted by the Centre of Small and Medium Size Enterprises of the University of Warwick is followed:

a) Small firms: those employing as many as 199 people;

b) Medium firms: those employing between 200 and 499 people;

c) Large firms: those employing more than 500 people.

It is recognised that the number of employees is not an ideal index and can constitute a bias especially in the case of capital intensive firms. The observation of the firms studied, however, demonstrated that the index could be used without real harm.

4. Sector of activities

The choice of sector of activities was based on the UKSIC codes[7]. In the sample studied in this research, firms were not found in some of the sectors ; there were, however, firms in the following divisions:

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6 For a discussion of the criteria of classification of size of firms, see Bolton (1971).

7 U.K.S.I.C., Standard Industrial Classification for the United Kingdom, Central Statistical Office

a) Division 1 : Energy and water supply industries

b) Division 2 : Extraction of minerals and ores other than fuels; manufacture of metals; mineral products and chemicals

c) Division 3 : Metal goods, engineering and vehicle industries

d) Division 4 : Other manufacturing industries

e) Division 8/9 : Banking, finance, insurance, business services, leasing and other services

It was decided to join divisions 8 and 9 because the number of firms in each division was small and the division was considered as a general division of services. In the case of transnational corporations and multi-product firms, the division was chosen according to the product that contributed most to the turnover of the firm.

APPENDIX 3.1

MINI-CASE STUDY:

DESCRIPTION AND FINDINGS

Table I

Mini-case studies on technology transfer

Company	Characteristics of the company			Characteristics of the recipitent market		Country stage of development	Main modes of technology transfer
	Size	Ownership	Production	Size	Structure		
P1 (1)	Large	TNC	Process	Large	Oligopoly	No main client	Joint venture
P2 (1)	Large	TNC	Process	Large	Oligopoly	No main client	Joint venture
P3 (1)	Large	TNC	Process	Large	Oligopoly	Developing countries	Direct Investment
T1 (2)	Large	TNC	Services	Large	Oligopoly	Developed countries	Licence
T2 (2)	Large	TNC	Products	Large	Oligopoly	Developed countries	Direct Investment
T3 (2)	Large	TNC	Products	Large	Oligopoly	No main client	Joint venture

(1) P1 3 – Petroleum companies
(2) T1 3 – Telecommunication companies

Table II

Reasons for transferring technology

Company	Why transfer technology?	Connection with funding R&D	What to transfer?
P1	Business of exploring, not business of transferring technology	Most of the transfer is made inside the group	Transfers new technology, when doing it
P2	Does not develop technology to put third parties in business; only if the technology is not strategic for the company	Does not expect return from R&D	Transfers new technology
P3	Since it is difficult to invest and have a 100% ownership, does joint venture	The income is considerable, but small comparing with amount of investments	Most of the technology transferred is up-to-date; it is a trouble to license old technology
T1	Not a manufacturer therefore wants firms to make products; also transfers to exchange technology or not to waste investments	Does not research for licensing purposes only	Wants companies to manufacture what is developed; usually licenses several firms to standardises the product and lower the costs
T2	First option is export; if demand exists and market is large to support local plant for a long period, transfers; wants to retain the market share where export is not possible	Does not sell technology to raise funds for R&D	Only transfer technology that is in public demand; the countries do not accept old technology; it is a tendency that has grown in the last few years
T3	If there is no possibility of selling products, then transfer; does not give the market away; creates a return stream for the future	It helps but the amount is very small comparing with most development	Only transfers latest technology because clients are very well informed and do not accept old technology

Table III

Mechanism for Transferring Technology

Comp.	How to transfer technology	Department responsible for technology transfer	Who decides about the transfer	Existence of formal procedures for transfer	Agents to sell technology	Kind of investment abroad	Centralisation of R&D	Main client
P1	Will not give any advantages to competitors	Engineering Division	Units are autonomous	General guide-lines	No official agent	Joint venture	Two big R&D Centres for the whole group	No main client
P2	Each transfer of technology is different	Engineering & Patent Division	There is autonomy for unit	General guide-lines	No official agent	Joint venture for commodity-type technology	Two big R&D Centres for the whole group	No main client
P3	It varies according to the country	Product & Licensing Division	Shareholder representatives have force; last word belongs to Committee Managing Director	General guide-lines	Operating companies all over the world establish contacts	Direct investment	Several R&D Centres in several countries	Developing countries - developed countries do not make investments anymore in the area
T1	Each case is different	Intellectual Property unit seeks sales in the world	Intellectual Property Unit and R&D unit; operating units give the final world	Only if it happens inside the company	No agents for selling products; only for consultancy	Licence for standardise products	Very active R&D Centre for the whole group	The Triad
T2	Transfer at pace of the country	Each unit has autonomy	Decision made in units; Board of Directors has a final word	There are formal procedures, but they are not evident	Agents get inquiries for technology and come straight back to them	Case by case decision; licence is the very last option	Each unit has a R&D Centre	Vary each year
T3	Tailor the best system to the occasion	Each division does its part of the whole	Divisions decide; Board of Directors has a final word	Own guide-lines for details and general guide-lines	No official agents	Joint venture and contracts to supply the inputs	Each division has a R&D Centre	Where there is market opportunity, there is interest

APPENDIX 4.1

QUESTIONNAIRE USED

WARWICK BUSINESS SCHOOL

MARKETING AND STRATEGIC MANAGEMENT GROUP

(For data process use)

SURVEY ON INTERNATIONAL TRANSFER OF TECHNOLOGY

The objective of this study is to examine strategies used by British industry to transfer their technologies to other countries on the basis of firm to firm links. It is carried out within the Marketing and Strategic Management Group of the Warwick Business School of the University of Warwick.

For the purpose of this questionnaire, INTERNATIONAL TRANSFER OF TECHNOLOGY is defined as any kind of transaction involving the transfer of any kind of knowledge, idea or information from one country to another with the aim of generating a product or service in a different location to fulfil a necessity. Not included in this definition are the sale of capital goods per se, the spontaneous migration of skilled manpower and the diffusion of innovation through publications and conferences.

All replies will be treated as strictly confidential.

DIRECTIONS

Please tick one answer for each question unless otherwise instructed. In the questions which have scale numbers, circle one number corresponding to the appropriate answer.

Please send the completed questionnaire to:

Professor Robin Wensley
Chairman
Warwick Business School
University of Warwick
Coventry, CV4 7AL

PART I : COMPANY BACKGROUND

1. **How can the nature of the production process\services in your company be best classified? Please circle the appropriate number.**

Highly Capital Intensive				Highly Labour Intensive
1	2	3	4	5

2. **If your company is a manufacturer, how can the type of production procedures be best classified?**

( ) Batch
( ) Line
( ) Process

3. **How can the majority of the labour in your company be best classified?**

( ) highly skilled labour
( ) skilled labour
( ) semi-skilled labour
( ) unskilled labour

4. **How can your company be best described, according to the nature of its corporate orientation?**

Strongly Production Oriented				Strongly Marketing Oriented
1	2	3	4	5

5. **By comparison with its main competitors, how can your company be best described in terms of introducing new products\services into the market? Please circle the appropriate number.**

Pioneer Producer				Very Late Producer
1	2	3	4	5

6. **What is the current market share of your company's main product?**

a. Domestic market		b. World market:	
( )	0 - 5%	( )	0 - 5%
( )	6 - 10%	( )	6 - 10%
( )	11 - 15%	( )	11 - 15%
( )	16 - 20%	( )	16 - 20%
( )	21 - 25%	( )	21 - 25%
( )	more than 25%	( )	more than 25%

7. **What are the main products\services of your company, and how much do they contribute to the company's total sales?**

Products\Services	% of turnover in 1989
______________________________	______________
______________________________	______________
______________________________	______________
______________________________	______________
______________________________	______________

PART II : R & D ACTIVITY

8. **Does your company possess a central R & D Department?**

( ) Yes
( ) No

9. **If yes, how many employees work in the central R & D Department, on average?**

Number of employees: ________

10. **If no, in which department(s) is this activity carried out?**

____

11. What is the main source of funding for the R & D activity in your company? Please rank the three most important to your company.

( ) Central budget
( ) Governmental funds
( ) International transfer of technology
( ) Internal customers
( ) External customers
( ) Other (please specify): ____________________

12. What is the current annual budget of the central R & D Department?

________________ million £ *or*

__________ % of turnover

PART III : TRANSFER OF TECHNOLOGY

13. Does your company have a special department, responsible for the transferring of technology?

( ) Yes
( ) No

14. If yes, what is the name of the department and how many employees work in this department?

Name:______________________________________

Number of employees: _______

15. If no, which department is responsible within the organisation for dealing with this kind of activity?

____

16. What kind of activity does the department do? Please rank the three most important to your company.

( ) Negotiation of technology
( ) Commercialisation of technology
( ) Following up of projects
( ) Technical assistance
( ) Management of projects
( ) Other (please specify:)____________________

17. **How many technology transfer contracts abroad does your company have, on average?**

_____ per year

18. **What type of technology does your company transfer overseas? Please rank the three most important to your company.**

( ) Product
( ) Process
( ) Equipment
( ) Management
( ) Engineering Project
( ) Other (please specify): ________________

19. **Does your company have a policy of transferring its latest technology abroad?**

( ) Yes
( ) No (go to question 22)

20. **If yes, what percentage of your company's technology transfer revenues represents the sale of technology that is still being used commercially in the British market?**

______ %

21. **What makes your company consider transferring your latest technology abroad? Please rank the three most important reasons to your company.**

( ) The technical support to start up plants/services based on the old technology is not available anymore
( ) The users are leading edge oriented
( ) The clients only accept the latest technology
( ) The buyers are very much aware of what they want
( ) The company do not have the means with which to train people in old technology
( ) Other (please specify): __________________

22. **If no, what kind of technology is usually transferred overseas?**

( ) Technology that is not being used commercially in the domestic market any more
( ) Technology that got old
( ) Technology that the company is unable to exploit adequately in the domestic market
( ) Technology that is in the public domain
( ) Other (please specify): __________________

23. When your company transfers its technology, who are its main clients? Please rank the three most important to your company.

( ) Subsidiaries
( ) Affiliates
( ) Other multinational companies
( ) Local companies in developed countries
( ) Local companies in East European countries
( ) Local companies in developing countries
( ) Other (please specify):___________________

24. Is there a particular country that has become your main client of technology in the last few years?

( ) Yes (please specify):___________________
( ) No

25. How does your company mainly (not ideally) transfer its technology?

( ) Foreign direct investment
( ) Licence
( ) Joint venture
( ) Turnkey projects
( ) Management contract
( ) Other (please specify): ___________________

26. How is the payment usually received when transferring technology? Please rank the three most important to your company.

( ) Royalties
( ) Technical assistance fees
( ) Supply of raw materials
( ) Supply of component parts
( ) Supply of machinery
( ) Management fees
( ) Engineering fees
( ) Other (please specify):___________________

27. If your company used licensing to transfer its technology overseas, why did it choose this channel?

( ) Capacity of recipient company to operate the new technology
( ) Shortage of funds for direct investment
( ) Shortage of management for investment abroad
( ) Host market too small for profitable investment
( ) Strong competition in the new market
( ) Politically risky situation for investment
( ) Pressures of the host government
( ) Other (please specify): ___________________

28. **Regarding your company's policy, what are the most important modes of transferring technology ? Please rank all the items below as to the degree of importance?**

( ) Opening a subsidiary
( ) Doing Joint Venture with affiliates
( ) Licensing technology to a non-related company
( ) Selling products\services directly
( ) Other (please specify): ____________________

29. **What motivates your company to start producing its products/services abroad rather than export from home? Please rank the three most important to your company.**

( ) The size of the new market
( ) The creation of a return stream for the future
( ) The foreign governments' policies, restricting the direct sale to them
( ) The high cost of labour in the home market
( ) Other (please specify): ____________________

30. **When your company decides to transfer its technology overseas, how important is each of the items in the list below? Please circle the appropriate number.**

Scale of 1 to 5 - 1 = very important - 5 = no importance

(1) Supply of additional know-how for your company 1 2 3 4 5

(2) Reciprocal use of technology 1 2 3 4 5

(3) Territorial control restrictions on local imports 1 2 3 4 5

(4) Lower labour costs in the new country 1 2 3 4 5

(5) Lack of funds for investment in your company 1 2 3 4 5

(6) Good opportunities in new market 1 2 3 4 5

(7) Comparative advantage of your company in manufacturing the product 1 2 3 4 5

(8) Economies of scale of the new plant 1 2 3 4 5

(9) Availability of managerial skills in your company 1 2 3 4 5

31. **With company practice in mind, how important is each of the items below in considering the destination of the transfer of technology? Please circle the appropriate number.**

Scale of 1 to 5 - 1 = very important; 5 = no importance

(1) Transfer to countries where your company has production facilities 1 2 3 4 5

(2) Transfer to countries where your company has entered into agreements with other organisations operating within the foreign country 1 2 3 4 5

(3) Transfer to countries where your company wishes to block competitors' entry 1 2 3 4 5

(4) Transfer to countries where your company wants to have access to strategic raw materials 1 2 3 4 5

(5) Transfer to countries where your company has competitive advantages over other companies 1 2 3 4 5

32. **With company practice in mind, please circle the appropriate number showing the degree to which you agree or disagree with each of the following statements.**

Scale of 1 to 5 - 1 = totally agree ; 5 = totally disagree

(1) Your company chooses to transfer its technology overseas when it is not profitable to produce anymore in the home country 1 2 3 4 5

(2) Technology is transferred to promote its rapid standardisation 1 2 3 4 5

(3) Your company chooses to transfer its technology overseas through foreign direct investment to control firms in different countries 1 2 3 4 5

(4) Your company chooses to transfer its technology overseas to finance its home R & D 1 2 3 4 5

(5) Your company chooses to transfer its technology overseas to increase the return on investment made in R & D 1 2 3 4 5

(6) Your company chooses to transfer its technology overseas to countries where it can create a dominant position in the market or there are only a few competitors 1 2 3 4 5

(7) Your company chooses to transfer its technology overseas when your home market is saturated 1 2 3 4 5

(8) Your company chooses to transfer its technology overseas when the competition in your home market is heavy 1 2 3 4 5

Question 32 continues on next page.

32. Continued....

Scale of 1 to 5 - 1 = totally agree ; 5 = totally disagree

(9) Your company chooses to transfer its technology overseas through foreign direct investment to countries that have a large market 1 2 3 4 5

(10) When the technology gets mature, licensing and joint ventures become more important channels rather than foreign direct investment 1 2 3 4 5

(11) Your company chooses to transfer its technology overseas when there are import restriction or protection of domestic market in the host country 1 2 3 4 5

(12) Your company chooses to transfer its technology overseas to maintain its leading position in the international market . . . 1 2 3 4 5

(13) The transfer of technology to a developed country soon creates competition in the international market 1 2 3 4 5

(14) Your company chooses to transfer its technology overseas through foreign direct investment to reduce the risk of loss to potential competitors 1 2 3 4 5

(15) Your company chooses to transfer its technology overseas through licensing to minimise management costs 1 2 3 4 5

(16) Your company chooses to transfer its technology overseas through foreign direct investment when it knows well the local environment, economy and market of the host country 1 2 3 4 5

(17) Your company chooses to transfer its technology overseas through joint ventures to speed the entry in a new market with small investment 1 2 3 4 5

(18) Your company chooses to transfer its technology overseas through licensing in order to facilitate access to patents and technologies of the licensee 1 2 3 4 5

(19) Your company chooses to transfer its technology overseas only when this technology is a widely available 1 2 3 4 5

33. Indicate the relative importance of the following factors that can influence the receiver's choice of technology. Please allocate 100 points across these factors.

_____ Time necessary to start production in industrial scale.

_____ Adequacy of raw materials and labour conditions in the country of the receiver.

_____ Characteristics and quality of the products to be manufactured with the technology, and adequacy to the national market of the receiver.

_____ Price of technology and operational costs.

_____ Technological assistance.

_____ Know-how for technical assistance to the clients of the company of the receiver.

_____ Bureaucracy of negotiation and legal papers related to the acquiring of technology.

_____ Reputation of the supplier.

_____ Efficiency of the technology supplier in helping the receiver company, giving information and facilitating the transference.

_____ Other (please specify):_____

======
100

PART IV : RESPONDENT DETAILS

Note: Omit this section if you prefer to remain anonymous.

Name of respondent: . . . .

Position: . . . .

. . . .

Name of company: . . . .

. . . .

Date: . . . .

APPENDIX 4.2

SEMI-STRUCTURED INTERVIEW

TRANSFER OF TECHNOLOGY - INTERVIEW STRUCTURE

01 - Explain the process of technology transfer inside the company. How does it happen in the company?

02 - Who are the people responsible for dealing with the area?

03 - Does your company make any differentiation between markets when it tries to transfer its technology?

04 - What sort of technologies are mainly transferred?

05 - Does your company have different departments for different ways of transferring technology?

06 - Is there a central department dealing with it?

07 - What are the functions of this department?

08 - Who decides about FDI? And Licensing? And Joint Venture? And others?

09 - Who makes the main decision?

10 - Who are the main technology transfer clients of your company?

11 - Is there any special reason that make them main clients?

12 - Does the company have agents to sell technology in countries where it doesn´t have any subsidiary or affiliate?

13 - Do technical factors or marketing factors determine the way the technology is transferred? Do they determine to where the technology is transferred?

14 - Is the lack of resources for R & D a very important reason for selling technology abroad?

15 - Is the commercialisation of technology an important source of funds for the company?

16 - Is there any formal procedure for transferring technology in your company?

17 - Is it a policy of your company to transfer only technology that is no longer profitable for you?

18 - Is there any formal link between British companies that transfer technology abroad?

19 - Do you happen to know what the process of technology transfer is like in other companies?

APPENDIX 4.3

FIRST COVER LETTER

WARWICK
BUSINESS SCHOOL

PROFESSOR
ROBIN WENSLEY
CHAIRMAN

27 June 1990
Ref.WBS-306/69

Dear Mr.

The Marketing and Strategic Management Group of the Warwick Business School of the University of Warwick is studying the strategies adopted by British companies to transfer their technologies to other countries. The objective of the research is to understand the process used by the British industry and, hence, offer suggestions on how to improve the mode of transfer of technology.

We are, therefore, very interested in learning about the experience of your company in transferring the technology you develop to other companies in different countries. Your contribution is essential for the purpose of the research and so we would like to ask you to spend some time completing the attached questionnaire.

All replies will be treated as strictly confidential. Data on individual firms will not be available to any external parties and the identification of any company involved in the research will be made only with its formal permission.

The researcher in charge of this project, Carlos Hemais, will call you in approximately ten days to see if you have any problem with this questionnaire. If you wish to contact him before that time on his telephone (0203) 524-504, he will be happy to clarify any doubt you have .

Please use the self-stamped envelop to send the questionnaire back to us.

Thank you in advance for your collaboration.

Yours sincerely,

J.R.C. Wensley
Chairman

APPENDIX 4.4

LES COVER LETTER

LES

LICENSING EXECUTIVES SOCIETY
BRITAIN AND IRELAND

Phone 081 397 5141
Telex 929612
Facsimile 081 391 5744
Date 27 June 1990

From: Dr.R.C.Cass
Borax Reseach Ltd.,
Cox Lane
Chessington
Surrey KT9 1SJ

Dear LES Members,

I should like to draw your attention to the enclosed questionnaire relating to the International transfer of technology. It forms part of a project being undertaken by the University of Warwick Business School.

The Council of LES Britain and Ireland are supportive of the project and request that if possible recipients collaborate by completing the questionnaire as far as they are able to do so.

The results of the survey will eventually be made available to the Society and it is intended that a summary of them will be published in Exchange.

Yours sincerely,

Roy Cass

R.C.Cass (Hon.Sec.)

APPENDIX 4.5

SECOND COVER LETTER

WARWICK
BUSINESS SCHOOL

27 July 1990
Ref.WBS-306/5a

Dear Mr.

At the end of June we sent out a questionnaire on international transfer of technology, as part of a research initiative by the Warwick Business School.

This initiative has the support of the Licensing Executives Society (see attached letter) and the Society regards the research as having important implications for its members, of which you are one. Warwick Business School and the LES will be co-operating in disseminating the research findings to the membership.

It is possible that you did not receive the first questionnaire, therefore we enclose a second. If you are not the appropriate person in your firm to answer the questionnaire, please forward it to the right one. We hope you will participate.

If you need any help in answering the questionnaire, please call me at (0203)524-504, and I will be happy to clarify any doubt you have.

Thank you very much for all your help.

Carlos Hemais
Marketing & Strategic Management Group

APPENDIX 4.6

THIRD COVER LETTER

24 September 1990
Ref.WBS1

WARWICK
BUSINESS SCHOOL

PROFESSOR
ROBIN WENSLEY
CHAIRMAN

Dear Mr.

We sent for your attention a questionnaire on the international transfer of technology, as part of a project developed under my supervision in the Warwick Business School.

As you can see in the attached letter, the Licensing Executives Society, in which your company is represented, understood the importance of this project and offered its support to us. We understand that you often receive similar requests and that it is difficult to find spare time for things that you may not see as being of primary importance to your company. But we would like to emphasize the significance of your participation, as with it we can make policy recommendations of use to all firms involved in technology transfer.

Many firms have already sent back the questionnaire. Until now, however, we have not received a reply from your company. Is it possible that the correspondence did not reach you? If so, we are enclosing a new questionnaire, as well as a self-addressed stamped envelope, so that your responses will be included in the study.

Please forward the questionnaire to the appropriate person in your firm if you do not think you are the right one to answer it, but otherwise we are counting on your participation.

Thank you very much for all your help.

J.R.C. Wensley
Chairman

APPENDIX 5.1

CODE BOOK

CODE BOOK

```
TITLE ' BRITISH TECHNOLOGY TRANSFER'

data list file=joint
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          labour 14
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          domar 20
          womar 22
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          employ 26-31
          budget 34-39
          turnover 42-47
          transfer 50
          contract 54
          policy 58
          revenue 60
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          territ 24
          lower 25
          lack 26
          good 27
          compara 28
          economy 29
          availabi 30
          facil 34
          organis 35
          block 36
          raw 37
          advant 38
          profit 40
          rapid 41
          fdi 42
          finance 43
          invest 44
          create 45
          home 46
          heavy 47
          large 48
          mature 49
          domestic 50
          lead 51
          develop 52
          risk 53
          minimise 54
          local 55
          jv 56
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          knownow 42-47
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          reputat 54-59
          efficien 60-65
          other 66-71
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          q16p1 to q16p6 12-17
          q18p1 to q18p6 20-25
          q21p1 to q21p6 27-32
          q22p1 to q22p5 34-38
          q23p1 to q23p7 40-46
          q26p1 to q26p8 48-55
          q28p1 to q28p5 57-61
          q29p1 to q29p5 63-67

Missing values nature to q29p5 (9)

Variable labels
     Nature 'Nature of production process-services'
     Manufac 'Manufacturer, best classification'
     Labour 'Labour, best classification'
     Corpora 'Corpor. orientation,best classification'
     Introduc 'Introd. new products,best classification'
     Domar 'Current domestic market share?'
     Womar 'Current world market share?'
     Central 'Do you have central R&D Dept?'
     Employ  'Number of employees in central R&D'
     Budget 'Current annual budget for R&D?'
     Turnover '% of turnover it represents?'
     Transfer 'Special dept for TT'
     Contract 'TT contracts per year'
     Policy 'Transfer of latest technology?'
     Revenue ' % of the sale of new technol?'
     Country 'Is there a main country client?'
     Mainly 'How is TT in your company?'
     Channel 'Why choose licensing for transfer?'
     Supply '"Supply of additional know how"'
     Recipr '"Reciprocal use of technology"'
     Territ '"Territ.restrictions on local imports"'
     Lower '"Lower labour in new country"'
     Lack '"Lack of funds for invest"'
     Good '"Good opportunities in new market"'
     Compara '"Comparative advantage in new product"'
     Economy '"Economies of scale of new plant"'
     Availabi '"Availability of managerial skills"'
     Facil '"Countries w.production facilities"'
     Organis '"Agreements w.companies in same country"'
     Block '"To block competitor  entry"'
     Raw '"To have access to raw materials"'
     Advant '"To use competitive advantages"'
```

```
Profit ´"Produce home is not profitable"´
Rapid ´"Promotion of rapid standardisation"´
FDI ´"FDI-control firms in different countries"´
Finance ´"To finance home R&D"´
Invest ´"To increase ROI in R&D"´
Create ´"To create dominant position in the market"´
Home ´"Home market is saturated"´
Heavy ´"When competition is heavy in home market"´
Large ´"Through FDI to large markets"´
Mature ´"Through licensing-JV mature technology"´
Domestic ´When there are import restrictions"´
Lead ´"To maintain leading position overseas"´
Develop ´"To developed country creates competition"´
Risk ´"Through FDI to reduce risk of losing market"´
Minimise ´"Through licensing to minimise costs"´
Local ´"Through FDI when the environment is known"´
JV ´"Through JV to speed entry in new market"´
Patent ´"Through licensing to access patents"´
Wide ´"When technology is widely available"´
Time ´"Time necessary to start production"´
Adequacy ´"Adequacy of raw materials-labour conditions"´
Charact ´"Characteristics of the product"´
Price ´"Price of technology-operational costs"´
Assist ´"Technological assistance"´
Knowhow ´"Know how for assist clients"´
Bureauc ´"Bureaucracy of negotiation "´
Reputat ´"Reputation of supplier"´
Efficien ´"Efficiency in helping the receiver"´
Other ´"Other"´
```

Value labels

```
Nature
1 ´Highly capital´
2 ´Capital intensive´
3 ´Nor capital-labour´
4 ´Labour intensive´
5 ´Highly labour´
/
Manufac
1 ´Batch´
2 ´Line´
3 ´Process´
/
Labour
1 ´Highly skilled´
2 ´Skilled labour´
3 ´Semi skilled labour´
4 ´Unskilled labour´
/
```

Corpora
1 ´Strongly production´
2 ´Production oriented´
3 ´Nor production-market´
4 ´Market oriented´
5 ´Strongly market´
/
Introduc
1 ´Pioner producer´
2 ´Early producer´
3 ´Nor pioner or late producer´
4 ´Late producer´
5 ´Very late producer´
/
Domar to Womar
1 ´0-5%´
2 ´5-10%´
3 ´11-15%´
4 ´16-20%´
5 ´20-25%´
6 ´More than 25%´
/
Central
1 ´Yes´
2 ´No´
/
Employ
1 ´Less than 49´
2 ´50-199´
3 ´200-499´
4 ´500-1000´
5 ´Over 1000´
/
Budget
1 ´Less than 1 million´
2 ´1-9´
3 ´10-49´
4 ´50-99´
5 ´100-500´
6 ´Over 500´
/
Turnover
1 ´Less than 1%´
2 ´1-5´
3 ´5-10´
4 ´10-30´
5 ´Over 30´
/
Transfer
1 ´Yes´
2 ´No´
/

```
' Contract
  1  '1'
  2  '2-5'
  3  '6-9'
  4  '10-14'
  5  '15-20'
  6  'Over 20'
  /
  Policy
  1 'Yes'
  2 'No'
  /
  Country
  1 'Yes'
  2 'No'
  /
  Mainly
  1 'FDI'
  2 'Licence'
  3 'JV'
  4 'Turnkey project'
  5 'Management contract'
  6 'Other'
  /
  Channel
  1 'Capacity-operate new technology'
  2 'Shortage-funds for direct invest'
  3 'Shortage-management for invest abroad'
  4 'Host market too small'
  5 'Strong competition in new market'
  6 'Risky situation for invest'
  7 'Pressures of the host governemnt'
  8 'Other'
  /
  Supply to Advant
  1 'Very important'
  2 'Important'
  3 'Neutral'
  4 'Some importantance'
  5 'No important'
  /
  Profit to Wide
  1 'Totally agree'
  2 'Agree'
  3 'Neutral'
  4 'Disagree'
  5 'Totally disagree'

Format source activity type latest overseas clients payment
      modes motiva (F1)
```

```
Variable labels

   Source´Source of funds for R&D´
   Activity´Activities the dept does´
   Type ´Type of TT´
   Latest´What makes transfer latest technology?´
   Overseas ´What kind of TT overseas?´
   Clients ´Who are its main clients?´
   Payment ´Payment for TT´
   Modes ´Most important mode of transfer´
   Motiva ´Motivation for producing abroad´

Value labels

   Source
   1 ´ Central budget´
   2 ´ Government funds´
   3 ´International TT´
   4 ´Internal customers´
   5 ´External customers´
   6 ´Others´
   /
   Activity
   1 ´Negotiation´
   2 ´Commercialisation´
   3 ´Following up projects´
   4 ´Technical assistance´
   5 ´Management of projects´
   6 ´Other´
   /
   Type
   1 ´Product´
   2 ´Process´
   3 ´Equipment´
   4 ´Management´
   5 ´Engineering Project´
   6 ´Other´
   /
   Latest
   1 ´Lack technical support´
   2 ´Leading edge users´
   3 ´Clients accept latest technol´
   4 ´Buyers are aware´
   5 ´Cant train people´
   6 ´Other´
   /
   Overseas
   1 ´Not commercially used at home´
   2 ´Old technology´
   3 ´Unable to exploit at home´
   4 ´Technology is public demand´
   5 ´Other´
   /
```

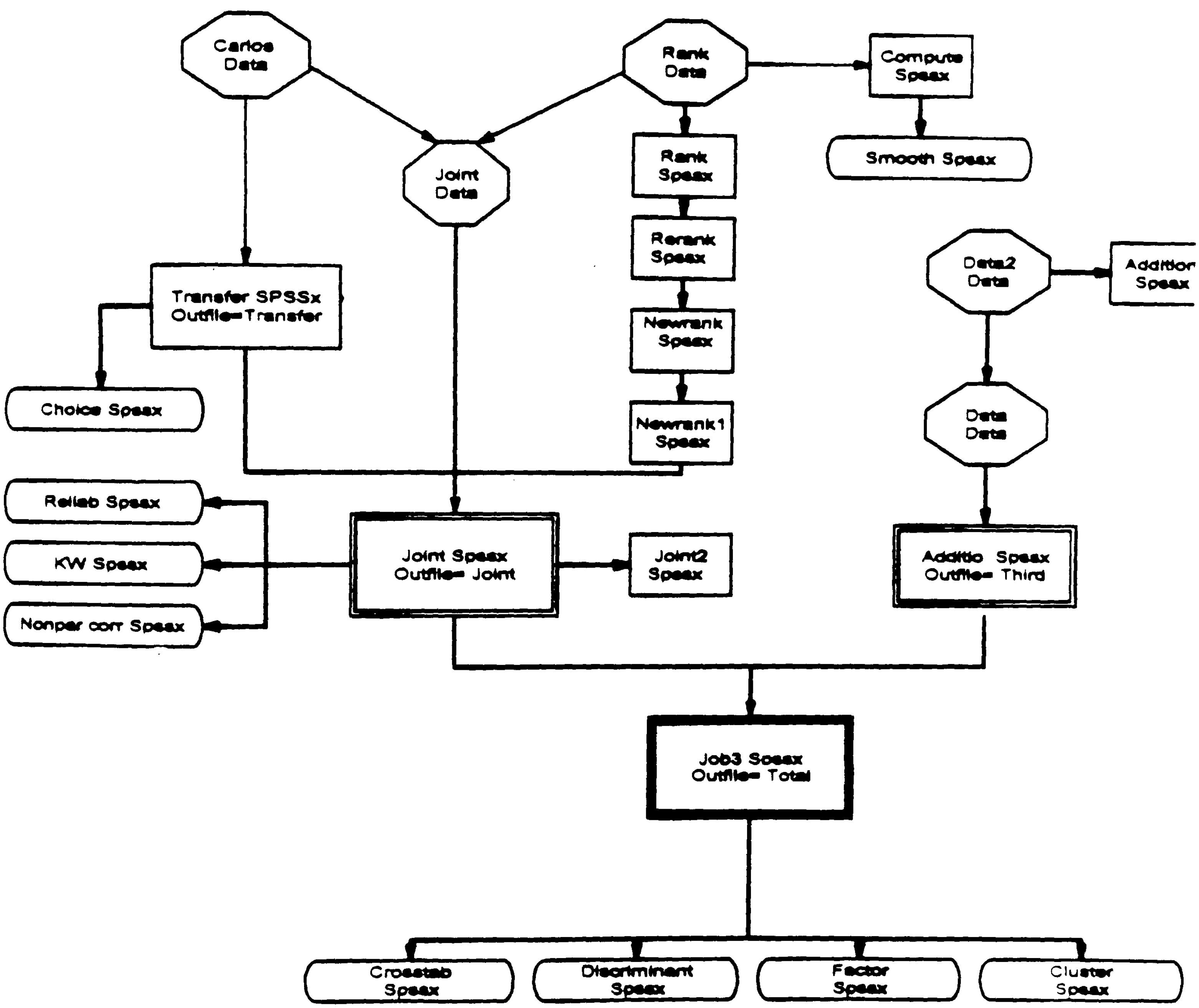
```
Clients
1 'Subsidiaries'
2 'Affiliates'
3 'Other multinational companies'
4 'Companies in developed countries'
5 'Companies in E E countries'
6 'Companies in N I C'
7 'Other'
/
Payment
1 'Royalties'
2 'Technical assistance fees'
3 'Supply of raw material'
4 'Supply of component parts'
5 'Supply of machinery'
6 'Management fees'
7 'Engineering fees'
8 'Other'
/
Modes
1 'Opening a subsidiary'
2 'Doing JV with affiliates'
3 'Licensing to non related company'
4 'Selling products services directly'
5 'Other'
/
Motiva
1 'Size of new market'
2 'Creation return stream'
3 'Foreign governments policies'
4 'High labour cost in home market'
5 'Other'

Title 'Rank of Answers ; Questionnaires on Technol.Transfer'

data list file = rank
      /
          q11p1 to q11p6 5-10
          q16p1 to q16p6 12-17
          q18p1 to q18p6 20-25
          q21p1 to q21p6 27-32
          q22p1 to q22p5 34-38
          q23p1 to q23p7 40-46
          q26p1 to q26p8 48-55
          q28p1 to q28p5 57-61
          q29p1 to q29p5 63-67

Variable labels
      q11p1 'Central budget for R&D'
      q11p2 'Government funds for R&D'
      q11p3 'Intern. TT funds for R&D'
      q11p4 'Internal customers funds for R&D'
      q11p5 'External customers funds for R&D'
      q11p6 'Other funds for R&D'
```

```
q16p1 'Negotiation of technology'
q16p2 'Commercialisation of technology'
q16p3 'Folowing up of projects'
q16p4 'Technical assistance'
q16p5 'Management of projects'
q16p6 'Other activities'

q18p1 'Product'
q18p2 'Process'
q18p3 'Equipment'
q18p4 'Management'
q18p5 'Engineering project'
q18p6 'Other type of technology'

q21p1 'Technical support is not available'
q21p2 'Users are leading edge oriented'
q21p3 'Clients only accept latest technology'
q21p4 'Buyers are very much aware'
q21p5 'Company is not able to train people'
q21p6 'Other reasons to not transfer old technology'

q22p1 'Technology not used commercially at home'
q22p2 'Technology that got old'
q22p3 'Company is unable to exploit at home'
q22p4 'Technology that is in public demand'
q22p5 'Other reasons to not transfer new technology'

q23p1 'Subsidiaries'
q23p2 'Affiliates'
q23p3 'Other MNC'
q23p4 'Companies in developed countries'
q23p5 'Companies in Eastern Europe'
q23p6 'Companies in NIC'
q23p7 'Other clients'

q26p1 'Royalties'
q26p2 'Technical assistance fees'
q26p3 'Supply of raw materials'
q26p4 'Supply of component parts'
q26p5 'Supply of machinery'
q26p6 'Management fees'
q26p7 'Engineering fees'
q26p8 'Other payments'

q28p1 'Opening a subsidiary'
q28p2 'Doint Joint Venture'
q28p3 'Licensing technology'
q28p4 'Selling product/services'
q28p5 'Other modes of TT'

q29p1 'Size of new market'
q29p2 'Creation of return stream'
q29p3 'Restrictions on direct sales'
q29p4 'High cost of labour at home'
q29p5 'Other reasons so produce abroad'
```

APPENDIX 5.2

SPSSx PROGRAMS USED

SPSSx PROGRAMS USED



APPENDIX 5.3

RANK OF ANSWERS

```
Title "Rank of Answers ; Questionnaires on Technol.Transfer"

data list file = rank
      /
           q11p1 to q11p6 5-10
           q16p1 to q16p6 12-17
           q18p1 to q18p6 20-25
           q21p1 to q21p6 27-32
           q22p1 to q22p5 34-38
           q23p1 to q23p7 40-46
           q26p1 to q26p8 48-55
           q28p1 to q28p5 57-61
           q29p1 to q29p5 63-67

Frequencies variables = q11p1 to q29p5

Define rerank ( stem1 = !charend('/')
              / stem2 = !charend('/')
              /     n = !charend('/'))
!let !f1 = !concat(!stem1, 1)
!let !f2 = !concat(!stem2, 1)
!let !l1 = !concat(!stem1,!n)
!let !l2 = !concat(!stem2,!n)

Compute £n0 = 0
do repeat x = !f1 to !l1
.  if (x=0) £n0 = £n0 + 1
end repeat
compute £r0 = !n - 0.5*(£n0 - 1)
do if max(!f1 to !l1) = 1
.  do repeat x = !f1 to !l1
           / y = !f2 to !l2
.     compute y = £r0 - 0.5*x*!n
.  end repeat
else
.  do repeat x = !f1 to !l1
           / y = !f2 to !l2
.     compute y = x
.     if (x=0) y = y + £r0
.  end repeat
end if
!enddefine

Rerank stem1=q11p
     / stem2=r11p
     / n=6
rerank stem1=q16p
     / stem2=r16p
     / n=6
rerank stem1=q18p
     / stem2=r18p
     / n=6
rerank stem1=q21p
     / stem2=r21p
     / n=6
rerank stem1=q22p
     / stem2=r22p
     / n=5
```

```
rerank steml=q23p
     / stem2=r23p
     / n=7
rerank steml=q26p
     / stem2=r26p
     / n=8
rerank steml=q28p
     / stem2=r28p
     / n=5
rerank steml=q29p
     / stem2=r29p
     / n=5

Condescriptive rllpl to r29p5

Finish
```

APPENDIX 5.4

REGROUPING THE RANKER QUESTIONS

```
Title "Regroup of the ranker questions"

Data list file = rank
Include file = newrank

Do repeat S = 1 to 6
  /V = r11p1 to r11p6
. if (v=1) source = s
End repeat
Do repeat S = 1 to 6
  /V = r16p1 to r16p6
. if (v=1) activity = s
End repeat
Do repeat S = 1 to 6
  /V = r18p1 to r18p6
. if (v=1) type = s
End repeat
Do repeat S = 1 to 6
  /V = r21p1 to r21p6
. if (v=1) latest = s
End repeat
Do repeat S = 1 to 5
  /V = r22p1 to r22p5
. if (v=1) overseas = s
End repeat
Do repeat S = 1 to 7
  /V = r23p1 to r23p7
. if (v=1) clients = s
End repeat
Do repeat S = 1 to 8
  /V = r26p1 to r26p8
. if (v=1) payment = s
End repeat
Do repeat S = 1 to 5
  /V = r28p1 to r28p5
. if (v=1) modes = s
End repeat
Do repeat S = 1 to 5
  /V = r29p1 to r29p5
. if (v=1) motiva = s
End repeat

Format source activity type latest overseas
     clients payment modes motiva (F1)

Frequencies variables = source activity type latest
               overseas clients payment modes motiva
  /statistical = all

Sort cases by questio
  / drop = q11p1 to q29p5

Finish
```

APPENDIX 5.5

DIFFERENCE OF MEAN RANK VALUE

```
Title 'Rank of Answers ; Questionnaires on Technol.Transfer'

data list file = rank
     /
          q11p1 to q11p6 5-10
          q16p1 to q16p6 12-17
          q18p1 to q18p6 20-25
          q21p1 to q21p6 27-32
          q22p1 to q22p5 34-38
          q23p1 to q23p7 40-46
          q26p1 to q26p8 48-55
          q28p1 to q28p5 57-61
          q29p1 to q29p5 63-67

Variable labels
     q11p1 'Central budget for R&D'
     q11p2 'Government funds for R&D'
     q11p3 'Intern. TT funds for R&D'
     q11p4 'Internal customers funds for R&D'
     q11p5 'External customers funds for R&D'
     q11p6 'Other funds for R&D'

     q16p1 'Negotiation of technology'
     q16p2 'Commercialisation of technology'
     q16p3 'Folowing up of projects'
     q16p4 'Technical assistance'
     q16p5 'Management of projects'
     q16p6 'Other activities'

     q18p1 'Product'
     q18p2 'Process'
     q18p3 'Equipment'
     q18p4 'Management'
     q18p5 'Engineering project'
     q18p6 'Other type of technology'

     q21p1 'Technical support is not available'
     q21p2 'Users are leading edge oriented'
     q21p3 'Clients only accept latest technology'
     q21p4 'Buyers are very much aware'
     q21p5 'Company is not able to train people'
     q21p6 'Other reasons to not transfer old technology'

     q22p1 'Technology not used commercially at home'
     q22p2 'Technology that got old'
     q22p3 'Company is unable to exploit at home'
     q22p4 'Technology that is in public demand'
     q22p5 'Other reasons to not transfer new technology'

     q23p1 'Subsidiaries'
     q23p2 'Affiliates'
     q23p3 'Other MNC'
     q23p4 'Companies in developed countries'
     q23p5 'Companies in Eastern Europe'
     q23p6 'Companies in NIC'
     q23p7 'Other clients'
```

```
      q26p1  'Royalties'
      q26p2  'Technical assistance fees'
      q26p3  'Supply of raw materials'
      q26p4  'Supply of component parts'
      q26p5  'Supply of machinery'
      q26p6  'Management fees'
      q26p7  'Engineering fees'
      q26p8  'Other payments'

      q28p1  'Opening a subsidiary'
      q28p2  'Doint Joint Venture'
      q28p3  'Licensing technology'
      q28p4  'Selling product/services'
      q28p5  'Other modes of TT'

      q29p1  'Size of new market'
      q29p2  'Creation of return stream'
      q29p3  'Restrictions on direct sales'
      q29p4  'High cost of labour at home'
      q29p5  'Other reasons so produce abroad'

Frequencies variables = q11p1 to q29p5

Define rerank ( stem1 = !charend('/')
              / stem2 = !charend('/')
              /     n = !charend('/'))
!let !f1 = !concat(!stem1, 1)
!let !f2 = !concat(!stem2, 1)
!let !l1 = !concat(!stem1,!n)
!let !l2 = !concat(!stem2,!n)
compute £n0 = 0
do repeat x = !f1 to !l1
.  if (x=0) £n0 = £n0 + 1
end repeat
compute £r0 = !n - 0.5*(£n0 - 1)
do if max(!f1 to !l1) = 1
.  do repeat x = !f1 to !l1
           / y = !f2 to !l2
.     compute y = £r0 - 0.5*x*!n
.  end repeat
else
.  do repeat x = !f1 to !l1
           / y = !f2 to !l2
.     compute y = x
.     if (x=0) y = y + £r0
.  end repeat
end if
!enddefine

Rerank stem1=q11p
     / stem2=r11p
     / n=6
rerank stem1=q16p
     / stem2=r16p
     / n=6
rerank stem1=q18p
     / stem2=r18p
     / n=6
```

```
rerank stem1=q21p
     / stem2=r21p
     / n=6
rerank stem1=q22p
     / stem2=r22p
     / n=5
rerank stem1=q23p
     / stem2=r23p
     / n=7
rerank stem1=q26p
     / stem2=r26p
     / n=8
rerank stem1=q28p
     / stem2=r28p
     / n=5
rerank stem1=q29p
     / stem2=r29p
     / n=5

Condescriptive r11p1 to r29p5


Subtitle 'Are rankers and tickers different?'

Compute GP=1

Value Labels
   GP
   1 'Ranks'
   2 'Ticks'
   /

If (max (q11p1 to q11p6) = 1) GP=2
Means r11p1 to r11p6 by GP
   / Statistics
Compute GP=1
If (max (q16p1 to q16p6) = 1) GP=2
Means r16p1 to r16p6 by GP
   / Statistics
Compute GP=1
If (max (q18p1 to q18p6) = 1) GP=2
Means r18p1 to r18p6 by GP
   / Statistics
Compute GP=1
If (max (q21p1 to q21p6) = 1) GP=2
Means r21p1 to r21p6 by GP
   / Statistics
Compute GP=1
If (max (q22p1 to q22p5) = 1) GP=2
Means r22p1 to r22p5 by GP
   / Statistics
Compute GP=1
If (max (q23p1 to q23p7) = 1) GP=2
Means r23p1 to r23p7 by GP
   / Statistics
```

```
Compute GP=1
If (max (q26p1 to q26p8) = 1) GP=2
Means r26p1 to r26p8 by GP
   / Statistics
Compute GP=1
If (max (q28p1 to q28p5) = 1) GP=2
Means r28p1 to r28p5 by GP
   / Statistics
Compute GP=1
If (max (q29p1 to q29p5) = 1) GP=2
Means r29p1 to r29p5 by GP
   / Statistics

Finish
```

APPENDIX 5.6

NON-PARAMETRIC CORRELATION FOR TESTING VALIDITY

```
Title "Non-parametric correlation for testing validity"

Match files
        file = Joint
        /file = Third
        /by = Questio

Nonpar corr
        /lead with create
        /territ with domesti
        /compara with advant

Statistic 1

Options 6

Save outfile = Total4

Finish
```

APPENDIX 5.7

TEST FOR RELIABILITY OF THE QUESTIONNAIRE

```
Title "Test for reliability of the questionnaire"

Match files
        file = Joint
        /file = Third
        /by = Questio

Compute zsplit = (trunc ($casenum/2) = $casenum/2)

T-test groups = zsplit (0,1)
        /variables = nature to wide

Save outfile = Total2

Finish
```

APPENDIX 5.8

K-W NONPAR TEST FOR TIMING THE QUESTIONNAIRE

```
Title "K-W nonpar test for timing the questionnaire"

Get file Joint

Recode questio
        (0 thru 32 = 1)
        (33 thru 50 = 2)
        (51 thru 64 = 3)
        into phase

Npar test K-W = nature, introduc, invest, large, wide
                    by phase (1,3)

Finish
```

APPENDIX 7.1

DISCRIMINANT ANALYSIS

Appendix 7.1

Discriminant analysis

Discriminant analysis is a multivariated statistical technique whose objective is to classify individuals and objects by a set of independent variables, in two or more categories, or to identify variables that can statistically discriminate between groups. The technique combines independent variables in one or more functions, which determine classification scores (classification function coefficient) for each individual or object.

Other tests, such as T-test are not sensitive enough to emphasise the cumulative effect of correlated variables because when pairs of variables are compared, fundamental conjunctural considerations are excluded from the global analysis. These tests can establish a correlation between groups but they do not explain the variables that form each group. Since the objective of this research is not only to establish connections between groups but also to discover the nature of the relationship between two or more variables, the use of a T-test does not seem appropriate. By reducing the data to dichotomies one looses very precious information.

Discriminant analysis was used assuming that the population had a multivariate normal distribution on the discriminating variables and an equal group of covariance matrices. However, the technique is so robust that it can tolerate some deviation in these assumptions of normality. In addition, the technique is not sensitive to minor violations of these assumptions[1]. Likert type scales, such as the ones used in the questionnaire, admit the use of this technique, which is much more simple and powerful than any non-linear combination.

"The mathematical objective of discriminant analysis is to weight and linearly combine the discriminant variables in some fashion so that the groups are forced to be as statistically distinct as possible. In other words, we want to be able to discriminate between groups in the sense of being able to tell them apart" (Klecka, 1975:435). The discriminant functions are of the form:

---

1 For more detail, discriminant analysis is well explained by Klecka (1975, 1980).

$$D = d_1Z_1 + d_2Z_2 + ...d_pZ_p$$

where **D** is the score on the discriminant function **l**, the **d**'s are weighting coefficients , and the **Z**'s are the standardized values of the **p** discriminating variables used in the analysis (Klecka, 1975).

When using the whole set of variables to run the discriminant analysis, two situations can occur: first, in many cases the total number of independent variables may contain excess information about the different groups; second, some variables may not properly discriminate among groups. To avoid these two situations, a stepwise selection method was run, selecting independent variables to be entered in the analysis on the basis of their discriminating power.

APPENDIX 7.2

DISCRIMINANT ANALYSIS PROGRAM

WITH

2-WAY CROSSTAB

```
Title "Discriminant analysis using policy and modes and
     joint 2-way crosstab"

Get file = Total
  /keep = policy modes supply to wide

Do repeat x = supply to wide
. if missing (x) x = 0
End repeat

Discriminant
  groups = policy (1,2)
  /variables = supply to wide
  /analysis = supply to wide
  /method = Wilks
  /priors = size
  /save = class = poldg
  /statistics = all
  /plot = combined

Do repeat x = supply to wide
. if missing (x) x = 0
End repeat

Recode modes (1,2 = 1) 93 = 2)

Value labels
  1 'FDI'
  2 'Licensing'

Discriminant
  groups = modes (1,2)
  /variables = supply to wide
  /analysis = supply to wide
  /method = Wilks
  /priors = size
  /save = class = moddg
  /statistics = all
  /plot = combined

Crosstab poldg by moddg
  /statistics = chisq

Finish
```