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Factors influencing the firm's propensity to adopt inward technology licensing in new product development: an empirical investigation

Kwaku Atuahene-Gima
University of Wollongong

Factors Influencing the Firm's Propensity to Adopt Inward Technology Licensing in New Product Development: An Empirical Investigation

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Kwaku Atuahene-Gima
BSc (Ghana), MCom (Marketing), UNSW, Dip.M., MCIM.

Department of Management
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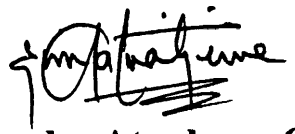
I certify that this work is original and has not been submitted for a degree in any other university or institution.



Kwaku Atuahene-Gima

Dedication

I wish to dedicate this dissertation to my late father, Nana Kwadwo Atuahene, for all the things he did for me. I know he would have been extremely pleased for me.

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ABSTRACT

Many scholars and practitioners accept that inward technology licensing (ITL) can be a viable alternative to internal R & D as a source of new products. Yet, new product development (NPD) research to date has focused mainly on internal development with little attention to external technology development methods.

The purpose of this study is to determine the factors that affect a firm's propensity to adopt ITL as an alternative to internal R&D in NPD. Three related research questions are addressed. First, what are the differences between firms which have adopted the ITL method and those which have not? Second, what are the separate effects of firm characteristics, management characteristics, the perceived relative costs and benefits of ITL, and perceived environmental hostility, on propensity to adopt ITL? Finally, what is the relative importance of the factors affecting ITL propensity? Previous research on technology licensing has failed to address these questions.

The data for the study were collected through a mail survey of 229 firms (116 licensees and 113 non-licensees) in the engineering, pharmaceutical and chemical industries in Australia. Discriminant analysis results indicate that licensee and non-licensee firms can be separated mainly along their management characteristics and management perceptions of the relative costs and benefits of ITL. Multiple regression analysis results suggest that management characteristics and the perceived costs and benefits of ITL had strong impacts on ITL adoption. Eight key factors explained 42% of the variance in the firm's propensity to adopt ITL. These factors were: management satisfaction with current ITL agreements, the firm's R & D capability; management awareness of ITL opportunities; perceived implementation costs; perceived loss of decision-making autonomy; potential diversification and market entry advantages offered by the technology; and management risk-aversion.

These findings have special implications for NPD research, technology marketing through licensing and policy-makers interested in promoting the adoption of ITL by industry. The study has also developed and tested new research constructs that may facilitate future research in technology licensing.

Chapter 1 Introduction

1.1 Research problem

Increasingly, inward technology licensing (ITL) is playing an important role in new product development (NPD) activities of many firms. Morehead (1984, p. 101) called product manufacture under license "the coming revolution in new product development". Additionally, according to Faber (1986), the solution to new product development risks for many major pharmaceutical firms has been the development of a licensing-in strategy as a source of new products. For example, Wind and Mahajan (1988) reported that over 50 percent of new prescription drug products introduced into the U.S. market between 1985-1988 were licensed-in from Japan and Europe. Furthermore, Friar and Horwitch (1985) have reported an increasing trend towards the use of external methods such as ITL in the firm's technology strategy at the expense of internal R&D. Likewise, studies in the U.K. and Sweden have reported an increasing recognition of the importance of ITL as a viable tool for achieving NPD and revitalisation of firms (Svensson 1984; Lowe and Crawford 1983).

In addition to its increasing importance to the NPD efforts of individual firms, ITL is of major importance to the economy of nations. Studies by Reid and Reid (1988) in Canada and Millman (1983) in the UK suggest that the use of ITL strategy by firms in a country may have a positive impact on the nation's economy. These authors recommend government action to ensure increased use of ITL strategy among firms. For example, Reid and Reid (1988, p. 402) concluded that:

> ....license use by manufacturers has such desirable payoffs as new venture formation, increased technological competitiveness and an enhanced industrial base. It suggests that public agencies can contribute to industrial development by encouraging manufacturers to use licensing.

The foregoing assertions are in concert with a number of scholars who point to the importance of external methods such as ITL (i.e., acquiring technology already developed by another organisation) as a viable alternative to internal R&D (Ford 1988; Gold 1982, 1987; Maidique and Patch 1982; Wind and Mahajan 1988). For example, Link, Tassey and Zmud (1983, p. 48) noted that:

> one may view the firm's decision to invest in its own R&D program as a conscious plan to internalise an activity for which an alternative external market exists.

Rothschild (1983, p. 45) echoed the same view, arguing that:

> at times it does not make any sense for a company to develop a product on its own. *Licensing* another's design and using it can be *extremely powerful* if you have a clear strategy (emphasis added).

Similarly, Capon and Glazer (1987) asserted that external acquisition of technology is a viable alternative means of building a firm's new product portfolio.

Although the benefits of external methods of new product acquisition are widely acknowledged, "there is very little literature on the external acquisition of technology per se" (Sen and Rubenstein 1990, p. 6). Most marketing texts ignore external sources in their treatment of the NPD process (McSurely and Parmeswaran 1986). Since firms do utilise ITL and other external methods to acquire new products, the relative neglect of the subject in the research literature is a major shortcoming. This neglect of external technology development methods has prompted calls for a re-examination of the NPD process. For example, Wind and Mahajan (1988, p. 307) observed that:

> Too much of the new product development effort is on internal development which is not always effective. New product development should encompass both internal and external efforts (such as licensing or strategic alliances). A totally internal focus can reduce the effectiveness of the process because such a focus ignores the benefits of strategic alliances in the various phases of research, development, engineering and marketing.

In a similar vein, McSurely and Parmeswaran (1986, p. 71) advocated that management and researchers need to take due cognisance of external alternative methods of NPD because "failure to give adequate attention to external sources of new products presents an unrepresentative view of effective marketing strategy development and implementation".

The choice between an external method of NPD and internal R&D is conceptually a 'make' or 'buy' decision (Capon and Glazer 1987). The NPD research agenda of the Product Innovation Management Association for 1989 included "the make or buy decisions related to new products" (Burger 1989, p.

53). Unfortunately, most of the research work in NPD is oriented toward the examination of the process within the firm. On the internal versus external development question, Capon and Glazer (1987) contended that several issues demand research attention. First, under what conditions does the firm tend to choose one option over another? Second, what is the relative importance of the factors affecting such a choice decision? Third, how successful are the various choice decisions? Finally, what structural firm characteristics and environmental factors correlate with the various NPD options and the levels of associated performance?

This study is designed to address some of these issues. The general research problem addressed is *what factors influence the firm's decision to choose ITL as a NPD option over internal R&D?*

As in the NPD literature, research attention on ITL in the technology licensing literature has been meagre. Empirical research has focused mainly on the licensor's (seller's) viewpoint in the technology marketing process (for example, Adam 1985; Contractor 1981; Carstairs and Welch 1982), with little attention to the licensee's (buyer's) viewpoint. Thus little is known about the factors that affect the firm's ITL decision compared to outward technology licensing (Caves, Crookell and Killing 1983). For example, Adam (1985) called for research dealing with technology licensing at the licensee level that aims at identifying the factors that should favour ITL as opposed to internal R&D. Similarly, Crawford (1985) called for research that provides insights into the behavioural factors involved in the use of ITL. These calls prompt this study. Three specific research questions which are the focus of the study are:

- what are the differences between firms which have adopted ITL and those which have not?

- what is the separate effect of each of firm characteristics; management characteristics; management perceptions of the relative costs and benefits of ITL; and perceived environmental hostility, on the firm's propensity to adopt ITL as an alternative to internal R&D?
- what is the most parsimonious set of factors that impact on the firm's propensity to adopt ITL, and their relative importance?

In summary, this study is justified on the grounds of the increasing importance of ITL as an alternative NPD method, and on its relative neglect in the NPD literature. Other justifications of the study relate to the methodological weaknesses in current technology licensing research and to the contributions of the study. These are discussed next.

1.2 Methodological weaknesses in ITL research

In addition to the relative neglect of ITL research, the lack of concern for measurement issues in the few studies conducted on ITL is another justification for this research. Many of the studies on ITL provide lists of factors influencing the license-in decision without providing evidence of the reliability and validity of the measures of the variables whose relationships are examined (for example, Killing 1975; Lowe and Crawford 1984; Crawford 1985; Shahrokhi 1987).

Additionally, most researchers use single item measures for constructs which are multi-dimensional. For example, Killing (1975) measured the firm's core skill by the percent of employees who are scientists and engineers. Kim (1988) measured the licensee firm's marketing and technical skills by advertising and

R&D expenditures as percentage of sales, respectively. According to Nunally (1978), single items such as these do not have the capacity to adequately and accurately capture the domain of the construct being measured.

Further, variables in the ITL literature are too often measured with dichotomous, "yes or no" questions rather than with metric scales directed at their intensity.. These measures do not allow for tests of the reliability and validity of the variables being measured (Peter 1979). While previous efforts to study the ITL process are commendable early steps, they may have been compromised by the lack of appropriate measurement instruments. As Venkatraman (1989, p. 944) argues:

> ...[without] a systematic basis to evaluate the adequacy of measures, confidence in research results is considerably eroded, which implies that the managerial implications derived from such results may be questionable.

A second methodological concern in the ITL literature is that most of the studies to date have not been theory-driven and therefore have tended towards a descriptive analysis of cases. There has been no attempt to conceptualise the "propensity to adopt ITL" as a dependent variable and examine the individual and the combined influence of independent variables on it, in a multivariate framework.

This research develops an explanatory model of the firm's propensity to adopt ITL, and a set of operational measures for variables, which are then used to test a series of specific hypotheses in a multivariate framework. Thus one of the unique characteristics of this research is the multivariate approach used and assessment of the validity and reliability of the measures of its key variables.

1.3 Contributions of the study

The potential applications of the research findings provide the final justification for the research. It will make both theoretical and practical contributions to the practice of NPD. From the theoretical perspective, the research develops and validates measures of variables, before using them to test the explanatory capacity of the ITL decision model. The new measures of the factors influencing the firm's propensity to adopt ITL, developed and validated, can facilitate future research by those interested in the subject.

In addition to the contribution towards measurement development, this research also has practical benefits to management and policy-makers. It has been remarked that a NPD framework incorporating both internal and external methods will help managers develop a better understanding of the internal resources and capability of the firm in the NPD process (McSurely and Parmeswaran 1986). Management become more involved in the process because such a framework encourages them to consider the advantages and disadvantages of each NPD method in the light of both the internal and external forces affecting the firm.

Therefore, corporate management faced with the development of a particular product are likely to find the results useful. Factors that may be of importance to such a decision are identified. For example, management may need to examine the extent to which the firm is either capable of developing the product internally, or acquire, absorb and exploit external technology.

The research findings suggest that management need to give due consideration to their own characteristics and perceptions, as well as external factors in NPD

decisions. The implication is that management can create the internal environment within which the ITL option may become feasible and/or more effective for the firm. For example, by taking measures to improve the internal capabilities of the firm, management would be creating the conditions for an expanded list of alternatives in NPD methods. Management is also able to identify the factors necessary to emphasise in recruitment, training and education programs to prepare itself for ITL adoption or to enhance the effectiveness and efficiency of current ITL strategy.

From the outward technology licensing perspective, the research results will have implications for management of licensor firms. They highlight some of the pertinent factors a licensor firm may need to consider in marketing technology to prospective licensees.

In addition to corporate management, the research findings have implications for public policy-makers. By identifying the significant factors affecting the firm's propensity to adopt ITL, the research findings help to ensure economy of effort and efficiency in the development and implementation of programs aimed at encouraging the use of ITL.

1.4 Definition of terms

For the purposes of this research the following definitions are adopted:

- **New product/technology development**

  An innovation is defined as any product, service or process that is new to the originating organisation (Rogers 1983). In this research, *new* product or technology development is defined as the efforts on the part of a firm to find, acquire and develop a

technology that enables it to produce and/or sell a product which represents a change in or addition to its commercial line. Thus a new product is seen as representing a change in or addition to an organisation's commercial line (Bart 1991).

- **Technology licensing**

Licensing is defined as a contractual agreement in which a selling firm (the licensor) provides a buying firm (the licensee) with access to technology in the form of a completely developed product or process, patents, designs, drawings, trade secrets, and know-how in exchange for an initial lump sum payment and/or royalties (Lowe and Crawford 1984; McDonald and Leahey 1985). From the licensor's viewpoint, selling of technology is termed licensing-out or outward technology licensing. From the licensee's viewpoint, buying technology is termed licensing-in or inward technology licensing.

Therefore inward technology licensing (ITL), the subject of this research, represents a contractual agreement through which a firm acquires technology which is *already developed* by another organisation. The technology involved in a licensing agreement may include *product* technology (the set of ideas embedded in the product itself), *process* technology (the set of ideas involved in the manufacture of the product), and *management* technology (the set of management procedures and knowledge required to market the product) (Capon and Glazer 1987).

It needs re-emphasising that this definition of technology excludes ideas in basic or applied research where nothing concrete has been developed

for transfer (Killing 1975). ITL agreements involve technology that is *fully developed, whether proven or unproven in the licensor's operations and markets* (Killing 1975; Pisano 1990).

- **Propensity to adopt ITL**

  Propensity to adopt ITL is used in this research to represent two things. First, it represents a measure of the firm's *manifest outcome ITL behaviour as indicated by whether or not the firm is currently involved in ITL.* This manner of defining propensity is commonly used in the international marketing literature (for example, Yaprak 1985).

  Second, propensity to adopt ITL is a measure of the firm's *attitudinal orientation or intention towards the future use of ITL.* In this study, the terms, propensity to adopt ITL, ITL adoption and ITL propensity are used synonymously.

1.5 Methodology

This section introduces the methodology used in the research. A more detailed description is provided in chapter 3.

1.5.1 Research design

Four methods of social research that could be considered for the investigation of a firm's ITL adoption have been described by Babbie (1990). These are controlled experiment, case study, field research or participant observation, and survey research. This section justifies the use of a mail survey methodology in this study.

In a controlled experiment the researcher intervenes in a social phenomenon to observe the consequences of such intervention. This method is most appropriate where a researcher is dealing with a few variables, which can be easily manipulated. The other limitations of this method are that it provides no descriptive data, and its relevance to the real world is debatable. Since this research involves the investigation of a large number of variables, and it was not the researcher's intention to intervene in firms' licensing situations, this method was rejected.

Case study analysis has been employed by many researchers to study technology licensing (for example, Crawford 1985; Lowe and Crawford 1984; Svensson 1984). While it allows for an in-depth analysis of a social phenomenon, this method was judged unsuitable for this study for two reasons. First, only a limited number of firms could have been studied with this method. Second, it does not lend itself easily to the development of measures, which was an important objective of the current research.

In a field research, the researcher directly observes and participates in a social phenomenon with the objective of studying behaviour in its natural setting. This research method is unsuitable for the current study because it is mainly qualitative rather than quantitative. Further, due to time, cost and lack of opportunity, it was impossible for the researcher to participate in firms' ITL decision-making processes.

The fourth research method is survey research which can be conducted through interviews or self-administered questionnaires. The interview method has the advantages of high response rate, responses with fewer missing data, and the opportunity for the researcher to probe the issues under study. However, it does

not allow a large number of respondents to be surveyed over a large area because of its high cost and length of time required.

In this research the self-administered mail survey was used for a number of reasons. First, since there was no available public information on licensee firms in Australia, it was not possible to identify respondents beforehand. Secondly, non-licensee firms were included in the research. The mail survey was judged to be the appropriate method that would effectively allow contact with a large number of licensee and non-licensee firms. The third reason for the use of the mail survey method was that it allowed for a large number of questions to be asked for the development of operational definitions and measures for the variables examined in the research (Moser and Kalton 1972). This advantage of the mail survey was of crucial importance in this research because of its aim to develop multiple measures of the key variables.

The fact that the potential respondents were spread over a large geographical area provided the final justification for the use of the mail survey over other research methods. For example, the cost of an interview or case study method would have been prohibitive.

In brief, other research methods were rejected in favour of the mail survey because of the need to:

- have both licensee and non-licensee firms in the research
- develop multiple measures of variables
- reduce cost and time required to collect data
- reach a widely geographically dispersed sample

The major drawbacks of the mail survey are the lack of opportunity for an in-depth probe of the issues under study and low response rate (Babbie 1990). In view of these limitations, steps were taken to ensure that the instrument was appropriate and would be able to provide the data required, and to increase the response rate, as discussed in chapter 3.

1.5.2 Data analysis techniques

The general methodological approach to data analysis was correlational. This choice of analytical design is justified by the objective of the research, which was to test the explanatory capacity of a firm's ITL propensity model. To test the validity of the measures developed, factor analysis was used.

Factor analysis is a technique used to detect and define a smaller set of variables forming the underlying dimensions of a much larger set of original variables. Items measuring the same construct load heavily on that construct, while loading weakly on constructs they are not supposed to measure (Churchill 1979). Hence it is an appropriate method for testing the convergent and discriminant validity of measures of constructs (Churchill 1979).

Consistent with the two ways of defining the dependent variable, ITL propensity, the explanatory model was tested by a two-stage procedure using discriminant and multiple regression analysis. As will be shown in chapter 3, the dependent variable was first measured categorically. For this reason, discriminant analysis was employed to distinguish between licensee and non-licensee firms. In addition to statistically differentiating between groups, the approach offers a useful classification instrument and has the ability to determine the relative importance of the independent variables on account of their discriminating power.

The second measure of the dependent variable was a composite of four intervally-scaled items. Multiple regression was therefore used to test the explanatory power of the model developed. This method is appropriate where the researcher is interested in finding the intensity of impact of several metric scaled independent variables on a single metric scaled dependent variable (Hair, Anderson and Tatham 1990). It builds a linear model between the dependent and independent variables, and produces a co-efficient of determination (R^2) which shows the extent of variation in the dependent variable accounted for by the combined effect of the independent variables.

As mentioned previously, a detailed description of the methodology is provided in chapter 3.

1.6 Delimitations of the research

This study is limited to firms in the engineering, chemical and pharmaceutical industries in Australia. These three industries were chosen because they constitute those industries with extensive use of both ITL and outward technology licensing (Lowe and Crawford 1984; Adam 1985; Adam, Pearson and Ong 1989; Ford 1985).

The scope of the research is also limited to licensing relations between Australian firms and unaffiliated or independent overseas companies. The rationale for this limitation is that ITL agreements between affiliated companies may take place for reasons such as taxation and remittances of profit, which may not be related to the true determinants of technology licensing. Additionally, since few licensors sell technology to domestic firms because of fear of competition in their local markets, the scope of the research was limited to

licensing agreements with overseas firms. For similar reasons Adam (1985) and Svensson (1984) limited their studies to overseas unaffiliated companies. Additionally, since the unit of analysis is the firm, charateristics of the technology licensed are not considered in this study.

The final limitation is that macro-economic issues and government technology licensing regulations are not considered in this research in the interest of parsimony.

1.7 Outline of the report

The remaining chapters of the study are outlined next. In chapter 2, a review of the literature is undertaken. The first objective is to identify gaps in the understanding of ITL adoption, some of which this research addresses. The second objective is to identify factors that are thought to influence ITL adoption. These factors are expected to help in building the theoretical model of ITL propensity. The chapter also presents a theoretical ITL adoption model and the hypotheses to be tested.

Chapter 3 contains a description of the methodology used to gather the data, the data collection instrument and the operationalisation of variables. It also describes the analytical techniques used to develop and validate measures, and analyse the data collected.

Chapter 4 presents the results of the survey and statistical analysis. The chapter has two major parts. The first part reports on the results of the measurement development process, while the second part reports on the statistical findings from the hypothesis testing process.

In chapter 5, the results are interpreted. The meaning and significance of the results in the light of the explanatory model tested and the previous literature are

discussed. The last chapter provides a summary and conclusions of the research together with management implications and a future research agenda. The chapter also presents the limitations of the study.

1.8 Summary

This chapter introduced the research report. It set the background, outlined the main research problem and questions. It also defined the terms, set out the key limitations and outlined the chapters of the study. With these foundations laid, the report can now turn to a discussion of the literature and hypotheses in chapter 2.

Chapter 2 Literature Review

2.0 Introduction

This chapter builds on the foundation of the research laid in the previous chapter. It explores the relevant literature as a first step in deriving an explanatory model for the firm's propensity to adopt ITL as an alternative to internal R&D. The chapter is organised into five sections. In the first section, the literature on the new product development (NPD) process is discussed. The major purpose of this discussion is to examine how the process is currently conceptualised and researched, and to identify the shortcomings of this conceptualisation. In addition the section presents the emerging alternative conceptualisation of the process.

The second section lays the theoretical foundation for the current study. This section argues that the NPD process is conceptually a 'make' or 'buy' decision between internal and external methods and identifies the constructs that underlie such a decision.

The third section of the chapter then presents the technology licensing literature to identify the factors that influence a firm to choose ITL as an alternative NPD option to internal R&D. The previous literature on technology licensing has progressed along two major streams. The first stream explores the conditions under which firms employ licensing as an alternative method to direct investment for international market entry (for example, Adam 1985; Adam, Pearson and Ong 1988; Carstairs and Welch 1982; Contractor 1981). The second research stream focuses on the use of licensing as a method of technology acquisition by firms. Our review concentrates on this latter stream

of research since it is the most germane to the current study. This section is categorised into four parts comprising the review of the impact of each of the firm's structural characteristics, management characteristics, management perceptions of the relative costs and benefits of ITL, and perceived environmental forces, on ITL adoption.

The methodological limitations discovered in the current ITL research are presented in the fourth section of the chapter. Finally, in section five, a theoretical explanatory model of ITL adoption that consolidates the relevant findings of the literature and addresses some of the methodological limitations is presented. In addition, a discussion of the hypotheses to be tested is presented in this section.

2.1 New product development (NPD) process

Many countries rely on new products for improved international competitiveness, favourable balance of payments and a higher level of standard of living (Dwyer and Alchin 1987). Likewise, new products are of vital importance to the growth, profitability and prosperity of most firms. Iwamura and Jog (1991) noted that firms innovate to protect and expand their customer base; to reduce costs; to respond to customer needs and suggestions; to enhance human growth and employee potential within the firm; and to enhance corporate image. In fact, an effective NPD strategy is an important determinant of the firm's ability to compete and survive (Crawford 1990).

The importance of new products is consistently stressed in the empirical literature. Cooper (1984) reported that on average 36.5 percent of the sales of a firm is derived from new products introduced in the last five years. Hopkins

(1980) found that 25 percent of firms attributed 30 percent of their current sales to new products.

The importance of new products seems to be more critical for industrial firms, especially high technology ones. In a study of industrial firms in Australia, 20 percent of the respondent firms attributed 60 percent of their sales to new products (Link 1987). In the pharmaceutical industry, Drews (1988) quoting an internal report of a study of the world pharmaceutical market by Hoffmann-La Roche, reported that on average the 25 leading firms (based on market share) obtained 30 percent of their current revenues from new products. In addition, companies that gained market share during the period under study had 47.6 percent of their sales accounted for by new products compared to 19.8 percent for those firms that lost market share. The foregoing findings suggest that the ability of a firm to gain market share has a positive correlation with its ability to introduce successful new products.

However, internal NPD is an inherently risky undertaking fraught with high rates of failure. It also requires high initial capital outlays and long lead times. Wind and Mahajan (1988) cited a study by A. D. Little Decision Resources which indicated that in the pharmaceutical industry it took an average of 10,000 compounds in basic research to result in 10 pre-clinical projects that, in turn, led to one regulatory approved drug product. The NPD process took an average of 14 years at an average cost of US$40 million. Hopkins (1980) found that for every 100 new industrial products launched, about 40 failed in the market. He also reported that about 63 percent of senior executives were somewhat or very dissatisfied with their firms' new product performance. Crawford (1979) estimated that new products face a 35 percent failure rate at launch.

Further, Cooper's (1984) research showed that for every 100 products that were fully developed, only 60 were commercial successes. In a similar vein, a Booz-Allen and Hamilton (1982) study reported that almost 50 percent of resources that U.S. firms spend on product development are spent on products that fail commercially. Finally, Link (1987) estimated the new product failure rate among industrial firms in Australia to be between 20 and 30 percent. In fact, according to Yoon and Lilien (1985) there are good reasons to expect that successful NPD will become even harder to achieve in the future. Their pessimism is based on the increasing shortage of new product ideas, the fragmentation of markets, increasing government regulations, capital shortages and the shortening of product life cycles due to rapidly changing technology. Due to the inherent risk associated with NPD, most research work focuses on the process activities that influence the success and failure of new products.

The NPD process is generally seen as a sequential system through which new ideas are generated, evaluated, and developed into products useful to some customer segment in the market. For example, Ronkainen (1983, p. 157) defined the process as "the procedure of bringing a product from an idea or concept to commercial sale ..." He went on to emphasise that "... it is a sequential decision process involving not only one decision point but a series of stages ending with 'go' or 'no go' decisions". He suggested a five-stage process model comprising concept, feasibility, product/process development, scale-up and standardisation. Similarly, Cooper (1979a, 1983), based on a study of industrial firms in Canada, suggested a seven-stage process model consisting of new product strategy development, idea generation, screening, business analysis, development, testing, and commercialisation.

Other researchers (for example, Crawford 1990) suggest a different number of activity stages in the NPD process. However, there seems to be a general

perception that the process is essentially a sequential one consisting of various activities that are *initiated and consummated with exclusive reliance on expertise within the firm.* For example, Ronkainen (1983, p. 157) stated, "each stage [of the new product development process] draws from the expertise of the various functional areas of the company". In other words, the NPD process activities are independently performed by the firm without any form of collaboration from outside.

As mentioned previously, this internally-oriented characterisation of the NPD process permeates current research work. Most of the research work that focuses on success and failure of new products concerns the identification of the factors that impact on the efficiency of this internal process. One of the earliest research concerned the common characteristics of successful new products (Myers and Marquis 1969). In an analysis of 567 successful innovations from five diverse industries in the U.S., they found that most of the innovations followed a NPD process consisting five major stages. They observed that about 79 percent of the successful new products were derived from the firm's understanding of the needs of the market (market pull). The rest were the result of technological developments (technology push). External channels of communication such as contacts with suppliers and the research community were found to be important sources of new product ideas.

In Globe, Levy and Scwartz's (1973) study of radical innovations, the major ingredients of success were related mainly to internal and technical factors. The success factors comprised the ability of the firm to recognise a technical opportunity and market needs; proficiency with which R&D and other NPD decisions were taken and managed; and availability of ample development resources. A review of the literature by Rothwell (1977) noted that most studies conducted between 1957 and 1976 found that among the factors critical to new

product success were: marketing and understanding of customer needs; efficiency of development; effective use of external technology and external scientific communication.

It is noteworthy that these early studies found the effective use of outside technology and communication with the external scientific community as important factors in successful NPD. Unfortunately, none of the subsequent studies explicitly examine these factors. For example, Cooper (1979a, 1979b) following the sequential, internally-focused conceptualisation of the NPD process, studied 103 industrial innovations and found that firms followed a stepwise process with a series of stages. The factors that were determined to impact on success were product uniqueness and superiority, market knowledge, proficiency of marketing activities, and the extent of fit between the product and the firm's marketing and technical skills. In a similar study in the U.S. electronics industry, Maidique and Zirger (1984) found that the most important ingredients of success were understanding of user's needs, products that matched customers' needs, clear marketing strategy, proficiency in marketing, well-planned and executed R&D process, synergy between the firm's markets and technologies, and the new product.

Recent studies continue to focus entirely on the proficiency with which the internal NPD process activities are performed by firms and its impact on the success and failure of new products. Cooper and Kleinschmidt (1986) determined that the major factor influencing failure of new products relates to the inadequate performance of the pre-development activities in the process. In a study of the management of the NPD process of 252 products in 123 firms, up-front activities such as initial screening, market assessment and market research were all rated as the weakest areas by respondent companies.

In a similar study, Calantone and di Benedetto (1988) concluded that the availability of technical and marketing skills, and resources is a necessary but not sufficient condition for successful NPD. Their study showed that the key variables that affected the success rate of new products were the efficiency with which the technical, marketing and launch activities were undertaken in the company. In concert with the foregoing findings, a more recent study of new product activities among Australian manufacturing firms determined weaknesses and inefficiencies in the performance of activities at every stage of the NPD process (Dwyer and Mellor 1990).

In summary, the current literature suggests that the availability of internal resources to proficiently perform the NPD process activities is the critical factor in successful NPD (Calantone and di Benedetto 1985; Cooper 1988; Dwyer and Mellor 1990). In fact, the lack of skills and resources to perform the process activities appears to be the major reason why some firms do not innovate. For example, Iwamura and Jog (1991) noted that among the key reasons for firms not to innovate are the high cost of innovation and implementation, long delay between innovation and marketability, great uncertainty of success, non-patentability of innovation, difficulty of maintaining market share, and inadequate resources and skills.

A close examination of the existing conceptualisation of the NPD process as an independent, internal process and its derived research output, discussed in the preceding pages, shows some significant shortcomings. First, the internally-oriented view of NPD is at variance with the early new product research which found that effective use of external technology impacts on the success of new products. Many of the recent studies recognise the importance of external sources at the idea generation stage of the NPD process (for example, Cooper and Kleinschmidt 1986; Dwyer and Mellor 1990). However, the effect of

external sources of resources and skills on the subsequent stages of the NPD process is largely ignored.

Second, the conceptualisation of the NPD process as essentially an independent, internal firm endeavour is based on the conventional market model where the firm operates as an independent competitive unit (Hakansson and Laage-Hellman 1984). In other words, internally-oriented NPD models allow little scope for the consideration of external collaborative methods. This is despite empirical evidence that the use of external technology positively influences NPD success (Rothwell 1977). For example, BHP, a large diversified Australian company, licensed-in the fully developed zincalume technology from Bethlehem Steel in the U.S. to facilitate faster entry into the roofing and wall-cladding market with new products which allowed it to dominate the market (Layton 1979). With this method the firm effectively skipped the early stages of the NPD process. Similarly, McGuinness (1990) recently studied 34 new product search activities of nine Canadian and British companies. In nine cases where the search processes were planned and structured, the companies had well-established policies for scanning external technology and building relationships with external technology sources. In all these nine cases, the companies licensed-in crucial technologies, that in one case allowed the firm to become a dominant world competitor.

The third shortcoming is that the implicit assumption contained in the internally-focused NPD models is that every firm has the capability, resources and time to develop new products from within. Such an assumption is not only false, but may be costly for many firms. It is also conceptually narrow and ignores the limitations of the internal R&D route to NPD and the advantages of the external route.

Wiedersheim-Paul (1982, p. 4) argued that "the competitive ability of a firm to a large extent consists of and is developed through resources which are situated outside the firm itself." Similarly, Hakansson and Laage-Hellman (1984) contended that an effective way to build competitive strength through the development of new products is through close relationships with other companies. These views suggest that a firm can acquire external resources as an alternative and/or complement to its NPD activities. For example, Wind (1982, p. 209) asserted that the "addition of new products to the firm's product/market portfolio can be done either by internal development or external acqusition." He maintained that marketing, technical and launch activities that impact on the success of new products could be acquired through external methods like technology licensing, contract research and joint ventures. Similarly, Calantone and di Benedetto (1988) suggested that firms that lack sufficient internal technical resources and skills, and those that want to reduce NPD risk may acquire product ideas and technology development from outside the organisation. In other words, at each stage of the NPD process management is faced with a 'make' or 'buy' decision: internal development (make option) or external acquisition (buy option) (Capon and Glazer 1987).

Unfortunately, the existing literature with its focus largely on internal NPD methods and activities, has not identified the factors that affect firms' decisions to adopt one NPD option such as ITL over another such as internal R&D (Capon and Glazer 1987). As mentioned previously in chapter 1, this study is designed to address the research problem concerning the factors that influence the firm to choose ITL as an alternative NPD option to internal R&D. In order to identify these factors, a foundation for a theoretical framework is presented in the next section. This involves the identification of the constructs that underpin the choice decision between ITL and internal R&D.

2.2 Foundations of an elclectic framework

As mentioned in the preceding section, the choice between internal R&D and ITL is a 'make' or 'buy' decision. Therefore a theory of ITL (the 'buy' option) must explain why this option is chosen over internal R&D (the 'make' option). Kogut (1988), as well as Hill, Hwang and Kim (1990) recommend that questions of 'make' or 'buy' need to be investigated with a more eclectic view of factors that include not only transaction, but also strategic and organisational learning factors.

Following this recommendation, this study adopts an eclectic framework to examine the factors that impact on the firm's choice of ITL over internal R&D as a NPD method. The framework employs as its foundation three constructs identified by Hill, Hwang and Kim (1990) which underlie the firm's decision to either internalise or use arm-length contracts to enter foreign markets. The three constructs are *control, resource commitment and risk exposure*. Although these constructs were developed with reference to the choice of an international mode of market entry, they appear to also underpin the choice decision between ITL and internal R&D. Each of these two methods of NPD has different implications for the degree of control that the firm can exercise over the NPD process, the amount of management, financial and other resources that it must commit to the process, and the level of risks it must shoulder. Each of these constructs is examined in detail below.

- **New product development and control**

Control, in the context of this study, refers to the ability of the firm to have complete authority and influence over the strategic and operational decisions involved in the NPD process. ITL and internal R&D both imply different levels

of control over such NPD process activities as product design and development, quality control, purchase of materials, production quantity, pricing, advertising and exporting. Internalisation of the NPD process through independent R&D facilitates complete and effective control over all aspects of the process (Hakansson and Laage-Hellman 1984). However, when a firm licenses-in new product technology from another company, the licensor company may impose various restrictive conditions which directly and indirectly limit the licensee's control over the use of the acquired technology (Caves, Crookell and Killing 1983; Gold 1982; Sen and Rubenstein 1989).

While the licensor can theoretically maintain effective control over the licensed technology through restrictive conditions, the degree of perceived and exercised control depends on a number of factors such as the size of the licensee relative to the licensor and the nature of the licensed technology. For example, Shahrokhi (1987) found that licensee firms who were larger than their licensors were able to negotiate licensing agreements with lower royalty payments and fewer restrictions. Further, licensing-in of matured technology involves fewer restrictions which allow the licensee more control over its use. This is because a mature technology market is usually competitive with many eager licensors (Contractor 1981). The higher level of competition among licensors tends to increase the bargaining power of licensees.

In general, however, the degree of control exercised by the firm over the NPD process activities is relatively lower in the case of ITL compared to internal R&D. As Hakansson and Laage-Hellman (1984) assert, a firm can have complete control of its NPD process only if it isolates itself from all other firms. Therefore, the acquisition of external technology through ITL indicates a willingness on the part of management to relinquish some control over its NPD process (Crawford 1985). Thus ITL by definition means some loss of control

over the NPD process. It is therefore theorised that control over the NPD process is relatively lower with ITL compared with internal R&D.

The assumption of full control over the NPD process through independent R&D has the attendant responsibility for high resource commitment and risks, as discussed next.

- **New product development and resource commitment**

In addition to control, resource commitment is considered an important underlying construct in the ITL versus internal R&D decision. Each method requires different levels of resource commitment from the firm. Resource commitment refers to the value or cost of assets, in terms of money, management skills and know-how, and time that the firm devotes to the NPD process. In the case of internal R&D, the firm incurs high costs of investments in R&D personnel and development of the product. Additionally, it may take years before these initial investments are recovered. In the case of ITL, however, the licensee firm incurs only search and evaluation costs, costs of adaptation of the licensed technology and licensor compensation costs (Shahrokhi 1987; Wind and Mahajan, 1988). Morehead (1984) estimated the cost of acquiring a fully developed product through licensing to be between 2 and 10% of the internal development cost. In addition, initial investments in licensing are relatively quicker to recover because of the speed of market entry the method allows (Shahrokhi 1987).

The level of resource commitment in the NPD process has important implications for the degree to which the firm is able to respond to changing technology. High levels of resource commitment in an activity may constitute an exit barrier (Hill, Hwang and Kim 1990). This suggests that due to the high capital investment and long lead time it requires, internal R&D may limit the

strategic flexibility of the firm. For example, Hakansson and Laage-Hellman (1984) observed that a firm with an introvert, internally focused NPD strategy may fail to respond in time to changes in the technology environment. Unlike internal R&D, ITL enables the firm to "preserve an open window on science and technology and to alert it to changing opportunities and threats" (Teece 1989, p. 38). It is concluded from the preceding discussion that compared to internal R&D, ITL involves lower resource commitment and higher strategic flexibility in NPD.

- **New product development and risk exposure**

The last construct presumed to underpin the firm's choice between internal R&D and ITL is risk. Development and marketing risks are key dimensions of the choice decision. Internal R&D is relatively a higher risk undertaking compared to ITL. For example, Capon and Glazer (1987, p. 5) commented:

> Risk capital is the key dimension in the choice of a method of enchancing the technology portfolio ... The firm's options range from independent research and development by the firm (high technological risk) to acquisition of a fully functioning technology... from another firm (low technological risk).

Internal R&D has high uncertainties and high probability of failure (Cooper 1984; Crawford 1979; Hopkins 1980; Link 1987). Unlike internal R&D, ITL allows the firm to reduce or avoid development and marketing risks by exploiting the experiences of the licensor (Killing 1978; Lowe and Crawford 1983). According to Shahrokhi (1987, p. 65) with ITL, "the licensor has already developed the technology and has patented it, so risk of failure is extremely low or non-existent". Furthermore, unlike internal R & D, ITL allows the firm to reduce financial risk (Roberts and Mozouchi 1989). While

ITL does have its own risks such as reducing the firm's base of skills and capabilities and increasing dependencies on other firms (Gold 1982; McDonald and Leahey 1985; Sen and Rubenstein 1989), the foregoing discussion indicates that, in general, risk exposure in the NPD process is lower with ITL compared to internal R&D.

The discussion in the preceding section suggests that the choice between ITL and internal R&D is underpinned by the degree of control, resource commitment (strategic flexibility) and risk exposure associated with each method. Table 2.1 presents a summary of these three underlying constructs showing the extent to which they vary between ITL and internal R&D.

Table 2.1 The Characteristics of ITL and Internal R&D

NPD Method	Control	Resource Commitment (Strategic Flexibility)	Risk Exposure
ITL	Low	Low (High)	Low
Internal R&D	High	High (Low)	High

2.3 Decision framework: Factors affecting propensity to adopt ITL

According to the theory developed in the previous section, factors that influence the choice between ITL and internal R&D are underpinned by three fundamental constructs: control, resource commitment, and risk exposure. Gold (1975) suggested that the decision to choose between alternative methods of NPD may be a function of the objectives and preferences of management, resource constraints, perceptions of the relative costs and benefits associated with the options, and the technological and market characteristics of the firm's industry. Similarly, Capon and Glazer (1987) speculated that firm structural characteristics and industry characteristics may be associated with the technology development choice decision.

Accordingly, the firm's propensity to adopt ITL as a NPD option is modelled as a function of four groups of factors:

- firm characteristics,
- management characteristics
- management perceptions of the relative costs and benefits of ITL, and
- perceived environmental hostility

The main thesis is that these groups of factors influence the firm's propensity to adopt ITL through their impact on the three underlying constructs discussed in section 2.2. Firm characteristics influence the choice decision mainly through their impact on the level of resources required in the NPD process. Firms with ample resources to meet their NPD goals may look more favourably to internalising the NPD process. Management characteristics influence the

decision primarily through their effect on control and risk exposure. For example, the extent to which ITL is consistent with management's desired level of control over the firm's NPD process will determine its willingness to consider the method. Since, ITL by definition involves some loss of control over the NPD process, a manager who desires complete control over the NPD activities of the firm may reject it as incompatible with his/her management philosophy. Such a manager will favour internal R & D, in spite of its relatively higher resource commitments and risk exposure. In addition, management's propensity for risk taking will have an impact on the evaluation of the risks associated with each of the two options.

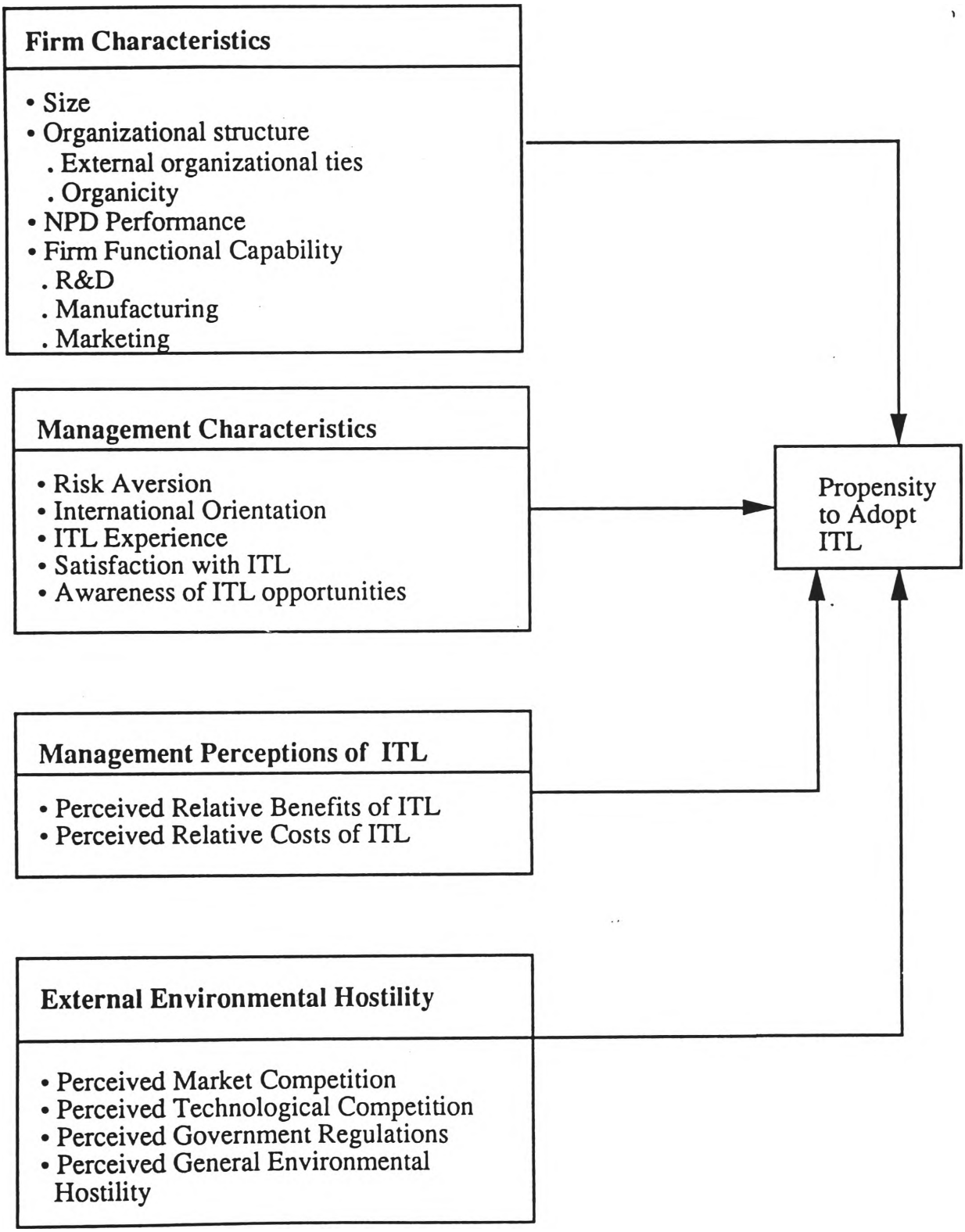
Management's perceived relative costs and benefits of ITL influence the choice decision through their impact on the level of control, resource commitment and risk exposure. Management's expectations of the extent to which the benefits of ITL are consistent with the goals of the firm, in terms of resource and risk reduction, will determine the likelihood with which the high control offered by internal R & D will be traded-off for the low control associated with ITL. Finally, perceived environmental hostility impacts on the decision through its influence on risk exposure. In a highly hostile environment firms are likely to prefer ITL.

In brief, while the internal R&D option allows the firm maximum and effective control over strategic and operational decisions in the NPD process, it also involves relatively high resource commitments, low strategic flexibility and high risk exposure. The nature of the firm's characteristics, management characteristics, perceptions of ITL and the environment may therefore motivate the firm to trade-off a high control method (internal R&D) for a low control one (ITL) involving low resource commitments, low risk exposure and high strategic flexibility.

Figure 2.1 presents an overview of the theoretical research model of the factors affecting ITL adoption. This model is used as a classification scheme to review the relevant technology licensing literature. The model differs from other studies of technology licensing by having an exclusive ITL focus. In addition, it not only enables the use of multivariate analytical techniques that allow for the examination of the relative impacts of the independent variables, but it also avoids the shortcomings of the case study approach which tends to underspecify explanatory variables.

In the following four parts of this section, specific issues of relevance and findings of the literature under each category of factors in the research model are discussed. Appendix 1 presents an overview of the relevant empirical studies, showing their sample, methodology and results pertinent to the current study.

Figure 2.1 Conceptual Model of the Firm's Propensity to Adopt ITL



2.3.1 Firm Characteristics

The first group of factors in Figure 2.1 is firm characteristics. A number of studies have focused on the description of the characteristics of licensee firms which provide evidence that propensity to license may be positively related to the internal capabilities of the firm.

Ford (1985) conducted a study among 152 U.S. firms, to determine the extent of, and common practices in technology licensing. Using the chi-square test of association, he found a statistically significant positive relationship between the firm's involvement in technology purchase deals and its size (measured by sales volume), R & D intensity, ability to generate marketable technologies, and extent of organisational ties through joint ventures, exporting, and technology sales deals.

Similarly, Parry and Watson (1979), in a study among Australian firms, reported a statistically significant positive relationship between technology purchases from unaffiliated firms and the size of the firm, its R & D expenditure and number of R & D personnel. However, unlike Ford (1985) they found a significant negative relationship between ITL and the firm's export sales. They argued that this is because technologies licensed from unaffiliated firms were more likely to contain stringent export restrictions.

In a more recent study, Reid and Reid (1988) compared licensee firms with non-licensee firms along a number of dimensions to determine the extent of their interest in ITL, and whether substantive differences existed between them. The study involved a mail survey of 230 Canadian small firms made up of 29 licensees and 201 non-licensees. In an analysis of responses from senior

managers of these firms, they reached the general conclusion that "inward licensing propensity and superior firm performance are associated" (p. 407). They reported that licensee firms, compared to non-licensees, tended to have the following characteristics:

- younger,
- higher levels of sales turnover and growth,
- larger in size (measured by sales volume and number of employees),
- higher number of trained and skilled production personnel, greater number of new product/process introductions,
- higher number of internally developed patents,
- more frequently intending to manufacture new products,
- higher frequency of forging organisational ties such as acting as resellers and distributors for other companies, and
- higher levels of diversified products/markets.

It appears from the preceding description of licensee firms that they have certain internal capabilities that predispose them to ITL. This conclusion is in accord with Killing's (1978, p. 160) assertion that a licensee firm needs to have technical skills in the area related to the licensed product to ensure success, and that "licensing [in] without in-house technical capability will be at a disadvantage". Similarly, Radnor (1991, p. 116) stated that "having a strong internal technical capacity ...is critical if one seeks to be a 'good' acquirer of external technology." This is because firms with strong internal capability are more likely to have knowledge of the available ITL opportunities. They are also more likely to be the target of the marketing efforts of licensors.

These views suggest that a licensee firm's internal capabilities and characteristics such as size, R&D, marketing, manufacturing capabilities, and linkages with overseas companies may be prime conditions for ITL adoption. However, the evidence regarding company size and R&D intensity is contradictory. Studies devoted to the reasons why firms adopt ITL have reported that small and medium-sized firms, and firms which lack internal capabilities to develop new products are more likely to use ITL (Lowe and Crawford 1983).

In addition to the conflicting findings, the foregoing literature has certain other limitations. With the exception of Reid and Reid's (1988) study, all the studies devoted to the description of licensee characteristics focused on licensee firms only. Without a comparative analysis of licensee and non-licensee firms, they do not provide any evidence of the characteristics that statistically differentiate licensees from non-licensees. Thus, they do not identify the distinctive characteristics of non-licensee firms that impede their adoption of ITL. One is therefore unable to determine to what extent the licensee characteristics identified by these studies actually facilitate ITL adoption.

Although Reid and Reid's (1988) study was a methodological improvement over the other studies, certain limitations need mention. First, while this study compared licensee and non-licensee firms, the researchers did not take the opportunity afforded by this research design to statistically confirm the differences they found. This is a major shortcoming, especially in the light of the varying number of firms in each grouping. Thus, despite the fact that their study provides some evidence that licensee and non-licensee firms may be different, the lack of rigorous statistical analysis means that the impact of firm characteristics on ITL adoption remains unclear.

Further, despite strong conceptual support for their influence on the firm's propensity to adopt ITL (Gold 1975; Pisano and Teece 1989), few studies have considered the influence that management characteristics and management perceptions of ITL might have on their propensity to adopt ITL. The literature on this issue is examined next.

2.3.2. Management characteristics

The second group pf factors in Figure 2.1 expected to impact on propensity to adopt ITL is management characteristics. Almost two decades ago, Gold (1975) called for greater research attention to management preferences and objectives in technology development decision-making. Svensson (1984) repeated this call. However, to date, there has been little empirical literature that explicitly examine the effect of management characteristics on the firm's propensity to adopt ITL as NPD method.

The first management characteristic affecting propensity to adopt ITL is international orientation. Shahrokhi's (1987) study reported that through international exposure and the nature of their jobs, some managers develop contacts for ITL opportunities. He found that 84 percent of his sample of 51 Ohio licensees had some international exposure prior to licensing-in technology. In a similar finding, Parry and Watson (1979) reported that the firm's propensity to license-in technology was positively related to the number of overseas visits undertaken by its senior management. These results suggest that managers of licensee firms may be more internationally oriented than those of non-licensee firms. This conclusion is in accord with the licensing-out literature which suggests that international exposure has a positive effect of the firm's decision to license-out technology (Carstairs and Welch (1982).

The second management characteristic is risk-aversion. Managers of licensee firms are more likely to be risk-averse compared to their counterparts in non-licensee firms. ITL has been described as a defensive strategy by which a firm protects itself against uncertainty and risk because with ITL "'the licensor has already developed the technology and has patented it, so risk of failure is extremely low or non-existent" (Shahrokhi 1987, p. 65). In a similar vein, Lowe and Crawford (1984, p. 131) noted that managers who want to steer a risk-averse course of NPD, may rely on ITL and other technology exchange agreements. These assertions indicate that management risk-taking propensity may impact on its willingness to enter into ITL agreements.

Indeed, in a study of firms' use of internal versus external methods of developing process innovations, Link, Tassey and Zmud (1983) reported that firms with high risk taking propensities were more likely to use internal R & D to acquire innovations. Although the focus of this study was not on ITL *per se*, it could be inferred from the preceding finding that the management of firms that acquire technology from outside sources may be more risk-averse than those who develop their technology internally.

With regard to the third management characteristic, Thunman (1983) argued that ITL experience can be deemed as one of the resources possessed by an organisation. Thus, a history of ITL may positively influence a firm's ITL. For example, Crawford (1985, p. 612) found that ITL was seen by firms as a learning process and that "companies that had used it once appear to use it again in many instances." Similarly, in a study of 28 licensee firms in the Korean pharmaceutical industry, Kim (1988) reported that future ITL opportunities with a licensor were of prime importance in a licensee's preparedness to pay a certain level of royalty for currently licensed technology.

In summary, it can be inferred from the foregoing findings that management of licensee firms are more likely to be internationally oriented, risk-averse and to have high positive expectations of the benefits of ITL. However, a limitation of this literature is that they have so far ignored the influence of other management variables like age, level of education, overseas business experience, awareness of ITL opportunities, and satisfaction with current ITL agreements on ITL propensity. Further, like the firm's characteristics, management characteristics have been examined in a descriptive manner by previous research, rather than for the extent of impact they have on ITL propensity. This criticism applies equally to the literature on management perceptions of the relative benefits and costs of ITL, described next.

2.3.3 Management perceptions of the benefits and costs of ITL

The third group of factors in the research model is management perceived relative benefits and costs of ITL.

2.3.3.1 Management perceived relative benefits of ITL

A number of researchers have examined the reasons why firms adopt ITL and have reached the same general conclusion: that the adoption of ITL originates from the organisation's motives to overcome internal resource constraints in the NPD process, and from the advantages that ITL offers to achieve that purpose.

The pioneering empirical study on the firm's reasons for ITL was conducted by Killing (1975) among manufacturing firms in Canada. He found that the major reasons for entry into ITL agreements related to the lack of internal product design, marketing and production skills, a need to reduce the risk of new product failure, the need for speedy market entry, growth and diversification. With respect to the use of ITL for diversification, he identified two types of ITL

agreements: current technology agreements; and current and future technology agreements. The former is an ITL agreement in which the licensor transfers only currently available technology to the licensee. The latter, on the other hand, involves the transfer of not only currently available technology but also future improvements and developments. He reported that firms utilised current technology agreements to diversify into areas closely related to their current product and markets, while current and future technology agreements were used for diversification into loosely related areas. He found that ITL was rarely used to diversify into areas unrelated to the firm's current activities and skills.

In a subsequent study of 40 companies manufacturing more than seventy products under license in Canada and the U.K., Killing (1978) confirmed his original findings. In addition, he also reported that firms licensed-in technology for several other reasons such as internal product development blocked by a patent, to adopt an industry standard, to keep abreast with new developments, and upgrade internal skills. He concluded that the major goal of firms in taking licenses was to benefit from the experiences of other firms.

The findings concerning the use of ITL for diversification have been supported by Caves, Crookell and Killing (1983). They surveyed 21 Canadian and 13 U.K. companies manufacturing a total of 80 products under license. Based on Killing's (1975) original reasoning, they classified skills useful for diversification into three: product design, production process, and marketing. They asked the licensees which of these skills they possessed internally at the time of the ITL agreement. Analysis of the responses showed that:

- 22 percent of the products were licensed-in to strengthen and improve the firm's existing capabilities, and

- 70 percent of the products licensed required skills closely related or loosely related to all the three diversification skills already possessed by the firm.

A similar study concerned with the reasons and advantages of ITL was conducted in the UK by Lowe and Crawford (1984). Their analysis of a sample of 183 firms produced the results presented in Table 2.2 The results appear to corroborate the preceding findings. Firms appear to license technology to overcome internal resource limitations by obtaining the support and expertise of the licensor to ensure speed market introduction, reduce R&D costs and risks, increase sales and diversify their product range.

In an effort to extend the Lowe and Crawford (1984) findings, Crawford (1985) conducted an in-depth case study of the role of licensing in the diversification strategies of firms. The major results of his study were in support of previous research findings. Specifically, he concluded that ITL was used mainly to:

- overcome internal resource limitations such as insufficient in-house finance and time,
- reduce costs and risks in NPD,
- ensure speedy growth and market expansion,
- fill product gaps, especially by firms with aging product portfolios and those operating in mature or contracting industries,

Table 2.2 Reasons and Benefits of ITL adoption

Benefit	Percentage response*
Speed of market entry	24
R&D work already done (cost)	24
Brand name/reputation	22
Increase in sales	19
R&D support	17
Established products (reduced risk)	15
Superior design	11
Diversification	9
Market backup	6
Other	15

* Total exceeds 100 percent because multiple responses were allowed.
Source: Lowe and Crawford (1984, p. 172)

- acquire products when in-house R&D failed to produce new products to meet the objectives of the organisation and where the market growth was too fast for internal R&D to be able to provide the products needed to effectively compete in the market, and
- ensure survival or growth through the diversification of current activities.

In concert with the foregoing studies, Shahrokhi (1987), reported similar results in a more recent study of 51 licensees in Ohio. He found that small to medium sized firms adopted ITL once their existing technology was in the decline stage of its life cycle. Such firms lacked competent internal R&D and skilled personnel to develop technologies in-house. Specifically, licensee motivations for ITL were supplementing their own R&D (38 percent), diversification of related activities (36 percent), avoiding R&D risks (32 percent), and securing patent rights (26 percent).

The foregoing findings support Svensson's (1984, p.181-182) assertion that the ITL decision is "usually evoked by the recognition of a need on the existing market of the licensee, or by the recognition of a problem within the licensee's own organisation". They suggest that internal skill deficiencies are strong motivating forces for firms' entry into ITL agreements. Thus, management of licensee firms may have very favourable expectations regarding the effect of ITL on the firm's NPD cost, risk, speed and other strategic objectives.

The findings also provide empirical support for Gold's (1975; 1982; 1987) arguments about the need for firms to consider ITL as a low cost and speedy alternative to internal R&D for the acquisition of new technology, especially where the firm needs to quickly augment a narrow or near obsolete product

portfolio. However, as mentioned previously, these findings contradict the literature on licensee characteristics, which suggests that firms with strong internal capabilities are more likely to license-in technology.

In addition, within the literature dealing with the reasons why firms license technology, some of the findings are contradictory. For example, the empirical findings concerning ITL as a low-risk and low-cost market entry strategy have been questioned by a number of scholars. Ford (1985) contended that the importance of speed of market entry as a reason for ITL may be overstated because only 22 percent of his sample of the 152 U.S. firms acquired technology for market entry. Similarly, Lowe and Crawford (1983, p. 28), hypothesized that "while speed of product introduction may be crucial in many cases, costs are probably a more important factor in many firms' decisions to use licensing."

Further, Lieberman (1989) found that the distribution of technology sources was roughly the same for surviving and non-surviving firms in his study. This finding led to the conclusion that "there is no evidence that internal technology development was a riskier entry strategy than licensing" (p. 446). These conflicting findings point to the need to examine the factors behind the firm's ITL propensity in a multivariate framework to allow for the determination of their relative importance.

In brief, on the one hand, the literature that focuses on licensee characteristics suggests that a firm's internal capabilities in terms of size, R & D, marketing and manufacturing positively influence ITL adoption. On the other hand, the ITL literature on benefits and reasons why firms adopt ITL suggests that firms may adopt ITL to obtain licensor expertise and support when they lack the internal capabilities and resources to develop technology in-house.

Two different interpretations can placed on the foregoing contradictory results. First, it appears that firms with strong internal capabilities may have more internal resources to draw upon in product innovation and may therefore be less likely to rely on external technology. This argument would suggest a negative relationship between ITL adoption and size, R & D, marketing and manufacturing capability.

Conversely, it could also be argued that firms with strong internal capabilities may have the financial and technical resources that would facilitate effective search for, acquisition of and exploitation of external technologies (Gold 1982; Killing 1977; Shahrokhi 1987). Such firms are more likely to be sought after by licensors (Radnor 1991). For example, McDonald and Leahey (1985, p. 37) asserted that "the internal capabilities of the licensee to effectively apply the licensed technology" are important considerations of licensors in selling their technology. Therefore, such firms may be better able to attract and negotiate profitable ITL deals with licensors. From this perspective, one would expect a positive relationship between the firm's internal capabilities and ITL adoption.

In all, then, it is not clear whether strong or weak internal capabilities will be associated with propensity to adopt ITL. It seems reasonable however to speculate that a firm may develop certain products internally and would license-in technologies for particular products for which it does not have the required internal capability to develop.

Perhaps, a reason for these contradictions is that previous researchers have not conceptualized "propensity to adopt ITL" as a dependent variable in order to examine the impact of independent variables on it. Assuming that management has specific expectations and views about the ITL, then, to the extent that ITL is

perceived as likely to achieve the goals of the firm, its adoption is undertaken purposefully. Therefore, ITL adoption behaviour will best be understood in the context of a *behavioural process* taking place as a result of an evaluation by management, in the light of conditions in the firm and the environment. The result of this evaluation is an attitude towards the future use of ITL, or *propensity to adopt ITL.*

In this sense, the list of reasons and advantages for ITL provided by the literature can be viewed as measures of management perceived relative benefits of ITL, *given* the capabilities of the firm and its environment. However, none of the previous studies has explicitly focused on management perceptions, management characteristics, firm characteristics and the external environment as explanatory variables. A conceptualization of "propensity to adopt ITL" as dependent variable, and the examination of the extent to which the preceding groups of variables facilitate or impede such adoption will shed meaningful light on these contradictory results. The foregoing discussion raises the question: might the procedure adopted by researchers have failed to isolate some fundamental organisational and environmental factors that may predispose or facilitate the organisation to adopt ITL?.

2.3.3.2 Management perceived relative costs of ITL

In addition to perceived benefits, management perception of the relative costs of ITL vis-a-vis internal R & D may influence their propensity to license. There are two major categories of costs associated with ITL: acquisition costs and implementation costs. Each cost category is discussed in turn.

- **ITL acquisition costs**

Sen and Rubenstein (1989) have identified a number of problems and costs in the process of external acquisition of technology. Some of these problems relate

to the high cost of technology acquired. In addition to the high cost of technology, ITL also involves transaction costs. For example, the lack of information for proper evaluation of alternative technologies and higher bargaining power of licensors are reported as major licensee problems in the external technology acquisition process. Additionally, the fact that few firms actively market their technology means that a potential licensee has a difficult and costly search process (Teece 1981). Other transaction costs relate to the costs of travel and negotiation.

Licensee-licensor conflict appears to be a major cost in the use of ITL (Weinrauch and Langlois 1987). Ford (1985) reported that, for the licensee, transaction costs of licensing relate to the risk of non-delivery, lengthy and costly negotiation, and disputes over delivery timetables. Conflicts and arguments with licensors were also found to be important transaction problems. In his study, respondents indicated that arguments over the quality and quantity of technology, cost of technology, amount of after-sales services, and payment were recurring problems in their relationships with licensors.

- **Implementation costs**

ITL implementation costs relate to the restrictive conditions that may be imposed on the licensee by the licensor (Sen and Rubenstein 1989). These conditions include restrictions on such things as exporting, purchase of raw materials, parts, sub-assemblies, grant-back of improvements, marketing, and pricing. Caves, Crookell and Killing (1983) examined 257 licensing agreements and found a high incidence of restrictive clauses including marketing (34 percent), production location (34 percent), and grant-back of improvements (43 percent). Parry and Waston (1979), and Parry (1988) have both found similar incidences of restrictive clauses in licensing agreements involving Australian firms.

Other costs that the licensee may incur due to the restrictive conditions include loss of decision-making autonomy in the use of the technology, and decreased efficiency and revenue. For example, according to Sen and Rubenstein (1989), restrictions on marketing and prices at which the licensed product may be sold could minimise the sales and growth potential of the licensee. In addition, grant-back provisions may lead to loss of control over crucial decisions and introduce costly impediments in the use of the licensed technology.

However, Parry (1988) contended that the mere presence of a restrictive condition in a license agreement does not imply effective limitation on the licensee operations. In a survey of 393 Australian firms on their sources of technology and the restrictions imposed, he drew a distinction between `nominal' and `binding' restrictions. The former is a formal restriction which appears in the license agreement but which has no practical importance because it has no effect on the operations of the licensee. For example, an export restriction placed on a licensee who, due to various factors, is incapable of exporting. A `binding' restriction, on the other hand, is that restriction which effectively limits the ability of the licensee to engage in an activity it is otherwise capable of pursuing.

Using this dichotomy, he found only a small proportion of his sample identified restrictions on exports and purchasing requirements as having some restrictive effect on their firms' operations. This result suggests that management decision to license-in may be unaffected by the mere presence of a particular restrictive condition in the agreement. The important factor may be management's perception of the potential effect of the restrictive condition on its future operations, given the firm's capabilities.

A further cost of ITL concerns the process of integrating the licensed technology into the licensee's operations. According to McDonald and Leahey (1985), ITL may create substantial problems in adapting the technology to the licensee's operations, especially where the licensor is located in a foreign country with language and cultural differences. Additionally, ITL may require additional scale-up, resulting in additional costs and delays in commercialisation.

Svensson's (1984) results give credence to these theoretical assertions. In a study of 50 licensing relationships and five cases of firms acting as licensees in Sweden, he found that in many cases substantial development work, involving costly adaptation of the acquired technology, was required before the licensed product could be introduced into the market. Another implementation cost or risk of ITL relates to the potential it has to hinder or even retard the internal NPD skill development of the licensee. While the empirical literature suggests that ITL may be employed by firms to build internal NPD capability (for example, Killing 1978; Patsalox- Fox 1983), some theoretical writings suggest that it may actually limit or even retard the internal NPD capability development of the licensee, and lead to dependence on the licensor for new technology.

For example, Sen and Rubenstein (1989) argued that technology licenses may discourage internal competitive research and foster the "not-invented-here" syndrome which increases the problems and costs of using externally acquired technology. Additionally, ITL does not necessarily result in an in-depth technical knowledge and training of personnel that could be gained from internal development. It may also require grant-back of technology improvements made by the licensee to the licensor. These improvements may then be licensed to other licensees who are competitors to the licensee firm

making the improvements (McDonald and Leahey 1985). It is therefore possible that the licensee's internal capability to innovate, and thus its long-run competitive ability, may be hindered.

Finally, it is contended that ITL is an investment in current technology, rather than technology which would be superior to the competition (McDonald and Leahey 1985). The licensed technology may be near the end of its useful competitive life, since licensors are more likely to license-out older technologies than new ones (Ford 1988).

The foregoing sections provided a description of the costs and risks involved in ITL. Despite the descriptive and anecdotal nature of these writings, they suggest that internal resource limitations or the possession of internal skills alone may not be sufficient to induce a firm to enter into an ITL relationship. In the final analysis, management perception of the benefits and costs of licensing vis-a-vis internal R&D may determine their willingness to adopt ITL. The firm is more likely to engage in technology licensing if management believes that it will contribute to the achievement of the firm's strategic goals.

Thus, the attractiveness of ITL will vary from firm to firm and this variance will be influenced by the management's subjective perceptions of the costs and benefits of ITL, and the firm's capabilities. The implication is that managers of licensee firms may have perceptions that the benefits of ITL exceed its costs compared to managers of non-licensee firms. Further, a higher perceived cost of ITL may override the perceived benefits leading to its rejection. Support for this line of reasoning is provided by Pisano and Teece (1989, p. 235) who argued that "high transaction costs will lead to a rejection of a license agreement even where other factors warrant it."

This view suggests that management's perception of the costs and benefits of ITL may play a crucial role in the firm's propensity to adopt the method. Yet, as mentioned previously, no study has attempted to explicitly examine the perceptual differences between licensee and non-licensee managers as to the benefits and costs of ITL, and thus, the influence of these variables on ITL adoption.

2.3.4 Environmental hostility

The last group of variables in Figure 2.1 is management perceived environmental hostility. In addition to the internal considerations discussed in the preceding four sections, market and technological competition have been cited as powerful inducements for firms' entry into ITL agreements. In relation to the impact of market competitive pressure on the firm's propensity to adopt ITL, Crawford (1985) found that in a majority of his sample of small and medium-sized firms, threat of competition was an important rationale behind their ITL decision. He suggested that competitive pressure led firms to adopt ITL as a means of urgently acquiring new products which could not be developed from internal resources alone.

In a similar vein, in a paper aimed at providing practical advice to management on `How to buy technology', Patsalox-Fox (1983) suggested that firms could be forced into technology licensing by government policies and market competition. He reported that, as a result of government de-regulation policies, manufacturers of PABX systems in the UK were forced to license-in technology to fill their product lines in the face of competitive threats from foreign entrants, who possessed superior technology and offered lower prices. The ITL agreements were structured to allow the licensees to assemble the product initially, followed by design modifications to suit local customer

requirements, and later to develop their own designs based on the original technology.

With respect to technological competition, conceptual writings suggest that rapid rates of technological change may lead firms to adopt ITL because it may not be possible for an individual firm to keep up with innovations in all the diverse areas (Gold 1975; Wilkinson 1985). Although direct empirical evidence of this argument is hard to find, results of some studies show that there is a high incidence of licensing agreements in the pharmaceutical, chemical and electronic industries (Ford 1985; Lowe and Crawford 1984; Wind and Mahajan 1988). The argument is that the rapid rate of product obsolescence and the availability of technology for licensing in such high technology industries lead firms to adopt ITL (Olleros 1986).

In brief, the discussion of the literature in the preceding five sections suggests that the firm's propensity to adopt ITL may be influenced individually and collectively by the four groups of variables presented in Figure 2.1. The discussion also shows that there are conflicting findings, especially in relation to the influence of firm characteristics and internal capabilities on ITL adoption. Further, the relative importance of some variables such as speed of market entry and cost is open to debate. Additionally, it was noted that despite strong conceptual support for their influence on ITL adoption, management characteristics and management perceptions of the relative costs and benefits of ITL remain relatively neglected areas of attention in the empirical literature. The lack of the examination of the individual and collective influence, and of the relative impact of the variables that affect ITL adoption, may be traced to the limitations in the methods used by previous researchers. These are discussed in the next section of the chapter.

2.4 Methodological limitations in ITL research

The literature discussed in the preceding pages shows clearly that the previous inquiry into why firms adopt ITL consists of fragmented efforts. Some of the studies focused on the reasons and advantages for firms adopting ITL. Others concentrated on the description of the characteristics of licensee firms. There has been no attempt to consolidate these empirical studies into a consistent comprehensive framework, in order to statistically examine the individual and collective influence of the four categories of factors identified as affecting ITL adoption. The result is that, to date, we have no indication of either their overall variance explained or the significant tests of the relative contribution of each factor.

This neglect results from the measurement and research design limitations of the previous studies. First, in most instances variables were determined by simply using a series of dichotomous "yes/no" questions rather than metric scales. Further, most of the empirical studies relied on single item measures for variables that are potentially multi-dimensional, indicating a lack of concern for the validity and reliability of measures. For example, Killing (1975, 1978), as well as Caves, Crookell and Killing (1983), measured the firm's core skill by the number of engineers and scientists employed. Kim (1988) measured the licensee's marketing skill and technical skill by the advertising and R&D expenditure as percentage of sales, respectively.

As previously mentioned in chapter 1, it is debatable whether such measures really capture what they are supposed to be measuring. For example, one may argue that a firm's "core skill" may relate not only to R&D, but also to its marketing, production, and other resources and experience. It may also be reflected in its relations with other organisations (Wiedersheim-Paul 1982).

Additionally, most of the studies have been case studies that precluded the effective development of operational measures of variables (for example, Crawford 1985). However, even those studies that relied on self-reported data with metric scales did so without any reliability or validity testing, with the notable exception of Shahrokhi (1987).

Such measuring instruments preclude the use of multivariate techniques (for example, factor analysis, multiple regression, etc.) to analyse the underlying dimensions, the collective impact, and the relative impact of the variables that influence the firm's propensity to license. Thus, most of the studies offer relatively simple descriptive quantitative results (for example, frequency distributions) (for example, Crawford 1985; Reid and Reid 1988; Shahrokhi 1987). Furthermore, ITL empirical studies have included only licensee firms in their samples. They have therefore failed to statistically test the existence of, or examine the discriminating power of firm and managerial characteristics that differentiate licensee from non-licensee firms. As mentioned in section 2.3.1., without a comparative analysis of licensee and non-licensee firms one is unable to determine to what extent licensee characteristics facilitate ITL adoption. The methodological weanesses discussed above are summarised in Table 2.3.

In summary, the overall profile that emerges from the preceding discussion on previous ITL research methodology is one of limited sophistication and inherent constraints. However, it is recognised that ITL research is in its infancy, so these studies are a foundation from which more rigorous studies would emerge. Therefore these criticisms are not to deny the central importance of these studies as sources of insight into a new field of research like ITL. Rather, they are to indicate that to advance ITL theory, there is a need to develop a more

Table 2.3 Methodological Problems in ITL Research

Sampling	1. Small sample sizes (e.g., Shahrokhi 1987) 2. Exclusion of non-licensee firms (e.g., Crawford 1985; Killing 1975).
Data Collection	1. Reliance on self-reporting by respondents without testing for reliability and validity (e.g., Lowe and Crawford 1984; Svensson 1984). 2. Opportunity for misinterpretation and biasing by researchers (e.g., interviews and content analysis of cases) (e.g., Crawford 1985).
Instrumentation	1. Measurement of variables generally by nominal scales not metric (e.g., Caves, Crookell and Killing 1983; Ford 1985; Reid and Reid 1988).
Analysis	1. Descriptive and non-parametric statistics prevail due to sampling and intrumentation used (e.g., Caves, Crookell and Killing 1983; Crawford 1985; Killing 1975; Shahrokhi 1987; Reid and Reid 1988). 2. Multivariate analysis is virtually non-existent.

comprehensive model of the firm's propensity to adopt ITL. Further, reliable measures of variables are required, that allow a systematic quantititative analysis of the ITL adoption decision focusing on the extent, significance and relative influence of the different explanatory factors.

A major contribution of this research is that unlike the previous studies, it includes both licensee and non-licensee firms for comparative analysis. Additionally, metric rating scales are utilized to assess the relative importance of the factors that influence ITL adoption. Further, multivariate methods are used to investigate the validity and reliability of measures, and the individual and combined influences of the independent variables on propensity to adopt ITL.

2.5 Theoretical model and research hypotheses

In the light of the preceding review of the relevant literature, the propensity to adopt ITL is seen as an explicit behavioural act on the part of the firm's management in response to stimuli, both internal and external to the firm. Thus the general implicit assumption that the firm will pursue ITL as a means of exploiting internal capabilities or overcoming internal resource constraints needs to be qualified by the existence of a positive managerial perception of ITL. In addition, other internal and external factors that facilitate the adoption of ITL must exist. Finally, the organisation must be assumed to make a conscious choice to pursue ITL for certain objectives.

The implication of this line of argument is that in order to investigate the factors that influence the firm's propensity to adopt ITL, we need to depart from the mere provision of a list of reasons and description of licensee characteristics. What is needed is the development of a more comprehensive explanatory model

of ITL adoption, and reliable measures of variables, that allow for an investigation of not only how these factors separately influence the firm's propensity to adopt ITL, but also their combined impact and relative importance. This is the rationale underlying the explanatory model presented in Figure 2.1 in section 2.3. The model examines the effects of four variable groups on ITL adoption: firm characteristics; management characteristics; management perceived costs and benefits of ITL; and perceived environmental hostility.

In brief, the intent is to develop a broader explanatory model of ITL adoption behaviour, with a richer set of variables, than had been previously available in the literature. Table 2.4 presents a summary of the hypothesized relationships between the independent variables and the dependent variable in the model. Where applicable, the expected direction of the effect of each independent variable on the dependent variable is denoted by a positive or negative sign.

Table 2.4 Summary of Hypotheses to be Tested

Research Question	Hypothesis	Expected Direction
1. What are the differences between firms that have adopted ITL and those who have not?	H1. Licensee and non-licensee firms can be separated along firm characteristics, management characteristics, management perceived costs and benefits of ITL, and perceived environmental hostility	N/A
2. What is the influence of each firm, managerial characteristics, managerial perceptions of costs and benefits of ITL and perceived environmental hostility on propensity to adopt ITL?	H2. The firm's propensity to adopt ITL is influenced by its characteristics.	
	H2a: The larger the firm, the higher the propensity to adopt ITL.	+
	H2b: The higher the extent of ties with overseas organisations, the higher the propensity to adopt ITL.	+
	H2c: The more organic the firm's structure, the more likely the adoption of ITL.	+
	H2d: The higher the firm's internal NPD capabilaity to achieve its performance objectives, the lower the propensity to adopt ITL.	-

Table 2.3 (Cont'd.)

H2e: The higher the firm's R&D capability, the higher the propensity to adopt ITL.	+
H2f: The higher the firm's manufacturing and marketing capability, the higher the propensity to adopt ITL.	+
H3: The propensity of a firm to adopt ITL is influenced by its management characteristics.	
H3a: The greater the risk aversion of management, the higher the propensity to adopt ITL.	+
H3b:The higher the international orientation of management, the higher the propensity to adopt ITL	+
H3c: The greater the ITL experience of the firm, the higher the propensity to adopt ITL	+

Table 2.3 (Cont'd.)

H3d: The greater the level of satisfaction with current ITL agreements, the greater the propensity to adopt ITL	+
H3e: The greater the awareness of ITL opportunities, the greater the propensity to adopt ITL	+
H4: The firm's propensity to adopt ITL is influenced by management's perceived costs and benefits of ITL.	
H4a: The higher the perceived relative benefits of ITL, the higher propensity to adopt ITL	+
H4b: The higher the perceived relative costs of ITL the lower the propensity to adopt ITL	-

Table 2.3 (Cont'd.)

	H5:	The greater the perceived market and technological competition, and increased government regulations affecting NPD, the higher the propensity to adopt ITL	+
3. What is the most parsimonious set of factors that influence the firm's adoption of ITL and their relaive importance?	H6:	The factors influencing propensity to adopt ITL will differ in their explanatory power.	N/A

2.5.1 Dependent variable: Propensity to adopt ITL

The dependent variable in Figure 2.1 is propensity to adopt ITL. As indicated in chapter 1, it is defined in two ways. First, it represents a measure of the firm's manifest outcome ITL behavior as indicated by *whether or not the firm is currently involved in ITL.* As will be indicated in chapter 3, this way of measuring propensity is commonly employed in the international marketing literature.

The second way of measuring the dependent variable was by a composite of four metric scaled items. As will be explained in chapter 3, it is a measure of the firm's *attitudinal orientation or intention towards future use of ITL.* Detailed definitions and measurement of the dependent and independent variables in the model are presented in chapter 3.

2.5.2 Differences between firms based on involvement in ITL

The literature reviewed in the preceding pages suggests that licensee firms may be different from non-licensee firms in terms of their characteristics and capabilities. Reid and Reid (1988) found that compared to non-licensee firms, licensee firms are more likely to introduce more new products, have more skilled personnel, higher sales turnover and growth, higher level of organisational ties and higher number of internally-developed patents. Licensee and non-licensee firms are also likely to differ in their management characteristics (Shahrokhi 1987); and management perceptions of the costs and benefits of ITL (Killing 1977; Crawford 1985). As noted in section 2.3.1 most studies have been limited to the description of only licensee firms. The one study that compared licensee and non-licensee firms did so without any

rigorous statistical analysis (Reid and Reid 1988). Nevertheless, based on the evidence of these studies the following hypothesis is tested:

Hypothesis 1

Licensee and non-licensee firms can be separated along firm characteristics, management characteristics, management perceived costs and benefits of ITL, and perceived environmental hostility.

2.5.3 Hypothesized relationship between propensity to adopt ITL and firm characteristics

The previous review of the literature in sections 2.3.1 and 2..3.3 on the characteristics of licensee firms and reasons for ITL adoption, suggests that the propensity to adopt ITL may be related to certain characteristics and capabilities of the firm. The studies concerned with the benefits and reasons for ITL adoption conclude that propensity to adopt ITL originates from the firm's motives to overcome internal resource constraints in the NPD process (for example, Crawford 1985, Killing 1975, 1977). A firm that lacks internal resources is therefore expected to forego control over the NPD process by adopting ITL to obtain the advantages of lower resource commitment and risk exposure.

However, studies that focused on licensee characteristics suggest that lack of internal NPD capability and resources may be a necessary but not sufficient condition for a firm to use ITL. The internal capabilities of the firm to successfully absorb and apply the licensed technology are prime conditions for the use of ITL to the mutual advantage of the licensor (Gold 1982; Killing 1978; Radnor 1991). In this regard, the following general hypothesis states that:

Hypothesis 2:

The firm's propensity to adopt ITL is positively related to its size; extent of ties with overseas companies; organicity of its structure; R&D, marketing and manufacturing capabilities; and negatively related to its overall NPD performance capability.

Each of these firm characteristics and its relationship with ITL propensity is described in detail below.

- **Firm size**

Empirical research findings about the relationship between the size of the firm and its involvement in ITL are equivocal. Several studies have found that firm size has a positive effect on ITL adoption (for example, Parry and Waston 1979; Caves, Crookell and Killing 1983; Ford 1985; Reid and Reid 1988). Empirical research indicates that firm size positively influences the speed with which the licensed product is introduced into the market (Svensson 1984). Thus, large firms are preferred as licensees since they possess the resources necessary to commercialise innovations (Shan 1990). However, other studies have reported that small firms are more likely to engage in ITL since they lack the internal resources to develop products internally (Lowe and Crawford 1983; Shahrokhi 1987).

In spite of these contradictions, it appears that small firms may not have the level of financial, marketing and production resources and expertise, nor the market coverage to attract licensors. Additionally, small firms may not possess the skills to search and negotiate ITL agreements, or the finance to employ licensing intermediaries. On *a priori* grounds therefore, one would expect large firms to have better management, financial, production and R&D resources, higher market coverage and power to attract licensors. Further, large firms are

more likely to have the internal skills to be able to find, evaluate and negotiate profitable ITL agreements. Therefore given a licensable technology large firms would prefer ITL to internal R & D. This reasoning underlies the following hypothesis:

Hypothesis 2a:

The larger the firm, the higher the propensity to adopt ITL.

- **Organisational structure**

The second independent variable is the firm's organisational structure, two aspects of which are considered in this research: (1) extent of organisational ties and (2) organicity of the structure, that is, the extent to which the organisation allows participatory decision-making.

As reported in section 2.3.1., a number of studies have found a tendency for licensee firms to have ties with overseas organisations through such activities as exporting, joint ventures, distributions agreements, and acting as manufacturing agents (Ford 1985; Parry and Waston 1979; Reid and Reid 1988; Shahrokhi 1987). Such ties provide avenues through which firms evaluate and gain experience with products prior to licensing them (Reid and reid 1988). Such prior experience tends to reduce the risks associated with the acquisition and implementation of the licensed technology.

These results indicate that firms that have organisational ties with overseas firms are more likely to have appropriate channels of communication through which they could have access to ITL-related stimuli. These firms are therefore more likely to adopt ITL than firms which lack such organisational ties. On the strength of this argument the following hypothesized relationship between ITL adoption and extent of the firm's organisational ties is presented.

Hypothesis 2b:

The higher the extent of ties the firm has with overseas organisations, the higher the propensity to adopt ITL.

The second aspect of organisational structure relates to its organicity. Organicity refers to the extent to which the organisation is organised to allow decentralisation of decision making, and less formalisation and rigid adherence to rules and regulations. As indictated in section 2.3.4, the firm's propensity to adopt ITL is influenced by environmental conditions (Crawford 1985; Gold 1982; Patsalox-Fox 1983). Further, an important source of ITL opportunities is personal contacts of company personnel (Kim 1988; Shahrokhi 1987)).

These findings suggest two things. First, the firm's ability to adapt to the environment by the use of ITL depends on its ability to secure, process and quickly respond to ITL-related information. Second, ITL opportunities discovered by company personnel need to be fully and objectively assessed to allow an effective response. This would require an organisational structure that allows initiative and decision-making autonomy for an unbiased and effective evaluation of the propective technology. The foregoing discussion indicates that a mechanistic organisational structure with high degrees of centralisation and formalisation may hinder the adoption of ITL. On the other hand, an organic structure with less emphasis on specific operational rules and regulations, and with open channels of communication and decentralised decision-making, may permit quicker awareness and response to ITL-related stimuli. The following hypothesis is presented:

Hypothesis 2c:

The more organic the firm's organisational structure, the higher the propensity to adopt ITL.

- **Overall NPD performance capability**

The empirical studies reviewed in section 2.3.1. indicate that a firm acquires a license when it does not have the appropriate internal capability to develop a new product to meet its objectives. Thus, ITL is used to either supplement internal efforts (Shahrokhi 1987) or to overcome financial, time and technical limitations in developing products internally (Caves, Crookell and Killing 1983; Crawford 1985; Killing 1975). However, Reid and Reid (1988) reported that licensee firms are more likely to be active in NPD and to have a larger number of new product introductions than non-licensee firms. These results suggest that while a firm may be active in NPD, it will adopt ITL in specific product areas to gain access to the products and skills of other organisations in order to meet its overall NPD performance objectives (Crawford 1985).

It can be argued that a firm with ample internal resources to achieve its NPD goals may prefer to retain effective control over its NPD by internalizing the process. However, a firm without ample resources may have to trade-off the high control method (internal R & D) for a low control one (ITL) involving lower resource commitments and risks. It is therefore hypothesized that:

Hypothesis 2d:

The higher the firm's internal capability to achieve its NPD performance objectives, the lower the propensity to adopt ITL.

- **R&D capability**

Like firm size, research findings of the relationship between ITL use and the basic R&D capability of the firm are contradictory. On the one hand, it is reported that the use of ITL is directly related to R&D capability, as measured by percent of sales, or number of R&D personnel (Parry and Waston 1979; Killing 1977; Ford 1985; Shahrokhi 1987). Similarly, Reid and Reid (1988) reported that licensee firms are more likely to introduce more new products than non-licensee firms. The conclusion to be drawn from these findings is that firms with higher R&D capability may be more capable of generating new products internally and are therefore less likely to acquire external technology. On the other hand, it could be argued that firms with higher R&D capability may have higher new product experience and skills to absorb licensed technologies and are therefore likely to be prime candidates for ITL (Gold 1982; Radnor 1991). They are also more likely to acquire external technology to increase the returns on their R & D investments (Capon and Glazer 1987).

Despite these conflicting interpretations, it appears that a competent internal R&D unit can facilitate the identification of alternative technologies, generation of information related to licensable technology, and improvement in the bargaining power of the firm in ITL negotiations (Sen and Rubenstein 1990). The implication of this are twofold. First, a competent in-house R&D unit may have or can develop adaptive skills to ensure successful acquisition and implementation of a external technology. Second, firms with higher R&D capabilities would be preferred by licensors because of their ability to apply licensed technologies and generate improvements which would be transferred to the licensor. Thus they are more likely to be the targets of the licensor marketing efforts. For these reasons it is hypothesized that:

Hypothesis 2e:

The higher the firm's R&D capability, the higher the propensity to adopt ITL.

- **Manufacturing and marketing capability**

In addition to R&D capability, licensor firms consider the capability of a prospective licensee firm to manufacture and market the licensed product in deciding to license-out technology (Lowe and Crawford 1984; Shahrokhi 1987; Teece 1988). Some studies suggest that licensee firms are likely to have strong marketing and production expertise with which to attract licensors (Caves, Crookell and Killing 1983; Lowe and Crawford 1984; Reid and Reid 1988; Thunman 1983). For example, Shan (1990) reported that biotechnology firms lacking adequate marketing skills license-out their new products to firms with the necessary manufacturing and marketing skills to profitably commercialise the new products.

The positive impact of the firm's manufacturing and marketing capability on ITL adoption can also be inferred from results reported by Kim (1988). Among the 28 licensees he examined, he found that absorptive capacity measured by the firm's marketing, technical, manufacturing experience and management capability influenced both the nature and extent of services provided to them by their licensors.

These empirical findings suggest that a firm with strong manufacturing and marketing competence is likely to be in a favourable position to perform the manufacturing and marketing activities related to the licensed technology. From the preceding discussion the following hypothesis is presented:

Hypothesis 2d:

The higher the firm's marketing and manufacturing capabilities, the higher the propensity to adopt ITL.

2.5.4 Hypothesized relationship between propensity to adopt ITL and managerial characteristics

In addition to firm characteristics, the research discussed in sections 2.3.2 suggests that management characteristics may influence the firm's propensity to adopt ITL. On the basis of that literature hypothesis 3 posits that:

Hypothesis 3:

The extent of management characteristics such as risk-aversion, international orientation, ITL experience, ITL satisfaction, and awareness of ITL opportunities will have positive impacts of propensity to adopt ITL.

The rationale for each of these sub-hypothesis is presented in the following sections.

- **Risk aversion**

Although according to Lieberman (1989), technology development through ITL may be as risky as internal R & D, some scholars argue that acquisition of external technology is relatively less risky. For example, according to Capon and Glazer (1987, p. 5), in developing technology :

> "The firm's options range from independent research and development (high technological risk) to acquisition of a fully functioning technology...from another firm (low technological risk)."

In conformance with this view, a number of studies have reported that ITL is used by firms to avoid or reduce NPD risks (Killing 1977, 1978; Lowe and Crawford 1983; Crawford 1985; Shahrokhi 1987). This finding suggests that management perceive internal NPD as a riskier strategy than ITL. This means that by adopting ITL, the licensee subcontracts R&D risks to the licensor. As Shahrokhi (1987) noted with ITL risk of failure is extremely low or non-existent because the technology is proven and the licensee can gain access to licensor experience and support. In addition, empirical findings by Killing (1978), and Caves, Crookell and Killing (1983) indicate that firms license-in technologies related to their current skills. This ensures successful exploitation of the licensed technology because current resources and expertise are devoted to it (Svensson 1984). These findings suggest that management risk-aversion may be a determinant of ITL adoption behavior. It is therefore hypothesized that:

> **Hypothesis 3a:**
> The greater the risk-aversion of management, the greater the propensity to adopt ITL.

- **International orientation**

International orientation is defined as the outwardness of management outlook in relation to other countries. Empirical results discussed in section 2.3.2 showed that managers with international exposure may be more likely to adopt ITL For example, Parry and Waston (1979) reported that the likelihood of the

firm licensing-in technology from unaffiliated firms was related to the number of overseas visits undertaken by senoir managers of the firm. In a similar vein, Shahrokhi (1987). found that international exposure preceded many firms' entry into ITL agreements. These findings are in accord with the licensing-out literature which suggests that international exposure has a positive impact on the firm's decision to license-out technology to foreign firms (Carstairs and Welch 1982).

Unlike domestic-oriented managers, international-oriented managers are more likely to be aware of technologies available for license and their suitability for their firms. This suggests that outward-looking management is more likely to be exposed to, and react positively to, ITL stimuli. This factor is of prime importance because of the fact that many firms are reluctant to license-out technology to local firms for fear of competition in their domestic markets (Svensson 1984). International orientation of management is therefore expected to be a background variable that may influence the probability of the firm being exposed to licensable technologies. Thus:

Hypothesis 3b:
The higher the international orientation of the firm's management, the higher the propensity to adopt ITL.

- **ITL experience**

The third management characteristic assumed to impact on ITL adoption is its experience in ITL transactions. Crawford (1985) reported that many licensees used ITL again after their first agreement. It is reasonable to expect that firms inexperienced in acquiring external technology may be less likely to be capable of searching for, selecting and absorbing such technology. Additionally, they may be more vulnerable to the contractual risks associated with external

technology acquisition (Pisano 1990). Thus, greater ITL experience means that the increased knowledge in ITL contractual negotiations and contacts already made by the licensee firm will make it easier for it to gain access to external technologies in the future. These arguments support the hypothesis that:

Hypothesis 3c:
The greater the ITL experience of the firm, the greater the propensity to adopt ITL.

- **ITL satisfaction**

While ITL experience may be an important influence, it could be argued that it is the *extent of satisfaction or dissatisfaction* that management has with their current ITL agreements that may be the relatively crucial factor. Future repeat purchase of products largely depends on the level of satisfaction with current usage. Thus, the expectation is that satisfaction with current ITL will lead to its repeated use. This reasoning underlies the following hypothesis:

Hypothesis 3d:
The greater the level of satisfaction with current ITL agreements, the higher the propensity to adopt ITL.

- **Awareness of ITL opportunities**

The last management characteristic hypothesized to impact on the firm's propensity to adopt ITL is the extent of management's awareness of ITL opportunities. Crawford (1985) speculated that provision of information on the availability of potential products for license may influence the quantity of ITL among small firms. Although this line of inquiry was not pursued in his research, it is expected that increased awareness of ITL opportunities through the receipt of unsolicited ITL offers, information about new technological

developments and ITL successes and problems of other firms may influence management to investigate this method of new product acquisition. This reasoning supports the following hypothesis.

Hypothesis 3e:

The greater management's awareness of ITL opportunities, the greater the propensity to adopt ITL.

2.5.5 Hypothesized relationship between propensity to adopt ITL and management perceived of relative benefits and costs of ITL

In addition to management characteristics, the literature discussed in sections 2.3.3 suggests that management perceptions of the relative benefit and costs of ITL are likely to have some influence on the firm's propensity to adopt ITL. Therefore according to hypothesis 4:

Hypothesis 4:

The degree of management perceived relative benefits and costs of ITL will have a positive and negative influence on the firm's propensity to adopt ITL, respectively.

The rationales for the two sub-hypotheses in hypothesis 4 are discussed in the following two sections.

- **Perceived relative benefits of ITL**

Favourable management predisposition towards ITL is required for it to be considered a viable strategy for NPD. Perceived relative benefits of ITL is therefore defined as the extent to which management perceives ITL as a better NPD strategy than internal R&D. The literature indicates that managers

perceive ITL to have several benefits over internal R&D such as: lower risk; speedy market entry; faster market growth and expansion; use of excess capacity; low cost; concentration of resources on other internal projects; quicker acquisition of technological skills and speedy diversification (Crawford 1985; Gold 1987; Killing 1977; Lowe and Crawford 1983, 1984; Shahrokhi 1987; Thunman 1983). The preceding section suggests that:

Hypothesis 4a:

The higher the perceived relative benefits of ITL, the higher the propensity to adopt ITL.

- **Perceived relative costs of ITL**

Perceived costs of ITL refers to the extent to which management perceive ITL as difficult, costly and risky to undertake relative to internal R & D. Despite its benefits, the literature suggests that ITL may have attendant costs and risks in the process of acquisition and implementation of the external technology (Sen and Rubenstein 1989). These relate to the high cost of technology; lack of suitable information for proper evaluation of alternatives; restrictions imposed by licensors that lead to loss of control; unsuitability of technology; high adaptation costs; difficulty of maintaining competitive advantage; the potential retardation of the internal skill development of the licensee; conflicts with licensor (Caves, Crookell and Killing; Ford 1985; McDonald and Leahey 1985; Parry 1988; Sen and Rubenstein 1989; Weinrauch and Langlois 1987).

According to Pisano and Teece (1989, p. 235), a higher perception of the costs and risks involved in ITL "...will lead to a rejection of a license agreement even where other factors warrant it". This assertion and the preceding literature provide the basis for hypothesis 4b.

Hypothesis 4b:

The higher perceived relative costs of ITL, the lower the propensity to adopt ITL.

2.5.6 Hypothesized relationship between propensity to adopt ITL and management perceived environmental hostility

The last variable group in Figure 2.1 expected to influence the firm's propensity to adopt ITL is management perception of the hostility in the firm's external environment, such as market competition, technological competition, and government regulations. Given a hostile environment, an organisation may require a less risky and costly method of developing new products. Section 2.3.5 discussed the external environmental forces that may influence the adoption of ITL. It was concluded that external threats hindering the achievement of the organisation's objectives may be powerful conditions that induce a firm to use ITL (Gold 1975; Crawford 1985; Wilkinson 1985).

First, in an environment of intense competition, it may be expected that the urgency of the need to acquire new products would lead to the firm to prefer ITL to internal R & D because of the former's speed of market entry advantage and lower risk (Capon and Glazer 1987; Pastalox-Fox 1983; Gold 1987). Second, although greater technological change leads to diverse opportunities for new products, it also leads to the need for substantial internal investment, and high risk in NPD (Olleros 1986). This is because technological competition shortens product life cycles and leads to market and technological uncertainties. In such a situation, therefore, firms are expected to engage in co-operative arrangements, such as ITL, in order to gain access to new products (Friar and Horwitch 1985; Shahrokhi 1987). In a similar vein, Olleros and McDonald (1988) suggested that an appropriate strategy to enter markets characterized by

rapid technological cahange is ITL, since it allows the firm to exploit its marketing expertise while delegating NPD risks and costs to entrepreneurial firms.

As Wilkinson (1985) argued, in an environment of rapid technological change a firm may need to acquire external technology to catch up with other firms and concentrate internal resources on the next generation of products. In complete accord, Gold (1975, p. 26) asserted that "the rapid expansion of technological frontiers...combined with the mounting costs of exploring them urges increasingly serious consideration of...licensing..."

The third aspect of external environmental hostility relates to government regulations. Increased government regulations on, and lack of support for, internal new product development efforts may be powerful inducements for firms to look outside for new products For example, Schnee (1979) argued that a self-reliant policy in NPD may not be appropriate in an environment of increased R&D risks resulting from government regulations.

Collectively, these theory-based assertions warrant the hypothesis that:

Hypothesis 5:

The greater the perceived market and technological competition, and increased government regulations affecting NPD, the greater the propensity to adopt ITL.

2.5.7 The combined influence of all factors on propensity to adopt ITL and their relative importance

Recall that one of the objectives of the study was to determine the combined impact of the most parsimonious set of variables that influence ITL adoption and their relative explanatory power. It was noted in section 2.2, the examination of the combined impact of firm, managerial and environmental factors on ITL adoption has been so far been ignored by researchers. It was also noted that scholars disagree on the relative importance of the various factors that influence the adoption of ITL, especially regarding the use of ITL for market entry (Ford 1985); risk reduction (Lieberman 1989); speed of market entry and cost reduction (Lowe and Crawford 1983).

Hence, the following hypothesis is put forward to examine the combined impact and the relative importance of the factors that influence ITL adoption:

Hypothesis 6:

The factors influencing the firm's propensity to adopt ITL will differ in their explanatory power.

2.6 Summary

This chapter reviewed the NPD process literature and noted various limitations in the way the process is currently conceptualised and researched. It was argued that contrary to the characterisation of the process as an independent, internal endeavour, firms do have a choice of utilising external technology development methods such as ITL as an alternative to internal R & D. Three constructs: control, resource commitment and risk exposure were then isolated as underlying the firm's decision to choose between ITL and internal R & D.

The relevant empirical and theoretical ITL literature was then discussed. The review of this literature revealed four categories of variables that may influence the organisations adoption of ITL. These were: (1) firm characteristics, (2) management characteristics, (3) management perceptions of ITL costs and benefits, and (3) perceived external environmental hostility. The review also revealed certain gaps and methodological shortcomings in the previous ITL empirical studies.

The empirical findings and the weaknesses identified in the literature provided the basis for a research model describing the relationship between ITL adoption and the four sets of explanatory variables. Next, the specific hypotheses to be tested and their rationale were discussed. Chapter 3 will present the methodology of the research and operationalisations of variables used.

Chapter 3 Methodology

3.0 Introduction

The previous chapter reviewed the relevant literature and presented a theoretical model of the firm's propensity to adopt ITL. The hypotheses to be tested and their rationales were also presented. This chapter describes the methodology of the research, and the operational definitions of the variables involved.

The chapter is organised into three sections. In the first section, the sampling plan is presented. The second section describes the operationalisation of the variables employed in the research. In the final section, the analytical techniques that were used to analyse the data collected are presented.

3.1 Sampling plan

The sample frame for the study comprised three directories:

- Australian Engineering Firms (1990),
- Association of Pharmaceutical Manufacturers of Australia (1990), and
- Australian Chemical Industry Council (1990).

Thus the study's population was limited to firms in these three industries. These industries were chosen for the research because of their high level of technology licensing activity (Adam, Pearson and Ong 1988; Ford 1985; Lowe and Crawford 1984).

The directory of engineering firms contained 1105 firms. Companies that could be clearly identified as not in manufacturing were eliminated. The remaining

721 firms were surveyed because of the need for a high response, given the measurement objectives of the research. The directory of pharmaceutical firms contatined 56 firms. All these firms were included in the sample. Finally, 74 chemical manufaturing firms were included in the sample. Thus the total sample of the research was 851, comprising 721 engineering, 56 pharmaceutical and 74 chemical firms.

3.1.1 Unit of analysis

A unit of analysis is the element about which information is collected and analysed (Babbie 1990). In this research the unit of analysis is the individual organisation which is either engaged in ITL or not engaged in ITL, rather than the individual ITL transaction. The use of the organisation as the unit of analysis is derived from the empirical literature, discussed in chapter 2, which suggests that it is the internal and external factors influencing the firm that motivate it to enter into ITL. Further, the use of the firm as the unit of analysis allowed the inclusion of non-licensee firms in the study in order to enhance the robustness of the research model..

3.1.2 Selection of key informant

According to Ford (1985), the technology licensing decision takes input and judgement of a number of executives in different departments of the organisation, including marketing, R&D, manufacturing, legal and the chief executive. For this reason, a useful informant approach to the study would have been to collect data respondents from different departments in each organisation in the sample. Philips (1981) found that reliance on single informants could lead to substantial errors in data collected. This is because the individual respondent may not have complete and reliable knowledge about the organisational phenomenon under study. Further, the researcher cannot ascertain whether or not the respondent, in his/her responses, is promoting

his/her personal opinions rather than that of the organisation. A multiple informant approach therefore allows for reliability checks of data across different informants and thus avoid the problem of relying on a single informant making judgements on an organisation-wide phenomenon (Campbell 1955).

Despite the preceding advantages of the multiple informant method, a single informant approach was used to collect data for this research for a number of reasons. First, Pennings (1979) suggests that the single informant is appropriate where the informant occupies a senior executive or ownership position. He argued that such people are direct participants in the organisation's boundary-spanning activities, and are therefore qualified to speak for the organisation. In a similar vein, Philips (1981) found that high ranking managers provide more reliable information on an organisational phenomena than lower ranking managers. Secondly, the single informant approach was used because of time and cost constraints on the study. As Connant, Mokwa and Varadarajan (1990, p. 371) argued, "...in the face of time and resource constraints the single informant approach allows for a large number of organisations to be surveyed."

The chief executive officer/managing director (CEO) was selected as the key informant for the study. The CEO was deemed the appropriate key informant because Ford's (1985) study found that CEOs were more involved in the licensing decision-making than any other management personnel. Secondly, according to Hambrick (1981), the CEO possesses the most comprehensive knowledge of the relevant characteristics of the organisation, its strategy and performance. Whilst the questionnaire was sent to the CEO, in instances where it was completed by a manager other than the CEO it was assumed that the CEO passed it on to such a manager, who in his/her judgement was capable of providing reliable information on the subject.

3.1.3 Data collection instrument and procedure

The data collection instrument contained a cover letter and a structured questionnaire (Appendix 6). In order to ensure its appropriateness, an initial pool of items was generated from the literature surveyed in chapter 2. This initial pool was subjected to analysis and review by five executives involved in licensing. After the review, the questionnaire for the study was developed. It was then pre- tested at 12 separate interviews with licensing executives. At these interviews, each executive was asked to identify any difficulties or ambiguities in the questions asked. Further, each executive was asked to suggest items for inclusion or exclusion. These interviews led to the deletion of some items and the inclusion of new ones. These and other changes made as a result of the pre-test led to improvements in the instrument to enhance respondent understanding.

Babbie (1990) recommends that the content of a questionnaire must be arranged in a format, with distinctive sections that helps respondent understanding of the different information required and ensures ease of answering the questions. Additionally, such a format generates interest and encourages the informant to complete the questionnaire. Before deciding on the final format, alternative formats were evaluated by two marketing academics who had wide experience in questionnaire design.

As shown in appendix 6, the cover page of the questionnaire contained the definitions of ITL, unaffiliated overseas company, and the word "company" as used in the research. It also contained a general instruction as to the completion of the questionnaire, and home and business telephone numbers, in case of questions from respondents. The first section of the questionnaire asked about the company's ITL experience and reasons for entering into ITL agreements. With the exception of question one, which concerned the firm's involvement in

ITL, this section was completed by respondents whose companies have ITL agreements.

In the second section, the respondent was asked to express some general opinions about the benefits and costs of ITL relative to internal R & D for the development of new products. This section also included four questions that tapped the firm's propensity to adopt ITL in the future. Section three of the instrument asked the respondent's opinions about the environment in which their firms operate, while the final section concerned the background of the company, its functional capabilities relative to competition, and its managers.

A package containing the survey questionnaire, a cover letter describing the purpose and importance of the study, and soliciting cooperation and a return-paid envelope, was despatched to the sample of 851 firms, addressed to the "General Manager". As a response inducement and to enhance reliability of responses, each respondent was promised a summary of the research findings. This offer was accepted by over 90 percent of the respondents.

A total of 59 questionnaires were returned because the respondent either could not be located or refused participation. Thus, the effective sample of the study was 792. A total of 193 completed questionnaires were received after the initial mailing. A telephone reminder was made to nonrespondents three weeks after the initial mailing. This follow-up effort yielded an additional 61 completed questionnaires. Overall, 254 questionnaires were received for a response rate of 32 percent. However, 25 of them were deemed unusable because of missing data on some key items; respondent admission that the study was irrelevant to his/her organisation; or because they were received from consulting or other service firms. Thus the effective response rate was 29 percent.

This response rate is considered encouraging, given the reluctance of firms to discuss their licensing agreements (Sen and Rubenstein 1989; Shahrokhi 1987). It also compares favourably with other studies in the field involving the use of mail questionnaires. For example, the response rate for Ford (1985) and Reid and Reid (1988) were 23 and 22 percent, respectively. The sample used in the analysis comprised 116 licensee and 113 non-licensee firms.

3.2 Operationalisation of research variables

This section of the chapter discusses the measures of the dependent and independent variables in the theoretical model presented in Figure 2.1. As previously discussed in chapter 2, one of the shortcomings of the current ITL literature is that no attempt has been made at using multiple items to measure variables. To extend the literature in this respect, multiple-item scales were employed to measure most of the variables in the study. Such scales are necessary for adequately and accurately capture the domain of the constructs (Churchill 1979; Nunnally 1978). This approach to measurement tends to reduce measurement error and increase reliability and validity of the measures (Peter 1979; Churchill 1979).

Given the problems of secrecy and unwillingness of managers to disclose detailed information about technology licensing operations (Shahrokhi 1987; Sen and Rubenstien 1990), most of the variables were assessed with perceptual items. This approach to measurement was deemed appropriate for two reasons. Firstly, managerial subjective assessments are generally consistent with objective measures (Dess and Robinson 1984). Secondly, management is often guided by their subjective perceptions in decision-making, rather than perfect objective knowledge of the world (Madsen 1989).

Consistent with the positive relationship found to exist between the number of scale points and reliability in a meta-analytic study by Churchill and Peter (1984), a seven-point scale, with no verbal labels for scale points 2 through 6, was employed to measure all the perceptual variables. All scale values for negatively worded statements were reversed prior to data analysis.

3.2.1 Dependent variable: Propensity to adopt ITL

The dependent variable of interest is the firm's propensity to adopt ITL instead of internal R&D, for NPD. As mentioned previously in section 2.5, this variable was defined and measured in two ways. First, the variable reflects the firm's manifest outcome ITL behaviour as indicated by its *current involvement in ITL.* The measure was a dichotomous, "yes/no" question: Has your company entered into an inward licensing agreement to acquire technology (product or process) from an unaffiliated company? (question 1 of the questionnaire). This way of measuring propensity by current involvement is frequently used in the exporting literature (for example, Yaprak 1985).

Second, propensity to adopt ITL was defined as a firm's *attitudinal orientation or intention towards the future use of ITL.* In other words, it pertains to the strength of the need and the likelihood of the firm to use ITL for its NPD activities. It was measured by asking respondents to indicate both the strength of the need in the firm for ITL, the likelihood of the firm actually engaging in ITL in the next two years, and the likelihood of the firm using ITL for entry into new markets, and for market expansion (question 7a to 7d). Apart from tapping the firm's intention towards the use of ITL, such intentional measures allowed the inclusion of firms not currently involved in licensing in the research. Although, not actually engaged in ITL, non-licensee firms may have it under consideration. This way of measuring propensity was employed by Reid (1985) in his study of exporting propensity.

3.2.2 Independent variables

The theoretical model presented in Figure 2.1 postulates that the firm's ITL propensity is a direct result of its internal and external conditions. It is the end product of an interaction between the firm's characteristics, management characteristics, and management perceptions of ITL, and the external environment. Since this research represents an initial attempt to examine the firm's ITL propensity through a set of behavioural hypotheses, many of the items used for measuring the predictor variables needed to be generated. This is because no established scales measuring the variables studied exist in the licensing literature. Items used here were generated through an extensive review of the licensing literature presented in chapter 2, the management literature (for example, Connant, Mokwa and Varadarajan 1990; Covin and Slevin 1989; Nevens 1990; Venkatraman 1989), and through a series of in-depth discussions with executives involved in technology licensing. The measures of the independent variables are presented below.

3.2.2.1 Firm Characteristics

- **Firm size**

Several measures including annual sales, profits, assets and number of employees have been used to operationalise firm size. In this research however, annual sales was used because it gives a good indication of aspects of the firm such as managerial skills, ability to withstand risk, and organisational slack (McGuinness and Little 1981). Thus, annual sales appears to be a good reflection of the financial and managerial resources possessed by the firm to exploit the licensed technology (question 15).

- **External organisational ties**

This variable pertains the extent to which a firm has ongoing relationships with overseas organisations through which it may come into contact with ITL opportunities. It was measured in two ways. First, with an index of two items which relate to the extent to which the firm is involved in joint ventures (question 12a), and in distribution agreements with foreign firms (question 12c). Second, it was measured with two single items that tapped the percentage of sales derived from exports and the extent of foreign ownership in the firm (questions 17 and 19).

- **Organicity of organisational structure**

Organicity of an organisational structure refers to the extent to which the organisation is structured in organic versus mechanistic manners (Covin and Slevin 1989). Unlike mechanistic structures, organic structures have a high degree of decentralisation and less formalisation, allowing for greater participatory decision-making, less rigidity and adherence to codified rules and regulations.

The 7-item scale used to measure organicity was adapted from Covin and Slevin (1989). This scale contained statements measuring the extent to which the organisation is characterised by structured channels of communication, uniformity of style of management, rigid adherence to formal procedures, formal job descriptions and management principles, and tight control of operations. Managers were asked to indicate the extent to which each item characterised their organisations (questions 12m to 12s).

- **Overall NPD performance capability**

This variable measures the perception of management regarding the success of the firm's internal efforts to achieve the orgaisation's overall NPD objectives..

Respondents were asked to respond to three questions which were adapted from Cooper (1985) relating to the extent to which the NPD program has met performance objectives over the last five years, its importance in generating sales and profits, and the success of the NPD program relative to competition (questions 13a to 13c).

- **R & D capability**

A 6-item scale (question 11) was used to measure the firm's basic R & D capability. These items were carefully selected to reflect the amount of resources put into R & D and the results of the firm's R & D efforts. Respondents were asked to evaluate the strengths and weaknesses of their organisations relative to competition on a scale ranging from '1 = much weaker' to '7 = much stronger' for each of the following items:

- R&D as percentage of total sales,
- skill of R&D personnel,
- number of R&D personnel employed,
- number of patents held,
- NPD success,
- technology sold to other companies.

- **Marketing capability**

The marketing capability variable reflects the effectiveness of the firm's implementation of its marketing activities relative to competition. This variable was measured with a 10-item scale. Like the R & D capability variable, the scale required the respondent to evaluate the strength and weaknesses of his/her firm in performing specific marketing activities relative to competition, on a 7-point scale.

Nevens (1990) argues that the organisation's commercialisation capability is indicated by the number of market segments, number of products and the speed with which it introduces new products. These formed the first three items of the marketing capability scale. Seven other items of the scale were selected because they are commonly regarded in the marketing literature as indicators of competence in marketing. The scale comprised the following items (question 11):

- number of market segments,
- product line diversity,
- speed of new product introduction,
- advertising effectiveness,
- quality of salespersons,
- quality of customer service,
- distribution network,
- advertising expenditure as percent of sales,
- market research ability, and
- product differentiation ability.

- **Manufacturing capability**

Like the two preceding variables, the firm's manufacturing capability was assessed by requring respondents to rate their firms on a number of items relative to competition. These to five original items (question 11) reflected the respndent's perception of the:

- quality of the firm's manufacturing technology,
- effectiveness of cost containment,
- skill of manufacturing personnel,
- cost of production, and

- extent of use of modern manufacturing technology such as CAD/CAM and JIT systems.

3.2.2.2 Management Characteristics

Management characteristics were represented by five component variables: risk aversion, international orientation, ITL experience, ITL satisfaction, and awareness of ITL opportunities. The operational measures of these variables are presented next.

- **Risk aversion**

Four items used to measure management risk-aversion were adapted from Venkatraman (1989). The items focused on management perception of the extent of risk reflected in the firm's resource allocation decisions, choice of products and markets. Respondents were asked to indicate their agreement or disagreement, on a 7-point scale, with the extent to which each item characterised their organisations (qestions 12h to 12k).

- **International orientation**

International orientation refers to the international outwardness of management. It measures the extent to which management is aware of developments in technology in the foreign business environment. The items selected to measure the variable were based upon the literature review related to the characteristics of licensee firms (Shahrokhi 1987; Parry and Waston 1979), and the export literature (for example Cavusgil and Naor 1987). In all, four single items (questions 14a, b, d, and e) which may facilitate management's exposure to ITL stimuli from overseas firms were selected to measure the variable. These were:

- level of education,
- number of managers with overseas business experience,
- ability to speak a foreign language, and
- frequency with which managers travel overseas.

Respondents were instructed to answer these items with reference to only the chief executive officer and marketing, manufacturing and R&D managers because these personnel have been found to be most involved in the firm's licensing operations (Ford 1985).

- **ITL experience**

ITl experience reflects the experience of management in using ITL. This variable was measured by a single item: the number of ITL agreements the firm has (question 2). The traditional measure of experience, number of years of involvement in an activity was rejected, because pre-testing showed that ITL experience depends on the number of ITL negotiations undertaken. In this light some of the licensing executives argued that a firm which has been operating, for example, three ITL agreements for five years may be more experienced than a firm which has been operating only one agreement for ten years.

This same method of measuring prior experience was used by Dawes, Dowling and Patterson (1992, forthcoming), when they measured management experience in buying consulting services by the number of service purchase decisions made. Number of ITL agreements therefore appears to be a better indication of management ITL experience than number of years of ITL involvement. All non-licensee firms were scored zero (i.e., no experience) on this item in the data analysis.

- **ITL satisfaction**

ITL satisfaction represents management's satisfaction with their ITL agreements. Managers of licensee firms were asked to indicate the extent of their agreement or disagreement with three statements (question 4) concerning:

- ITL contribution to profit,
- top management satisfaction with the performance of licensed technologies, and
- overall satisfaction with the firm's ITL involvement.

Like ITL experience, non-licensee firms were scored zero on each of the three items measuring this variable in the data analysis.

- **Awareness of ITL opportunities**

The extent to which management is aware of ITL opportunities is the last management characteristic examined in this study. The variable was measured with two scales. The first scale contained two items which focused on management perception of the extent to which the firm has a formal procedure to scan external technological developments, and the firm R & D unit's contact with technological developments in the outside world. These measures were used because Sen and Rubenstein (1989) found that the extent of the R & D unit's interaction with the outside technological world influences the success of the firm's external technology acquisition program. The second scale employed to measure ITL awareness contained three items which tapped the extent to which respondents were aware of ITL success and problems of other firms, and the frequency with which they receive unsolicited ITL offers (questions12b, and 12d to 12g). The rationale for this measure is that increased awareness of ITL, in and by itself, is likely to lead managers to search for, and evaluate licensable technologies.

3.2.2.3 Management perceptions of ITL

The construct, management perceptions of ITL, is defined as the degree to which there exist strong views about ITL concerning its benefits, costs and obstacles, and the role it can play in achieving the NPD strategic objectives of the firm. It reflects the current knowledge of management about the benefits and costs of ITL relative to internal R & D. The operationalisation of these two component variables are discussed below.

- **Perceived relative benefits of ITL**

Perceived relative benefits of ITL is defined as the degree to which management perceive ITL as a better NPD strategy than internal R&D. It reflects licensee firms' reasons for using ITL. For non-licensee firms, it taps the perceived potential advantages of ITL in the achievement of the NPD goals of the firm.

For licensees, the variable was measured in terms of the importance management attached to each of seventeen items in their decisions to license-in technology instead of developing it in-house (question 5). For non-licensees, it was measured in terms of the extent to which respondents agreed or disagreed with the same seventeen items as potential benefits for the use of ITL for NPD over internal R&D (question 6). The ITL benefit items are listed below:

- sales and market expansion,
- keep pace with competition,
- speed of market entry,
- upgrading technical skills,
- NPD risk reduction.
- access to patents held by a licensor,

- adoption of industry standard,
- ready availability of proven product/process,
- access to future technology opportunities,
- quickly gain advanced knowledge,
- save in-house resources for other uses,
- secure products to fill product portfolio gaps,
- gain competitive advantage,
- use spare capacity,
- diversify product range,
- gain faster return on investment, and
- lower cost of technology

- **Perceived relative costs of ITL**

Perceived relative costs of ITL reflects the degree to which management perceives ITL as relatively costly, risky and difficult to undertake, compared to internal R&D. This scale contained sixteen statements designed to tap the perceived risks, costs and obstacles involved in ITL transactions. Respondents were asked to indicate the extent to which they agreed or disagreed with each of the sixteen statements. The items comprising this scale are listed below (question 8):

- extensive and costly searches,
- overwhelming paperwork,
- lengthy and costly negotiations,
- complexity of choice among alternative technologies,
- uncertainty regarding the correctness of ITL decisions,
- difficulty of entry into and exit of ITL agreements,

- too many complications in ITL agreements,
- high cost of adapting licensed technology,
- ITL does not offer competitive advantage,
- too many restrictions imposed by licensors,
- high cost of licensed technology,
- high cost of terminating ITL agreements,
- discourages internal R&D staff,
- grant-back clauses lead to loss of competitive advantage,
- loss of control over licensed technology due to licensor restrictions, and
- low margins on licensed products.

3.2.2.4 Perceived environmental hostility

A hostile environment is that dimension of the environment which poses a threat to the viability and performance of the firm (Covin and Slevin 1989). Such an environment is characterised by intense competition, unfavorable regulatory controls, and generally harsh business conditions. The construct was represented by four component variables. The first three were market competition, rate of technological change, and government regulations. Since this research was undertaken during a period of recession in the country, the last dimension assessed management perception of hostility in the general business environment.

- **Market competition**

The items employed to measure this variable were perceived intensity of each of three types of competition: general competition, price, and product quality. (question 9). Respondents were asked to rate on a scale ranging from '1= moderately high' to '7= extremely high' the extent to which each item characterised their industries.

- **Technological competition**

Technological competition was measured by asking respondents to rate on a 7-point scale ranging from '1 = low' to '7 = high', on three items pertaining to the rapidity of technological change influencing the need for the introduction of new products in their respective industries. The three items were: the frequency of new product introductions, rate of product obsolescence, and rate of change in the general level of technology (question 10).

- **Government regulation**

This variable relates the perceptions of management about the influence of government regulations on their NPD activities. The variable was measured in terms of the degree of the respondent's agreement or disagreement with four statements relating to the nature of government incentives for internal R&D, the effectiveness of patent laws in protecting new products from imitation, effect of product liability laws on internal development, and the general effect of government regulations on NPD efforts.

- **General environmental hostility**

The 3-item scale used to measure this variable was an adaptation of Covin and Slevin's (1989) environmental hostility scale. These items required respondents to indicate the degree of their agreement or disagreement with statements relating to the extent of threat posed by the general environment, the availability

of marketing opportunities, and the extent of control the firm has over the environment.

3.3 Data analysis methods

The preceding section of the chapter described the operational definitions and measures of variable employed in the research. This section presents details of the methods that were used to analyse the data collected.

3.3.1 Reliability of measures

Prior to their use in data analysis, the measures of variables were assessed for reliability. Reliability assesses the extent to which measures of variables are free from error and thus yield consistent results (Peter 1979). According to Churchill (1979, p. 68), responses to items in a measure that belong to the domain of a single variable "...should be highly intercorrelated. Low inter-item correlations...indicate that some of the items are not drawn from the appropriate domain and are producing error and unreliability." He asserted that "coefficient alpha absolutely should be the first measure that one calculates to assess the quality of the instrument" (p. 68). Additionally, Peter (1979, p. 8), asserted that coefficient alpha is the most commonly accepted statistic for measuring the reliability of multi-item measurement scales with multiple points, as used in this research.

A large alpha indicates that the multiple measures adequately capture the construct being measured, while a low alpha means that the measures perform poorly in measuring the construct (Churchill 1979). In determining what is "low" and "high" alpha, Churchill (1979) and Nunally (1978) suggested that an alpha in the range of .50 to .60 is suitable for early stages of research, while .70 and above would be adequate for most research purposes. In an extensive

review of the empirical marketing literature, Churchill and Peter (1984) reported that 85 percent of the studies used .50, while 69 percent used .70 alpha value as adequate. Since this research appears to represent the first attempt at employing multiple items to measure ITL-related variables, the standard for judging the acceptability of the reliability of items measuring a variable was set at .50.

3.3.2 Factor analysis

Factor analysis is a technique used to find a smaller set of variables which form the underlying dimensions of a larger set of original variables. It is therefore an appropriate technique for testing the validity of measurement scales containing a large number of items (Churchill 1979). Since three constructs in this research, that is, perceived relative benefits, and perceived relative costs ITL, and the firm's R & D, manufacturing and marketing capabilities were measured with a large number of items, they were factor analysed to assess the validity of the component variables.

Two aspects of validity assessed were convergent and discriminant validity. Convergent validity measures the extent to which different items measuring the same variable correlate with each other (Churchill 1979). Discriminant validity, on the other hand, measures the extent to which measures of one variable differ from measures of another variable. This validity is indicated by low correlations between the items measuring the variable of interest and those which are supposed to measuring other variables. Factor analysis was therefore deemed the appropriate method for assessing these aspects of validity. The use of this technique also helps to reduce collinearity among the resulting factors to be used in subsequent analysis (Hair, Anderson and Tatham 1990).

In using factor analysis, the suitability of the sample size was assessed. Hair, Anderson and Tatham (1990), recommended that a researcher generally should not factor analyse a sample of fewer than 50 observations. A sample size of 100 or more is required. They asserted that as a general rule there should be four or five times as many observations as there are variables to be analysed. The largest number of items factor analysed in this research were 21 items relating to the functional R & D, manufacturing and marketing capabilities of the firm. With a sample size of 229, this study therefore meets the standard recommended by these authors.

3.3.3 Discriminant analysis

Discriminant analysis is an appropriate analytical method when the dependent variable is categorical and the independent variables are metric. As previously mentioned in section 3.2.1, one measure of the dependent variable was a categorical "yes or no" question. Consistent with this way of operationalising the variable, discriminant analysis was used to test the differences between licensee and non-licensee firms. The technique distinguishes statistically between two or more groups of cases on a number of characteristics on which they are expected to differ. In addition, it also offers the advantage of providing a useful instrument for classification, and determines the relative importance of the independent variables on account of their discriminating power (Hair, Anderson and Tatham 1990). The method was therefore useful for this research because it allowed for the discovery of the characteristics that separate licensee from non-licensee firms, as well as determining their relative importance.

3.3.4 Multiple regression

Multiple regression is the analytical method a researcher uses when interested in finding the intensity of impact that several metric scaled independent variables have on a single metric-scaled dependent variable. In section 3.2.1,

the second way of defining the dependent variable, propensity to adopt ITL, was a composite of four metric-scaled measures. These items tapped the attitudinal orientation or intention of firms' for the use of ITL in the future. Thus multiple regression was deemed an appropriate method to test the explanatory power of the ITL propensity model.

The method builds a linear model between the dependent and a number of independent variables. The result is an R^2 which shows that variation in the dependent variable accounted for by the independent variables. Thus this analytical method was used because of its ability to determine the seperate and combined influence of the four variable groups presented in Figure 2.1, on the dependent variable.

The stepwise regression procedure was used. This procedure brings into the regression equation the variable with the highest explanatory power first, and then others are progressively included depending on their relative contribution in explaining the dependent variable, taking account of the variables already in the equation. This procedure facilitated the identification and ranking of the independent variables in accordance with their impact on the dependent variable.

The use of both discriminant and regression analyses assumes the absence of correlation between the independent variables. High correlation between independent variables lead to incorrect estimation of the regression coefficients. However, there is no generally accepted level of correlation which creates a multicollinearity problem. In dealing with this problem, Green, Tull and Albaum (1988) reported that the rule of thumb for some researchers is to discard from analysis one of any pair of variables that correlate more than .90.

In this research two measures were taken to reduce the problem of multicollinearity. As previously mentioned in section 3.3.2, the variables measured with a large number of items were factor analysed to reduce multicollinearity. In addition, in order to obtain a more robust test of the model and the hypotheses advanced in the research, one of any pair of independent variables that correlated more than .50 was discarded from the analysis. Thus the correlations between the independent variables were all .50 or below, indicating no severe multicollinearity problems.

In testing the overall model, the test of significance used was the F-test at the .05 level. The critical probability level for testing the significance of the impact of each independent variable on the dependent variable was set at .10, a probability level which both practioners and academics accept for exploratory studies of this nature (Kinnear and Taylor 1987; Sinkula 1991). In determining the percent of variance in ITL propensity explained, the adjusted R^2 as used, since unlike the simple R^2, because it corrects for the inflation of irrelevant regressors (Hair, Anderson and Tatham 1990).

In using both discriminant and multiple regression analyses, the Likert scales used in this research were treated as interval scales. A number of reasons account for this. First, these scales have been found to communicate interval properties to the respondent, and therefore produce data that can be assumed to be intervally scaled (Madsen 1989; Schertzer and Kernan 1985). Second. in the marketing literature Likert scales are almost always treated as interval scales (for example, Kohli 1989).

3.4 Summary

This chapter discussed the methodology of the research. The study was a cross-sectional mail survey involving licensee and non-licensee firms in three industries: engineering, pharmaceutical and chemical industries.The mail survey was considered the appropriate research method, given the measurement objectives of the study, and the time and cost constraints. The data collection instrument was a self-administered questionnaire.

In the second section of the chapter, the measures of the dependent and independent variables were presented. Most of these measures involved perceptual items given the difficulty of collecting objective data on a sensitive subject like ITL. The chapter also described the analytical methods employed in the study. Discriminant analysis was used to separate licensee firms from non-licensee firms, while multiple regression analysis was employed to the test the individual and combined impact of the independent variables on the propensity of the firm to adopt ITL.

The next chapter presents the analysis of the data collected, relating to the assessment of the reliability and validity of measures of the variables described in this chapter, and the test of the hypotheses that were advanced in chapter 2.

Chapter 4 Data Analysis

4.0 Introduction

The previous chapter presented a description of the research methodology, operationalisation of the dependent and independent variables, and the data analysis methods. The purpose of this chapter is to present the analysis of the data collected.

The chapter is divided into five sections.The first section presents the test of nonresponse bias. The second presents the descriptive statistics of critical demographic characteristics of the research sample. The third section discusses the reliability and validity tests of the measures of the dependent and independent variables. The variables that are found to be reliable and valid are then employed to test the differences between licensee and non-licensee firms, in section four. Finally; the tests of hypotheses 2 to 6 are presented in section five.

4.1 Test of nonresponse bias

Prior to analysing the data collected, non-response bias was assessed. Armstrong and Overton (1979) suggest that late respondents are likely to be similar to nonrespondents. Consequently, a lack of significant differences between early and late respondents would suggest that non-response might not be a serious problem. This test of non-response is commonly used in the marketing literature (for example, Kohli 1989).

Accordingly, in this research, non-response bias was assessed by testing for significant differences between early and late respondents. As reported in

section 3.1.5, 168 usable questionnaires were received before follow-up. After follow-up, a further 61 were received. These two groups were compared on a number of demographic characteristics, and attitudinal variables relating to the perceived costs and benefits of ITL using cross-classification analysis and the T-test procedure, respectively. As tables 4.1 (a) and (b) show, no statistically significant difference was found between the early and late respondents. It appears that non-response bias is not an issue.

Table 4.1(a) Test of Non-response bias : Firm characteristics

Variable	Range						n	x^2	p
Annual sales	<$5m	$6-$25m	$26-$50m	$51-$15m	$76-$100m	>$100m			
E*	31	36	13	5	4	11	166		
L*	26	26	16	8	3	20	61	11.5	.32
Number of employees	0-99	100-199	200-299	300-399	400-499	500>			
E	49	26	6	5	1	13	167		
L	41	25	10	5	2	18	61	8.1	.62
Average age of managers	25-34 yrs	35-44 yrs	45-54 yrs	55-64 yrs					
E	2	44	51	3			164		
L	4	48	48	0			58	3.5	.74
Frequency of overseas travel per year	Never	1-2 times	3-4 times	5-6 times	7-10 times				
E	8	69	22	1	.6		163		
L	4	69	22	5	0		58	4.8	.78

*E = early respondents, L = late respondents

Table 4.1b T-test for Non-response Bias: Early and Late Respondents (attitudinal variables)

Variable	Early Respondents	Late Respondents	
	Mean (n=139)*	Mean (n=51)*	Sig.
Perceived relative costs			
Implementation cost (IMPCOST)	15.4	14.0	.13
Loss of decision-making autonomy (LOSSDM)	12.4	12.2	.67
Competitive advantage (COMADV)	12.5	12.8	.61
Perceived relative benefits			
Access to future technology (ACESFT)	6.9	6.4	.48
Diversification advantage (DIVADV)	15.7	15.9	.77

* reduced sample size due to missing data.

4.2 Descriptive statistics

This section presents statistics on key demographic characteristics of the sample. These are presented in Table 4.2. As the table indicates, the responding firms comprised 80 percent engineering, 7.5 percent pharmaceutical, and 11.8 percent chemical firms. The low proportion of pharmaceutical and chemical firms in the sample preclued industry specific analysis.

In terms of position occupied by the respondent, 64.6 percent were CEOs; 8.7 percent marketing/sales managers; 2.6 percent R&D managers and 10.9 percent production/operations managers. The cadre of respondents and their interest shown in receiving a summary of the research findings assure the credibility of the information provided. Table 4.2c shows that , 50.7 percent of the responding firms were currently involved in licensing agreements, while 49.3 percent had no such involvement. The average number of current ITL agreements for licensee firms was three. A vast majority (86 percent) of licensee firms only had between one and six agreements. A further six percent had between 7-10 agreements. Less than one percent of the sample reported more than 10 ITL agreements. In contrast to this heavy concentration of number of ITL agreements, the contribution of these licensed-in products to the firm's overall sales revenue varied widely. (Table 4.2e). For approximately half of the licensee firms, licensed-in products contribute only 10 percent or less to overall sales revenue. At the other extreme are the 20 percent of firms where licensed-in products contributed 25 percent or more to sales revenue in the last financial year.

Table 4.2 Characteristics of Firms in the Sample

(a) Type of Industry

Type	Number	Percentage
Engineering	183	79.9
Pharmaceutical	17	7.5
Chemical	27	11.8
not reported	2	0.8
Total	229	100.0

(b) Respondent's Position in the Firm

Position	Number	Percentage
CEO/Managing Director	148	64.6
Marketing/Sales Manager	20	8.8
R&D Manager	6	2.6
Production/Operations	25	10.9
Others (e.g Company secretary; division manager)	30	13.1
Total	229	100.0

(c) Involvement in ITL Agreements

Category	Number	Percentage
Licensee	116	50.7
Non-licensee	113	49.3
Total	229	100.0

Table 4.2 (cont'd.)

(d) Number of ITL Agreements

Number	Percentage
0	49.3
1	15.3
2	14.4
3	6.6
4-6	7.5
7-10	3.0
12	0.4
23	0.4
not reported	3.1
N=229	100.0

Mean number of agreements for licensees = 3

(e) Contribution of Licensed Products to Annual Sales

Category	Percentage
less than 1%	17.2
1-5%	25.9
6-10%	9.5
11-15%	11.2
16-20%	9.5
21-25%	6.9
26-30%	6.0
over 30%	13.8
N=116	100.0

Table 4.2 (cont'd.)

(f) Firm Size by Number of Employees

Category	Number	Percentage
1-99	107	46.7
100-199	58	25.3
200-299	16	7.0
300-399	11	4.8
400-499	3	1.4
500 and over	34	14.8
Total	229	100.0

(g) Firm Size by Annual Sales (AU$)

Category	Number	Percentage
less $5 million	68	29.7
6-25 million	76	33.2
26-50 million	33	14.4
51-75 million	13	5.7
76-100 million	8	3.5
over $100 million	30	13.1
Not reported	1	0.4
Total	229	100.0

The size of the responding firms was assessed by the number of employees and annual sales turnover. From Table 4.2f on the preceding page, approximately 47 percent of the sampled firms were small enterprises employing between 1 and 100 people. Twenty-five percent employed between 101 and 200. In terms of relative size measured by annual sales turnover, approximately 30 percent of the responding firms had sales less than AU$ 5 million; 33 percent had sales between AU$ 6 and 25 million and 13 percent had sales above AU$ 100 million. Table 4.1g provides details of the annual sales distribution of responding firms.

4.3 Reliability and validity tests of measures

As mentioned previously in chapter 2, one of the major gaps in the ITL literature is the lack of concern for the reliability and validity of measures. To address this shortcoming and extend the literature in this regard, the reliability and validity of measures of the dependent and independent variables were assessed before hypothesis testing.

4.3.1 Validity test of measures

Two types of validity were considered in the research: convergent and discriminant validity. As indicated in chapter 3, firm capabilities, perceived costs and benefits of ITL were measured with a large number of items. The underlying dimensions of these variables were therefore examined with principal component factor analysis (varimax rotation). Variables were developed from the emergent factors. The convergent and discriminant validity of the variables were then assessed by examining the extent to which items measuring each variable load heavily on it.

In each case, the choice of a factor solution was based on the following criteria:

- Factor interpretability: whether or not the variable groups matched the intuitive conceptualisation of the hypothesized concept.
- The amount of variation explained by each factor or latent root must be greater than one.
- The scree test which plots the eigen values against the number of factors in the order of extraction. Where the curve levels off indicates the appropriate number of factors to extract. According to Stewart (1981), the roots criterion and the scree test provide an effective way of determining the number of factors.

The SPSSX program allows factor loadings of a specified level to be suppressed to facilitate easy interpretation. Factor interpretation based on factor loadings .40 and greater is considered good practice (Hart 1989). Accordingly, .40 was selected as the level below which factor loadings were to be suppressed. This procedure also allowed for the sorting and ranking of the items loading on each factor. In the following three sections, the emergent factors in each scale, and their names corresponding to the factor labels determined for each factor group are presented.

4.3.1.1 Factor analysis: Firm capability scale

When the responses to the 21 items comprising the firm's R & D, manufacturing and marketing capability scale were subjected to principal component factor analysis (varimax rotation), a structure of five underlying dimensions emerged which explained 63 percent of the total variance. Table 4.3 presents the results of this analysis.

Table 4.3 Factor Analysis: Firm Capability Scale

Factor/Label/Items	Factor Loadings	Eigen value	Percent of variance
1. R&D Capability (RDCAP)		**6.4**	**30.6**
R&D expenditure as percent of sales	.84		
Number of R&D personnel	.81		
Skill of R&D personnel	.76		
Number of patents	.73		
Number technologies sold	.62		
Success of NPD[a]	.62		
2. Manufacturing Capability (MFGCAP)		**2.1**	**10.2**
Skill of manufacturing personnel	.76		
Quality of manufacturing technology	.76		
Cost of production	.72		
Use of modern technology	.60		
Effectiveness of cost containment	.60		
3. Marketing Communication Capability		**1.9**	**9.2**
Effectiveness of advertising	.82		
Advertising expense as percent of sales	.78		
Market research ability	.55		
Extent of distribution network[b]	.53		
4. Product Commercialisation Capability (PRDCOM)		**1.4**	**6.7**
Speed of new product introduction	.72		
Quality of customer service	.65		
Quality of salespersons	.64		
Product differentiation ability	.61		
5. Extent of Diversification (EXTDIV)		**1.3**	**6.1**
Product line diversity	.86		
Number of market segments	.80		

Cumulative variance explained: 63 percent

a. item also loaded on factor 4 (.50)
b. item also loaded on factor 5 (.44)

Factor 1: R & D capability. The first factor of the firm's capability scale captures six items. Three of these items reflect the resources that an organisation had invested in its R & D program: R & D expenditure as percent of sales; number of R&D personnel; and skill of R & D personnel. The other three items clearly pertain to the output of the firm's R & D activities: number of patents; number of technologies sold to other organisations; and success of NPD. An appropriate label for this factor is "R & D capability". All items but one loaded cleanly on this factor. "Success of NPD" loaded .62 and .50 on this factor and factor 4 respectively. It seems that "NPD success" also reflects the firm's product commercialisation ability, but more so its R&D capability. Consequently, this item was retained in Factor 1. The factor explains 30.6 percent of the total variance.

Factor 2: Manufacturing capability. This second factor explains 10.2 percent of the total variance. It captures five items: skill of manufacturing personnel; quality of manufacturing technology; cost of production; use of modern manufacturing technology; and effectiveness of cost containment. They reflect the resources employed in the organisation's manufacturing operations, and the quality and efficiency of these operations.

The preceding two factors matched two of the, *a priori*, hypothesized constructs of the firm capability scale. As Table 4.3 shows, the third hypothesized construct, marketing capability, appears to have three major and distinct underlying dimensions. These form the next three factors of the firm capability scale.

Factor 3: Marketing communication capability. The first marketing capability factor captures four items: the firm's effectiveness in advertising; expenditure on advertising; market research capability; and the extent of firm's

distribution network. The last item also loaded on Factor 5 (.44), indicating that extent of distribution network is an aspect of the firm's diversification. However, its relatively stronger loading on this factor indicates that it reflects more of the firm's marketing communication capability than diversification.

The inclusion of distribution network and market research capability with the other two items shows the need for a firm to understand its target market and distribution system as pre-requisites for effective market communication. Taken together they represent the effectiveness with which an organisation communicates its product offerings to its target market. The factor explains 9.2 percent of variance among the variables.

Factor 4: Product commercialisation capability. The inclusion of four items in this factor: speed of new product introduction; quality of customer service; quality of salespersons; and product differentiation ability, suggest it represents the organisation's marketing experience in commercialising its new products. It explains an acceptable 6.7 percent of the total variance.

Factor 5: Extent of diversification. Factor five (labelled "Extent of diversification") accounts for 6.1 percent of the explained variance. Two items had heavy loadings on this factor: product line diversity and number of market segments. These items clearly represent the extent to which an organisation is diversified.

With the exception of two items, all items measuring the five preceding factors in the firm capability scale displayed acceptable convergent and discriminant validity as reflected by their heavy loadings on the factors they were supposed to measure, and weak loadings on other factors.

4.3.1.2 Factor analysis: Perceived relative benefits scale

Seventeen items were included in the questionnaire to measure management's perception of the relative benefits of ITL over internal R&D. One item, adoption of industry standard, did not load heavily on any factor and was subsequently omitted. Four underlying dimensions or factors, with eigen values greater that one, emerged when the sixteen remaining items were factor analysed. Together, they accounted for 57 percent of the variance. The items, factor loadings, eigen values and percent of variance explained are presented in Table 4.4.

Factor 1: Faster, low cost market entry advantage. This first factor captured seven items which tapped the advantages of ITL such as reduction in NPD risk; speed of market entry; low cost of ITL; faster return on investment; availability of proven product or process; quicker acquisition of advanced technical knowledge; and upgrading of the firm's technical skills. With the exception of the last item which also loads on Factor 4 (.41), all items in this factor loaded heavily on this construct indicating reasonable convergent validity. Given that firms use ITL to reduce NPD risk, increase technical skills and acquire advanced technical knowledge in order to catch up with competition (Gold 1987; Killing 1977; Lowe and Crawford 1983), these items together reflect the use of ITL as a fast, low cost method of entering the market. By facilitating access to new skills and products that have been proven in the licensor's market, ITL helps the licensee to enter markets more quickly compared with internal R&D. To reflect the speed and low cost elements involved, the factor was labelled "Faster, low cost market entry advantage".

Table 4.4 Factor Analysis: Perceived Benefits of ITL

Factor/Label/Items	Factor Loadings	Eigen value	Percent of variance
1. Faster, low cost Market Entry (FENTRY)		**4.9**	**30.9**
Reduce NPD risk	.73		
Speed of market entry	.65		
Low cost of ITL	.62		
Faster return on investment	.60		
Availability of proven product/process	.59		
Gain advanced technical knowledge quickly	.58		
Upgrade technical skills[a]	.56		
2. Diversification Advantage (DIVADV)		**1.6**	**10.1**
Diversify product range	.79		
Fill product gaps	.78		
Use spare capacity	.66		
Save resources for in-house developments	.47		
3. Competitive Advantage (COMADV)		**1.4**	**8.8**
Gain competitive advantage	.74		
Increase sales and market expansion	.72		
Keep pace with competition	.72		
4. Access to Future Technology (ACESFT)		**1.1**	**6.8**
Patent of technology held by licensor	.80		
Future ITL opportunities from the licensor	.70		

Cumulative Variance explained: 57 percent.

a. item also loaded on factor 4 (.41).

The factor had an eigen value of 4.9 and accounted for an impressive 30.9 percent of the total variance explained. The high explained variance indicates that this factor is highly successful in capturing the underlying dimension represented by the seven variables.

Factor 2: Diversification advantage. The second factor was labelled "Diversification advantage" of ITL since it included four items that tap the use of ITL for diversification purposes: diversify product range; fill product gaps; use spare capacity; and save resources for in-house developments. A degree of ambiguity is associated with the relationship of the first two and the last two items. The first two items clearly relate to diversification, however, the last two seem to relate to the use of internal resources. It seems that by allowing firms to use their excess capacity and save internal resources, ITL facilitates the exploitation of untapped opportunities in the firm's market.

Conceptually, the four items reflect the availability of unused resources and opportunities. It seems that the use of ITL assists to maximise the use of internal resources to exploit untapped, external opportunities. This factor explains 10.1 percent of the total variance.

Factor 3: Competitive advantage. The third factor includes three items: gain competitive advantage; increase sales and market expansion; and keep pace with competition. These items reflect the underlying rationale of firms' use of ITL for advantage over competition. The factor explains 8.8 percent of the total variance.

Factor 4: Access to future technology advantage. The last factor in the perceived benefit scale was labelled "Access to future technology advantage". It contains two items which tap the use of ITL to secure patents and to provide

access to future technology of the licensor. It accounts for only 6.8 percent of the total variance explained. As Table 4.4 clearly indicates, all the scale items measuring perceived relative benefits of ITL demonstrate reasonable convergent and discriminant validity by loading heavily on independent factors.

4.3.1.3 Factor analysis: Perceived relative costs scale

A factor analysis was also used to evaluate the underlying dimensions of the 16 items measuring management's perception of the costs and risks involved with the use of ITL. The results are presented in Table 4.5. Four factors emerged, accounting for 60.1 percent of the total variance. All four factors demonstrated reasonable convergent and discriminant validity. The description of each of these factors follows.

Factor 1: Implementation cost of ITL. This factor was richest in detail since it contains six items. It was identified as "Implementation costs" because all six items relate to the problems and obstacles involved in the adaptation and use of the licensed technology such as: high cost of adaptation; too many complications in the use of ITL; difficulty of gaining competitive advantage; too many restrictions; high cost of licensed technology (royalty); and the ongoing uncertainty with the correctness of the decision to license. With the exception of the last item which also loaded on Factor 4 (.41) all items displayed high convergent and discriminant validity. The factor explains 34.5 percent of the total variance amongst the variables.

Table 4.5 Factor Analysis: Perceived relative costs of ITL scale

Factor/Label/Items	Factor Loadings	Eigen value	Percent of variance
1. Implementation Cost (IMPCOST)		**5.5**	**34.5**
High adaptation cost	.83		
ITL too complicated	.79		
Difficult to gain competitive advantage	.69		
Too many restrictions	.66		
High cost of technology	.66		
Never sure of correctness of ITL decision[a]	.52		
2. Loss of Decision-making (LOSSDM)		**1.5**	**9.4**
Loss of control due to restrictions	.79		
Grant-back restrictions lead to surrender of future competitive advantage	.77		
ITL discourages internal R&D staff	.56		
Low margins on licensed products	.49		
3. Search Costs (SCOST)		**1.4**	**9.0**
Extensive and costly search	.81		
Overwhelming paperwork[b]	.68		
Lengthy and costly negotiations[c]	.58		
Choosing among alternative technologies can be complex	.48		
4. Entry and Exit Barriers (EEBARR)		**1.2**	**7.2**
Difficult to go in and out of ITL	.83		
High cost of terminating ITL agreements	.80		

Cumulative variance explained: 60.1 percent

a. item also loaded on factor 4 (.41)
b. item also loaded on factor 1 (.46)
c. item also oaded on factor 1 (.53)

Factor 2: Loss of decision-making autonomy. The second factor accounts for 9.4 percent of the explained variance. It included items such as: loss of control due to licensor restrictions; loss of future competitive advantage due to grant-back provisions in ITL agreements; tendency for ITL to discourage internal R&D staff; and low margins on licensed products. Together these items suggest the perceived risk of ITL in hindering or retarding the internal skills development and competitive advantage of the licensee, due to licensor restrictions. These restrictions could lead to loss of decision-making autonomy on the part of the licensee in areas such as exporting, quality control, pricing, and production (Sen and Rubenstein 1989). The factor was therefore labelled "Loss of decision-making autonomy".

Factor 3: Search costs. The search costs factor links four items: extensive and costly search for technology; overwhelming paperwork; lengthy and costly negotiations; and the complexity of choosing among alternative technologies. Together they reflect the problems firms encounter in searching for ITL agreements. However, a considerable amount of ambiguity is associated with the factor relationship of one item, "lengthy and costly negotiations", with the other three items in this factor. It also loads on Factor 1 (.53). The item was retained because its strong conceptual and intuitive linkage with the search process is sufficient to deem it an appropriate element within the search costs factor. The explanatory power of this factor was only 9 percent.

Factor 4: Entry and exit barriers. The fourth and final factor in the perceived relative costs scale concerns the difficulty of entering into, and the high cost involved in terminating ITL agreements. These items clearly represent the perceived costs of entering and exiting an ITL agreement. The percent of total explained variance for this factor is 7.2.

4.3.2 Reliability test of measures of the dependent and independent variables

The preceding section presented factor analysis results which indicate that the items measuring the perceived benefits and costs of ITL, and firm capability have acceptable validity. After conducting validity tests, the next step in the analysis process involved testing the reliability of the measures for the dependent and independent variables. Appendix 2 contains a summary of the definitions and labels of all variables. As discussed previously in section 3.3, reliability was assessed by computing the coefficient alpha for all the variables measured with multiple items.

The results of the reliability tests are displayed in Table 4.6. In each case, the table shows the variable name, label, component items measures, corrected inter-item correlation coefficients, and coefficient alpha. As the table shows, most of the variables meet or exceed the acceptable alpha standard for most research purposes of .70 (Churchill 1979, Nunnally 1978). Following Churchill (1979), items with low inter-item correlation were eliminated from two scales ORGAN and RISKAV in order to improve their reliability, by increasing the coefficient alpha.

Recall that in Section 3.3.1 it was reasoned that since this study appears to be the first to use multiple measures to test ITL-related hypotheses, the reliability standard was set at .50 coefficient alpha. As previously indicated this level of alpha is widely accepted and used in the marketing literature (Churchill and Peter 1984). Two variables which did not meet this standard (ORGTIES .43 and GENHOST .47) were eliminated from subsequent analysis.

Table 4.6 Reliability Analysis: Dependent and Independent Variables

Variable/Label/items	Alpha	Inter-item Correlation
(a) Dependent Variable		
ITL propensity (ITLPROP)	.91	
• Seek ITL in next 2 years		.87
• Need/desire for ITL		.75
• Likelihood of entering markets with ITL		.78
• Likelihood of expanding markets with ITL		.75
Independent Variables		
FIRM CHARACTERISTICS		
1. Firm Size (SALES)[a]		
2. Extent of foreign ownership (FOWNER)[a]		
3. Export as percentage of sales (EXPORT)[a]		
4. External organisational ties (ORGTIES)b	.43	
• Extent of involvement in joint ventures		.28
• Extent of involvement in distribution agreements		.28
5. Organicity of structure (ORGAN)	.83	
• Structured communication channels (r)		.65
• Uniform managerial style (r)		.64
• Old proven managerial principles (r)		.46
• Adherence to formal procedures (r)		.64
• Tight formal control (r)		.50
• Formal job descriptions (r)		.67

a. single item no alpha computed.
b. variable deleted from further analysis alpha < .50.
r. items reverse scaled prior to data analysis.

Table 4.6 (continued)

Variable/Label/items	Alpha	Inter-item Correlation
6. NPD Capability (NPDCAP)	.82	
• Extent to which internal NPD has met objectives over the last five years		.64
• Importance of NPD in generating sales and profits over the last five years		.64
• Overall success of NPD program		.74
7. R&D Capability (RDCAP)	.88	
• R&D expenditure as percent of sales		.81
• Number of R&D personnel		.82
• Skill of R&D personnel		.69
• Number of patents held		.73
• Success of NPD		.61
• Number of technologies sold		.51
8. Marketing Communication Capability (MKTCOMM)	.73	
• Advertising expenditure as percent of sales		.59
• Advertising effectiveness		.62
• Market research ability		.46
• Distribution network		.42
9. Product Commercialisation Capability (PRDCOM)	.67	
• Quality of salespersons		.42
• Speed of new product introduction		.47
• Quality of customer service		.44
• Product differentiation ability		.52
10. Extent of Diversification (EXTDIV)	.77	
• Product line diversity		.63
• Number of market segments		.63

Table 4.6 (continued)

Variable/Label/items	Alpha	Inter-item Correlation
12. Manufacturing capability (MFGCAP)	.76	
• Quality of manufacturing technology		.65
• Skill of manufacturing personnel		.60
• Cost of production		.59
• Effectiveness of cost containment		.40
• Use of modern manufacturing technology		.48
MANAGEMENT CHARACTERISTICS		
1. Risk Aversion (RISKAV)	.60	
• Conservative with major projects		.32
• Prefer to market proven products		.51
• Company operations are high risk (r)		.28
2. International Orientation		
a. Number of managers with university education (UNI)[a]		
b. Number of managers with overseas business experience (OVSEAS)[a]		
c. Number of managers who speak a foreign language (SPEAK)[a]		
d. Frequency of overseas travel (TRAVEL)[a]		
3. ITL Experience (LAGREE)		
4. ITL Satisfaction (ITLSATIS)	.98	
• Top management satisfaction with performance of licensed products		.94
• Profit contribution of licensed products		.95
• ITL has been a rewarding experience		.97
5. R&D unit's awareness of ITL opportunities (LAWARE1)	.52	
• Existence of a procedure to scan external technology		.35
• R&D keeps close watch on external technology development		.35

r. item reversed scaled prior to data analysis.
a. single item no alpha computed.

Table 4.6 (continued)

Variable/Label/items	Alpha	Inter-item Correlation
7. Management awareness of ITL opportunities (LAWARE2)	.71	
• Receipt of unsolicited ITL offers		.43
• Awareness of ITL success of other companies		.55
• Awareness of ITL problems of other companies		.59
MANAGEMENT PERCEPTIONS OF ITL		
1. Perceived Relative Benefits of ITL		
a. Faster, low cost market entry (FENTRY)	.81	
• Reduce NPD risk		.43
• Speed of market entry		.60
• Gain technical knowledge		.52
• Upgrade technical skills		.55
• Acquire proven product/process		.54
• Faster return on investment		.61
• Lower cost of ITL		.60
b. Diversification advantage (DIVADV)	.71	
• Diversify product range		.59
• Fill product gaps		.50
• Use spare capacity		.50
• Save resources for in-house developments		.40
c. Competitive advantage (COMADV)	.67	
• Increase sales and market expansion		.51
• Gain competitive advantage		.46
• Keep pace with competition		.50
d. Access to future technology (ACESFT)	.50	
• Access to licensor patents		.32
• Future licensor ITL opportunities		.41

Table 4.6 (continued)

Variable/Label/items	Alpha	Inter-item Correlation
2. Perceived Relative Costs and Risks of ITL		
a. Implementation cost (IMPCOST)	.84	
• High adaptation costs		.68
• High cost of ITL		.67
• ITL too complicated		.72
• Too many restrictions		.65
• Difficult to gain competitive advantage		.59
• Unsure of correctness of ITL decision		.44
b. Loss of decision-making autonomy (LOSSDM)	.64	
• Loss of control due to restrictions		.57
• Loss of future competitive advantage due to grant-back provisions		.52
• ITL discourages R&D staff		.38
• Lower margins on licensed products		.26
c. Search costs(SCOST)	.73	
• Extensive and costly search		.48
• Overwhelming paperwork		.68
• Lengthy and costly negotiations		.57
• Choice of alternative technology can be complex		.38
d. Entry and Exit barriers (EEBARR)	.67	
• Difficult to go in and out of ITL		.51
• High cost of terminating ITL agreements		.51

Table 4.6 (continued)

Variable/Label/items	Alpha	Inter-item Correlation
PERCEIVED ENVIRONMENTAL HOSTILITY		
a. Market competition (MKTCOMP)	.67	
• Intensity of market competition		.61
• Price competition		.52
• Product quality competition		.35
b. Technological competition (TEKCOMP)	.82	
• Frequency of new product introductions		.73
• Rate of technological change		.73
• Rate of product obsolescence		.58
c. Government regulations (GOVREGU)	.61	
• Little incentive for R&D		.35
• Weak patent law		.38
• Stringent product liability law		.38
• Regulations hinder internal R&D		.46
d. General environmental hostility (GENHOST)	.47b	
• Safe business environment (r)		.24
• Rich in marketing opportunities (r)		.25
• Able to control external environment (r)		.39

b. variable deleted from further analysis, alpha < .50.

r. items reversed scale prior to data analysis.

The respective items measuring each variable were then summed and a simple average computed to obtain scores for subsequent analysis.

4.3.3 Assessing potential multicollinearity

As discussed in chapter3, discriminant and multiple regression analyses require that the independent variables do not have excessively high correlations with each other. However, there is little agreement on what is "excessively high" correlation among independent variables. Since it was the objective of the research to develop and test a parsimonious explanatory model of the firm's propensity to adopt ITL, a more stringent standard for multicollinearity was set. Accordingly, one of any pair of independent variables which correlated more than .50 was discarded.

All but two pairs of the independent variables (IMPCOST and SCOST - = .62; LAGREE and ITLSATIS r = .59) had correlations.50 or below.. Two variables LAGREE and SCOST were discarded from further analysis. The correlation matrix presented in Appendix 3 shows that there were no serious multicollinearity problems. Table 4.7 presents the summary statistics of the independent variables finally employed in the data analysis.

Table 4.7 Summary Statistics of the Dependent and Independent Variables used in the Analysis

Variable	Mean	S.D	MIN	MAX	N
Dependent					
ITLPROP	12.06	5.95	3.25	22.75	228
Independent					
NPDCAP	10.14	3.23	2.33	16.33	222
SALES	2.82	2.04	1.00	7.00	228
FOWNER	38.01	45.77	0.00	100.00	227
EXPORT	10.30	13.69	0.00	70.00	224
RDCAP	21.14	7.70	5.18	36.17	209
MKTCOMM	13.04	3.73	4.00	22.00	224
EXTDIV	7.37	2.16	1.50	10.50	225
PRDCOM	16.08	3.00	8.75	22.50	224
MFGCAP	19.73	4.13	6.20	29.20	221
ORGAN	23.67	6.38	5.17	36.17	223
UNI	2.31	1.38	0.00	4.00	224
OVSEAS	1.31	1.24	0.00	4.00	214
SPEAK	0.68	0.87	0.00	4.00	224
TRAVEL	2.22	0.61	1.00	5.00	222
ITLSATIS	5.73	6.23	0.00	16.33	229
LAWARE1	5.21	2.29	1.50	10.50	222
LAWARE2	7.66	3.41	2.33	16.33	224
RISKAV	10.63	3.12	2.33	16.33	224
FENTRY	29.31	7.00	6.14	43.00	222
DIVADV	15.85	4.12	3.25	22.75	227
COMADV	12.56	2.63	2.33	16.33	228
ACESFT	6.68	2.42	1.50	10.50	228
IMPCOST	14.87	5.55	5.17	28.67	223
LOSSDM	12.46	3.76	3.25	22.75	224
EEBARR	6.51	2.09	1.50	10.50	225
MKTCOMP	11.83	3.15	2.33	16.33	227
TEKCOMP	8.29	3.51	2.33	16.33	228
GOVREGU	14.25	3.85	3.25	22.75	228

4.4 Hypothesis testing

The purpose of this section is to present the findings of the study related to the hypotheses advanced in chapter 2. Table 2.3, in chapter 2, presented a summary of the hypotheses to be tested.

The section is divided into two parts. Part one presents the results of a discriminant analysis which explores Hypothesis 1, regarding the differences between licensee and non-licensee firms. The second part presents multiple regression results concerned with the impact of the four categories of variables presented in Figure 2.1 on ITL propensity, and their relative importance.

4.4.1 Hypothesis 1: Discriminant Analysis: Test of differences between licensee and non-licensee firms

As mentioned previously in chapter 2, no study has statistically tested for the differences between licensee and non-licensee firms. The purpose of this section is to test the Hypothesis 1 which stated that:

> **Hypothesis 1**
> Licensee and non-licensee firms can be separated along their firms' characteristics, management characteristics, management perception of the costs and benefits of ITL, and perceived environmental hostility.

The dependent variable in this hypothesis is whether or not the firm is currently involved in ITL. Given the categorical measure of the dependent variable, discriminant analysis was used to test this hypothesis. Based on this measure of

the dependent variable, the total sample was divided into 116 licensee firms and 113 non-licensee firms. The two objectives of the discriminant analysis were: (1) to derive a discriminant function that differentiates between licensee and non-licensee firms, and (2) to determine the relative importance of the significant discriminating variables.

Since there was a large number of variables, which *a priori*, were thought to have an impact, it was necessary to achieve satisfactory discrimination with the most parsimonous set of independent variables. For this reason, the stepwise method was employed. This method initially selects the variable with the most discriminating power. Other variables are subsequently included in the discriminating function according to their ability to improve the discrimination two groups of firms.

The initial run showed statistically significant differences between licensee and non-licensee firms on 12 variables at the $p < .05$ level. However, an examination of the results concerning management's perceptions of costs and benefits of ITL showed a surprising finding. As expected non-licensee firms had high perceived costs of ITL compared to licensee firms. What was surprising however was that they perceive marginally higher benefits from ITL (with the exception of "competitive advantage" COMADV) than do their counterparts in licensee firms. Non-licensee firms had a mean score of 18.8 and 30.9 on the "diversification advantage" (DIVADV) and "fast, low cost market entry" variables compared to 15.1 and 27.6 by licensee firms, respectively. Concerning the "access to future technology" (ACESFT) benefit, non-licensee firms again surprisingly had a higher mean score (7.2) compared to licensee firms (6.4). The differences are all significant at the $p = .05$ level. The lack of the lack of involvement of these firm in ITL, despite the high perceived benefits, confirms Pisano and Teece's (1989) hypothesis that a higher

perception of the costs of ITL will lead to its rejection, even where other factors warrant it.

Since the influence of perceived costs was so powerful as to override the higher perceived benefits, it was reasoned that their inclusion in the discriminant analysis would lead to misleading results. Therefore, to get a better picture of the discriminating power of the other variables, the three perceived costs variables "implementation cost" (IMPCOST), "loss of decision making autonomy" (LOSSDM), and "entry and exit barriers" (EEBARR) were removed. The discriminant analysis was then re-run with 24 independent variables as potential discriminators.

As Table 4.8a displays, the performance of the discriminant function was encouraging, with 10 variables emerging as significant discriminators (Table 4.8b). First, its power of separation of licensee firms from non-licensee firms was strong as indicated by: (1) the eigen value of the discriminant function of 0.57, which measures the total variance existing between the discriminating variables, (2) the canonical correlation coefficient of 0.60, which measures the linear correlation between the discriminant function and the set of group variables, and (3) the Wilks' lambda of 0.64, which is a measure of the overall power of the discriminant function (i.e., small values of Wilks' lambda means that the group means appear to be different, thus the lower the lambda the better the discriminating power of the function) (Hair, Anderson and Tatham 1990; Norusis 1988). The function had a chi-square of 78.0, which was significant at $p < 0.0000$ level.

Table 4.8 (a) Validity of the Canonical Discriminant Function

Eigen Value	Canonical Correlation	Wilks' Lambda	Chi Square	DF	Sig.
0.57	0.60	0.64	77.8	11	0.0000

Table 4.8 (b) Significance of Discriminating Variables between Licensee and Non-licensee Firms

Variable	Group Means L	Group Means NL	F-value	Sig.
Firm Characteristics				
• Firm Size (Sales)	3.6	2.1	27.87	**0.0000**
Management Characteristics				
• Management awareness of ITL (LAWARE2)	8.5	6.7	14.20	**0.0003**
• Managers with university education (UNI)	2.8	1.9	19.50	**0.0000**
• Frequency of overseas travel (TRAVEL)	2.4	2.1	10.95	**0.0008**
• Managers with overseas business experience (OVSEAS)	1.5	1.1	5.09	**0.0319**
Management Perceptions of ITL Benefits				
• Competitive advantage (COMADV)	13.0	12.1	4.56	**0.0248**
• Diversification advantage (DIVADV)	15.0	16.8	9.82	**0.0027**
• Access to future technology (ACESFT)	6.4	7.1	3.78	**0.0381**
• Faster, low cost market entry (FENTRY)	27.6	30.9	10.70	**0.0013**
Perceived Environmental Hostility				
• Technological competition (TEKCOMP)	8.9	7.9	3.73	**0.0490**

L = Licensee
NL = Non-licensee

To evaluate the discriminant function further, its ability to correctly classify licensee and non-licensee firms was examined. The confusion matrix is presented in Table 4.9, under the assumption that the prior probabilities of group membership are equal to the size of the respective groups in the sample (Licensee = 0.51; Non-licensee = 0.49). The matrix shows that a respectable 75.4 percent of the cases were correctly classified. This classification accuracy compares favourably with that of other studies in the marketing literature. (for exampleCavusgil and Naor 1987). This suggests that the discriminant function is reasonably successful in correctly separating the two groups. Further, the centroids (the mean discriminant score for each group) are relatively separated, (licensee group = 0.73; non-licensee group = -0.78) indicating considerable spatial separation between the groups (Dawes, Dowling and Patterson 1992; Hair, Anderson and Tatham 1990).

Table 4.9 Confusion Matrix of Predicted Group Memberships

	Predicted Group Membership				
	Licensee		**Non-licensee**		
	(n)	**%**	**(n)**	**%**	**Total**
Licensee	78	75.7	25	24.3	**103**
Non-licensee	26	25.0	78	75.0	**104**
Total	**104**		**103**		**207**

Percent of "grouped" cases correctly classified: **75.36%.**

Centroids of groups in reduced space

Licensee: **0.73**

Non-licensee: **-0.78**

4.4.1.1 Relative importance of the discriminating variables

The second objective of the discriminant analysis was to determine the relative power of the variables that were significant in discriminating between licensee and non-licensee firms. According to Hair, Anderson and Tatham (1990), discriminant loadings, which measure the correlations between each variable and the discriminant function composite score, are more valid than discriminant weights or F-values for evaluating the relative discriminating contribution of each independent variable. Following this recommendation, discriminant loadings were used to determine that discriminating power of each of the ten significant independent variables. Table 4.10 ranks these variables in the order of their importance.

4.4.1.2 Validation of the discriminant function

An upward bias may occur in a discriminant analysis if the discriminant function is applied to the same data that was used to estimate the function. For this reason, even though the discriminant function was found to be significant at $p < 0.0000$ level, it required validation. In validating a discriminant function, the researcher divides the sample into two: analysis sample and holdout sample. An analysis sample is used to estimate the function and the holdout sample is employed to test the validity of the function. However, there are no standard guidelines as to how to split the sample into two groups (Hair, Anderson and Tatham 1990). Due to missing data, the sample employed in the validation process consists of 210 firms. The sample was randomly divided into two, 132 (63 percent) analysis sample, and 78 (37 percent) holdout sample.

Table 4.10 Discriminant Analysis Results: Relative Importance of the Discriminating Variables

Independent Variables		Discriminant Loadings	Importance Sig.	Rank
1.	Firm size(SALES)	.51	0.0000	1
2.	Managers with university education (UNI)	.44	0.0000	2
3.	Management awareness of ITL (LAWARE2)	.37	0.0003	3
4.	Frequency of overseas travel (TRAVEL)	.34	0.0008	4
5.	Faster, low cost market entry (FENTRY)	-.32	0.0013	5
6.	Diversification advantage (DIVADV)	-.30	0.0027	6
7.	Competitive advantage (COMADV)	.22	0.0248	7
8.	Managers with overseas business experience (OVSEAS)	.21	0.0319	8
9.	Technological competition (TEKCOMP)	.20	0.0490	9
10.	Access to future technology (ACESFT)	-.12	0.0381	10
11.	Government regulation (GOVREGU)	-.12	NS*	
12.	R & D awareness of ITL (LAWARE1)	.11	NS	
13.	Product commercialisation capability (PRDCOM)	-.09	NS	
14.	R & D capability (RDCAP)	-.07	NS	
15.	NPD capability (NPDCAP)	-.07	NS	
16.	Extent of foreign ownership (FOWNER)	-.07	NS	
17.	Extent of diversification (EXTDIV)	.03	NS	
18.	Market competition (MKTCOMP)	.03	NS	
19.	Market communication capability (MKTCOMM)	.02	NS	
20.	Risk aversion (RISKAV)	.02	NS	
21.	Managers who speak a foreign language (SPEAK)	.02	NS	
22.	Manufacturing capability (MFGCAP)	-.02	NS	
23.	Export as percentage of sales (EXPORT)	.01	NS	
24.	Organicity of structure(ORGAN)	-.01	NS	

*NS = not significant at .10 level, two-tailed test

As Table 4.11a shows, the overall classification accuracy of the analysis sample was 80 percent. There was a drop in this classification power to 68 percent, when the discriminant function was tested with the holdout sample. (Table4.11b). The table shows that the function correctly classifies 55 percent licensees and 81.6 percent of non-licensees in the holdout sample, indicating reasonably strong discriminating power of the variables.

Morrison (1969) proposed that a proportional chance criterion could be used to gain additional insight into the goodness of classification results of a discriminant analysis where the group sizes are unequal. Since the group sizes were unequal in the holdout sample (40 licensees and 38 non-licensees), the proportional chance criterion was therefore used to validate the discriminant function. On the basis of this criterion the percentage of firms correctly classified would be 50 percent. The discriminant-based percentage of correct classification of 68 percent compares favourably with this criterion. This suggests that the discriminant function can be considered as reasonably valid in classifying licensee and non-licensee firms.

Table 4.11 (a) Confusion Matrix of Predicted Group Memberships (Analysis Sample)

	Predicted Group Membership Licensee		Non-licensee		
	n	**%**	**n**	**%**	**Total**
Licensee	48	75.0	16	25.0	64
Non-licensee	11	16.2	57	83.8	68
Total	**59**		**73**		**132**

Percent of "grouped" cases correctly classified: **79.6%.**

Table 4.11 (b) Confusion Matrix of Predicted Group Memberships (Holdout Sample)

	Predicted Group Membership Licensee		Non-licensee		
	n	**%**	**n**	**%**	**Total**
Licensee	22	55.0	18	45.0	40
Non-licensee	7	8.4	31	81.6	38
Total	**29**		**49**		**78**

Percent of "grouped" cases correctly classified: **67.95%.**

Proportional Chance criterion = $(40/78)^2 + (38/78)^2 = 50\%$.

4.4.2 Hypothesis testing: Multiple regression analysis

As in the discriminant analysis, only variables which were found to have coefficient alpha of .50 and above were used in the regression analysis. This meant that Hypothesis 2b, concerning the relationship between the extent of firm's ties with other organisations (ORGTIES) and its propensity to adopt ITL could be tested with only the two single items, extent of foreign ownership and percentage of sales derived from exports.

To test hypotheses 2 to 6, five stepwise regression analyses were run. Each of the first four regressions tested the separate effect of each of the four variable groups on the dependent variable. The fifth regression examined the combined effect of the most parsimonious set of all variables and their relative importance. In each case, the coefficient of determination (adjusted R^2) at the final step of the regression indicated the portion of the dependent variable that is explained by the influence of the variables in the equation.

In all five regressions, the F-test was used to determine the "goodness- of-fit" for the regression equation and the significance of the adjusted R^2. As mentioned previously, the level of significance used was .05. Further, in each case, the histogram of the residuals was examined and indicated no obvious voilation of the normality assumption of the regression models. Additionally, scatterplots of the various independent variables with the dependent variable were examined to determine if any non-linear relationships were evident. No apparent non-linear relationships were observed.

The critical probability level for testing each hypothesis was set at $p < .10$, a probability level which both practitioners and academics accept for exploratory

studies of this nature (for example, Cavusgil and Naor 1987; Kinnear and Taylor 1987; Sinkula 1991). Therefore, a significance level of .10 or less was required for a variable to enter and remain in the regression equation. It is important to note that if data for any of the variables included in the regression equation was missing, the case was eliminated. This resulted in minor variations in the effective sample size for each of the regression models.

4.4.2.1 Empirical testing of Hypothesis 2: Influence of firm characteristics on propensity to adopt ITL.

Hypothesis 2 posited that the firm's propensity to adopt ITL is positively related to its characteristics. The following sub-hypotheses were tested:

H2a: The larger the firm, the higher its propensity to adopt ITL.

H2b: The higher the extent of ties the firm has with overseas organizations, the higher the propensity to adopt ITL.

H2c: The more organic the firm's structure, the more likely the adoption of ITL.

H2d: The higher the firm's internal NPD capability to achieve its performance objectives, the lower the propensity to adopt ITL.

H2e: The higher the firm's R&D capability, the higher the propensity to adopt ITL.

H2f: The higher the firm's manufacturing and marketing capability, the higher its propensity to adopt ITL.

The regression analysis results presented in Table 4.12 show that firm characteristics explained only 4 percent of the variance in the firm's propensity

Table 4.12 Stepwise Regression Analysis Hypothesis 2: Influence of Firm Characteristics on Propensity to Adopt ITL

Multiple R:	.23
R^2	.05
Adjusted R^2	.04
Standard error	5.82
F statistic	5.50
Significance Level	0.0047

Variables in the Equation

Variable (Order of entry)	Standardised Beta	T	Sig
R & D capability (RDCAP)	-0.19	-2.71	**0.0074**
Firm size (SALES)	0.17	2.37	**0.0185**
(Constant)		11.0	**0.0000**

Variables not in the Equation

NPD capability (NPDCAP)	-0.10	-1.26	0.2097
Manufacturing capability (MFGCAP)	0.02	0.32	0.7490
Organicity of structure (ORGAN)	-0.00	-0.00	0.9977
Extent of diversification (EXTDIV)	-0.04	-0.58	0.5602
Extent of foreign ownership (FOWNER)	-0.09	-1.26	0.2099
Export as % of sales (EXPORT)	-0.01	-0.16	0.8758
Product commercialisation (PRDCOM)	-0.00	-0.08	0.9361
Market communication ability (MKTCOMM)	0.06	0.76	0.4511

N=203

to adopt ITL. Thus firm characteristics appear to have only little impact on the firm's ITL propensity. Notwithstanding, the adjusted R^2 of .04 was statistically significant from zero (p = .005). Despite their overall weak impact, two firm characteristics were found to have statistically significant influence on propensity to adopt ITL. Each of the sub-hypothesis in Hypothesis 2 is discussed below.

Hypothesis 2a posited that the larger the firm, the higher its propensity to adopt ITL. Firm size had a beta of .17, significant at the .05 level, thus supporting the hypothesis. In Hypothesis 2b, it was stated that the extent of ties the firm has with overseas organisations, as measured by percentage of sales derived from exports (EXPORT), and extent of foreign ownership (FOWNER), will have a positive impact on the propensity to adopt ITL. Both variables had a negative relationship with ITL adoption but not at significant levels, thus refuting the logic underlying the hypothesis. Similarly, the positive relationship expected between the extent to which the structure of the firm is organic and propensity to adopt ITL in Hypothesis 2c was also not confirmed.

Hypothesis 2d stated that the higher the firm's internal NPD capability to achieve its performance objectives, the lower the propensity to adopt ITL. Although NPD capability (NPDCAP) did not enter the regression equation, judging from the beta coefficient (- .10), its sign and significant level (p = .21), suggest that the hypothesis is partially confirmed. The variable R & D capability (RDCAP) was found to have a highly significant (p = .01) relationshipwith propensity to adopt ITL. However, the sign was negative (beta -.19), contrary to the the expected direction in Hypothesis 2e.

Finally, a positive relationship between the firm's manufacturing and marketing capability and its propensity to adopt ITL was predicted in Hypothesis 2f.

Although one of the three variables measuring marketing capability, market communication capability (MKTCOMM), had the expected signs, they were was not significant. The other two variables measuring marketing capability, extent of diversification (EXTDIV) and product commercialisation ability (PRDCOM), were negatively related to propensity to adopt ITL. Similarly, manufacturing capability (MFGCAP) had a positive relationship with ITL adoption as hypothesized but was not statistically significant. These results are contrary to the relationship expected in Hypothesis 2f.

4.4.2.2 Empirical testing of Hypothesis 3: Influence of management characteristics on propensity to adopt ITL.

Hypothesis 3 maintained that the propensity of a firm to adopt ITL is influenced by its management characteristics as follows:

H3a: The greater the risk aversion of management, the greater the propensity to adopt ITL.

H3b: The higher the international orientation of the firm's management, the higher the propensity to adopt ITL.

H3c: The greater the ITL experience of the firm, the greater the propensity to adopt ITL.

H3d: The greater the level of satisfaction with current ITL agreements, the higher the propensity to adopt ITL.

H3e: The greater the awareness of ITL opportunities, the greater the propensity to adopt ITL.

As the regression results in Table 4.13 display, management characteristics have a strong impact on the dependent variable. Together, they explained 25 percent of the variation in the firm's propensity to adopt ITL. The F-value of

Table 4.13 Stepwise Regression Analysis Hypothesis 3: Influence of Management Characteristics on Propensity to Adopt ITL

Multiple R	.50
R^2	.25
Adjusted R^2	.25
Standard Error	5.17
F Statistic	35.01
Significance	0.00

Variables in the Equation

Variable (Order of entry)	Standardised Beta	T	Sig
ITL satisfaction (ITLSATIS)	0.41	6.58	**0.0000**
Management awareness of ITL opportunities (LAWARE2)	0.18	2.91	**0.0040**
(Constant)		8.34	**0.0000**

Variables not in the Equation

R&D awareness of ITL opportunities (LAWARE1)	-0.06	-1.00	0.3411
Number of managers who speak a foreign language (SPEAK)	0.09	1.43	0.1543
Frequency of overseas travel (TRAVEL)	0.00	0.06	0.9507
Risk aversion (RISKAV)	-0.04	-0.72	0.4725
Number of managers with university education (UNI)	-0.00	-0.10	0.9188
Number of managers with overseas business experience (OVSEAS)	-0.00	-0.15	0.8791

N=210

the equation was 9.14, significant at the .05 level. Two of the eight management characteristics significantly affect the firm's propensity to adopt ITL.

Hypothesis 3a, which posited a positive relationship between management risk aversion and propensity to adopt ITL was not supported. Management risk-aversion (RISKAV) had a non-significant negative relationship with ITL propensity. However, in the final regression model which determined the combined effect of the most parsimonious set of variables that influence ITL propensity, the negative relationship of risk-aversion with the dependent variable (beta -.09) was actually significant at the 0.10 level, confirming the hypothesis.

According to Hypothesis 3b, managers with greater international orientation are more likely to enter into ITL agreements. Contrary to the strong support given to this hypothesis by the results of the discriminant analysis reported earlier, it was not supported by the regression analysis. None of the four single items measuring international orientation appaer to be significantly, positively related to ITL propensity.

As expected, management satisfaction with current ITL agreements (ITLSATIS) was found to be significantly positively related to the dependent variable, thus supporting Hypothesis 3d which postulated such a relationship. As mentioned previously in section 4.3.3, due to multicollinearity problems, the two variables, management ITL experience (LAGREE) and satisfaction (ITLSATIS) could not be used together in the same equation. It was therefore decided to test the effect of management ITL experience, as measured by the number of ITL agreements (LAGREE) separately. For this purpose another regression was run without ITL satisfaction in the equation. This analysis confirmed Hypothesis 3c. Management's ITL experience had a positive impact

on the firm's propensity to adopt ITL (beta = .28, p = .0000). Appendix 4 presents the results of this analysis.

Recall that in chapter 2, it was argued that while ITL experience may be important, the crucial, more powerful factor that may explain propensity to adopt ITL is nature of the experience gained. In other words, if ITL satisfaction accounts for ITL adoption more than ITL experience, then the impact of satisfaction should emerge as not only significant, when the two are in the same equation, but also sufficiently large to suppress the impact of experience, as an explanatory variable. This proposition was investigated by running a regression analysis with both variables in the same equation. The results showed that ITL satisfaction had relatively stronger impact on ITL propensity (beta = .42, p = .0000) as anticipated. ITL experience, while having a positive impact on propensity to adopt ITL, was not significant (beta = .08, p = .2830). Appendix 5 presents the results of this analysis.

In Hypothesis 3e, it was stated that greater the management's awareness of ITL opportunities (LAWARE2), the greater the propensity to adopt ITL. This hypothesis was strongly supported. However, contrary to expectation, R & D unit's awareness of ITL opportunities (LAWARE1) was found to be negatively related to propensity to adopt ITL, though not significant.

4.4.2.3 Empirical testing of Hypothesis 4: Influence of management perceptions of ITL on propensity to adopt ITL

Hypothesis 4 stated that the firm's propensity to adopt ITL is influenced by management's perception of its relative benefits and costs. The two sub-hypotheses tested were:

H4a: The higher the perceived relative benefits of ITL, the higher the propensity for ITL adoption.

H4b: The higher the perceived relative costs of ITL, the lower the propensity for its adoption.

Results of the regression analysis investigating these hypotheses are presented in Table 4.14. They indicate that management perceived costs and benefits of ITL has reasonable explanatory power, accounting for 26 percent of the variance in the firm's propensity to adopt ITL.

Hypothesis 4a predicted that the higher the perceived relative benefits of ITL, the higher the propensity for ITL adoption. This hypothesis was comfirmed. One of the four variables measuring perceived benefits of ITL, competitive advantage (COMADV) had a significant, positive relationship with propensity to adopt ITL. It had a beta of .13, significant at the .05 level. The other three perceived benefit variable, faster, low cost market entry (FENTRY), diversification advantage (DIVADV) and access to future technology (ACESFT) were not significant but had the predicted signs.

Hypothesis 4b posited that perceived relative costs had a negative effect on ITL adoption. Two of the three cost variables, implementation cost (IMPCOST) ($p = .0000$) and loss of decision making autonomy (LOSSDM) ($p = .01$) were found to be significantly, negatively related to the dependent variable, thus confirming the hypothesis. It is interesting to note that both the two perceived costs variables in the model had stronger impacts on propensity to adopt ITL, than the perceived benefit variables. This confirms the power of the perceived cost variables found in the discriminant analysis. This result is a further justification of the decision to exclude the perceived cost variables from the second stage of the discriminant analysis, in order to allow the full effect of the other variables to emerge.

Table 4.14 Stepwise Regression Analysis Hypothesis 4: Influence of Management Perceptions of ITL on Propensity to Adopt ITL

Multiple R	.52
R^2	.27
Adjusted R^2	.26
Standard Error	5.11
F Statistic	26.47
Significance Level	0.00

Variables in the Equation

Variable (Order of entry)	Standardised Beta	T	Sig
Implementation cost (IMPCOST)	-0.33	-4.65	**0.0000**
Loss of decision-making (LOSSDM)	-0.20	-3.04	**0.0026**
Competitive advantage (COMADV)	0.13	2.12	**0.0354**
(Constant)		7.12	**0.0000**

Variables not in the Equation

Faster, low cost market entry (FENTRY)	0.04	0.66	0.5116
Diversification advantage (DIVADV)	0.07	1.22	0.2277
Access to future technology (ACESFT)	0.04	0.65	0.5248
Entry and exit costs (EEBARR)	-0.02	-0.31	0.7622

N = 215

4.4.2.4 Empirical testing of Hypothesis 5: Influence of perceived environmental hostility on propensity to adopt ITL.

Hypothesis 5 stated that the greater the perceived market and technological competition, and increased government regulations affecting NPD, the greater the propensity to adopt ITL. With the exception of the last variable, the signs of the beta coefficients were in the predicted direction. Management perceived environmental hostility had a significant, but nevertheless, a weak influence on ITL adoption. It explained only 3 percent of the variability in the firm's propensity to adopt ITL (adjusted R^2 = .03). Table 4.15 displays the results. The pattern of the regression results indicate both the market competition (MKTCOMP) and technological competition (TEKCOMP) variables had significant, positive relationships with propensity to adopt ITL. This result is perhaps not surprising, given the strong influence of competitive advantage (COMADV) as a benefit of adopting ITL. The general environmental hostility (GENHOST) variable did not behave as expected, but was not significant.

Table 4.15 Stepwise Regression Analysis Hypothesis 5: Influence of Perceived Environmental Hostility on Propensity to adopt ITL

Multiple R	.20
R^2	.04
Adjusted R^2	.03
Standard Error	5.85
F Statistic	4.76
Significance Level	0.0095

Variables in the Equation

Variable (Order of entry)	Standardised Beta	T	Sig
Market competition (MKTCOMP)	0.14	2.06	**0.0409**
Technological competition (TEKCOMP)	0.13	1.95	**0.0521**
(Constant)		4.30	**0.0000**

Variables not in the Equation

Government regulations (GOVREGU)	-0.05	-0.73	0.4640

N = 225

4.4.2.5 Empirical test of the combined influence and relative importance of independent variables

Hypothesis 6 explored the combined effect of the most parsimonious set of variables among the four variable groups of firm, managerial characteristics and perceptions of ITL, and external environmental factors, on the firm's propensity to adopt ITL. Further, hypothesis 6 examined the relative importance of the variables with significant impact on ITL propensity.

This hypothesis was examined with the final regression model. The results presented in Table 4.16 show that eight variables explain a significant amount of the variance in the dependent variable with an adjusted R^2 of 0.42. In order to determine the relative impact of the independent variables on a dependent variable in a regression model, the beta coefficient (standardized partial regression coefficient) is used (Hair, Anderson and Tatham 1990). Accordingly, determine the relative explanatory power of the eight variables that statistically significantly impact on ITL propensity, their beta coefficients were compared

Referring to Table 4.16, ITL satisfaction (ITLSATIS) with a beta of .33 has the strongest influence on the firm's propensity to adopt ITL. The second most important variable is R & D capability (RDCAP). This variable had a nagative beta coefficient which supports the previous result reported in section 4.4.2. Management awareness of ITL opportunities (LAWARE2) ranked third. Another management characteristic, risk-aversion (RISKAV), ranked eighth.

The fourth most important variable is perceived implementation cost (IMPCOST). The second perceived cost variable that entered the equation, loss

Table 4.16 Stepwise Regression Analysis: Combined Influence Parsimonious set of Independent Variables and their Relative Importance

Independent Variables (Order of Importance)	Standardised Beta	Sig	Importance Rank
ITL satisfaction (ITLSATIS)	0.33	0.0000	**1**
R&D capability (RDCAP)	-0.24	0.0000	**2**
Management awareness of ITL opportunities (LAWARE2)	0.23	0.0002	**3**
Implementation cost (IMPCOST)	-0.18	0.0051	**4**
Loss of decision-making autonomy (LOSSDM)	-0.17	0.0087	**5**
Diversification advantage (DIVADV)	0.14	0.0368	**6**
Faster market entry (FENTRY)	0.12	0.0633	**7**
Risk aversion (RISKAV)	-0.09	0.0946	**8**

Adjusted R^2	.42
F Statistic	18.82
Sig. Level	0.00
N	197

of decision-making autonomy(LOSSDM), ranked fifth in the order of importance. Confirming the results reported in section 4.4.2, these variables had negative coefficients. The two perceived benefit variables among the parsimonious set of variables, diversification advantage (DIVADV) and faster, low cost market entry (FENTRY) had positive beta coefficients and ranked sixth and seventh, respectively. Thus, all the variables behaved in a similar fashion to the earlier regression models, indicating stability of the parameter estimates. It is also important to note that, here again, the perceived cost variables ranked higher than the perceived benefit variables. This further confirms the earlier findings about the power of perceived costs to overwhelm the perceived benefit variables in explaining ITL adoption.

4.5 Summary

This chapter presented the results of the study. In the first section, the descriptive statistics of the sample were presented. In the second section, the test of the reliability and validity of the measures of the dependent and independent variables were assessed by computing coefficient alpha for variables measured with multiple items. This was after first determining the underlying dimensions of the three scales measuring firm capabilities, perceived relative costs and benefits of ITL, with factor analysis. Next the reliabilities of the measures of variables were assessed by computing coefficient alpha. All but two of the independent variables met or exceeded the reliability standard for the research which was set at .50.

The third section of the chapter presented the results of the hypothesis testing process. This was accomplished in two stages. In stage one, a discriminant analysis was performed to test for differences between licensee and non-licensee firms (Hypothesis 1). The results indicated that licensee firms, in fact,

differ from non-licensee firms on a number of dimensions, especially in terms of the characteristics of management, management perception of the relative costs and benefits of ITL, and management perception of environmental hostility. The second stage of the hypothesis testing involved a test of the influence on ITL adoption of four variable groupings: firm characteristics, management characteristics, management perceptions of ITL, and perceived environmental hostility.

Concerning the individual hypotheses, Hypothesis 2 posited a relationship between six firm characteristics and propensity to adopt ITL. Two firm characteristics, firm size (SALES), and R & D capability (RDCAP) were found to have statistically significant impact on ITL adoption. While firm size behaved as expected, R & D capability behaved contrary to expectation.

Hypothesis 3 concerned the influence of management characteristics on propensity to adopt ITL. As hypothesized, management awareness of ITL opportunities and satisfaction with ITL had strong positive impacts on the dependent variable. In contrast, the hypothesized positive relationship between management risk-aversion (RISKAV) and ITL adoption was not supported. In fact, a significant negative relationship was observed, suggesting that adoption of ITL requires some risk-taking propensity on the part of management.

According to Hypothesis 4, management's perceived relative costs and benefits ITL have positive and negative influences on ITL adoption, respectively. Both hypotheses were supported. The fifth hypothesis postulated a positive relationship between perceived external environmental hostility and propensity to adopt ITL. Two variables measuring this construct, technological competition (TEKCOMP) and market competition (MKTCOMP), had the predicted relationship with ITL adoption, thus confirming the hypothesis.

Finally, Hypthesis 6 posited that the individual variables affecting propensity to adopt ITL will differ in their relative explanatory power. This hypothesis was also confirmed.

In conclusion, the model developed and tested in this study appears to perform reasonably well in explaining the firm's propensity of firms to adopt ITL. In the next chapter the meaning and significance of the research findings are discussed.

Chapter 5 Discussion of Results

5.0 Introduction

Chapter 4 presented the results of the study. In this chapter the meaning and significance of the results of each of the hypotheses tested are discussed. The chapter is categorized into six sections. In the first section, the results of the discriminant analysis are discussed. This is followed by a discussion of the multiple regression results concerning the four variable groups: firm characteristics, management characteristics, perceived relative benefits and costs of ITL and perceived environmental hostility in the next four sections. The last section relates to the a discussion of the relative importance of the factors affecting ITL propensity. In each discussion, the similarities and contradictions of our findings with the previous literature are noted and commented upon, with plausible explanations offered. Table 5.1 presents a summary of the results.

5.1 Hypothesis 1: Differences between licensee and non-licensee Firms

The discriminant analysis results dislayed in Table 4.8 in the previous chapter showed that licensee and non-licensee firms can be statistically separated, mainly along management characteristics and management perceived costs and benefits of ITL. This means that one can describe a profile of firms that are involved in ITL. This finding is a statistical confirmation of the Reid and Reid (1988) proposition that firms with acquired licenses may be different from those without. However, firm characteristics which were the main focus of attention by these authors appear to be poor discriminating variables, in this study.

Table 5.1 Summary of Results of Hypothesis Testing

Hypothesis	Expected Relationship	Statistical Test Employed	Findings
1	Licensee and non-licensee firms differ	Discriminant analysis	Ten variables found to statistically separate licensee and non-licensee firms. **Conclusion:** Hypothesis 1 supported.
2a	The larger the firm, the higher the propensity to adopt ITL	Regression analysis	Statistically significant positive relationship between firm size and ITL propensity (beta = .17, p = .05) **Conclusion:** Hypothesis supported.
2b	The higher the extent of ties with overseas organisations, the higher the propensity to adopt ITL	Regression analysis	Correlations in opposite direction proposed and not statistically significant. **Conclusion:** Hypothesis not supported.
2c	The more organic the structure of the firm, the higher the propensity to adopt ITL	Regression analysis	Correlation in opposite direction proposed. One statistically significant at .10 level. **Conclusion:** Hypothesis not supported.
2d	The higher the internal NPD capability to achieve firm objectives, the lower the propensity to adopt ITL	Regression analysis	Correlation in direction proposed and significant (beta = - .10, p = .21) **Conclusion:** Hypothesis supported.
2e	The higher the R&D capability of the firm, the higher the propensity to adopt ITL	Regression analysis	Correlation in opposite direction proposed and statistically significant (beta = - .19 p = .01) **Conclusion:** Hypothesis not confirmed.

2f	The higher the manufacturing and marketing capabilities, the higher the propensity to adopt ITL
3a	The greater the risk aversion of management, the greater the propensity to adopt ITL
3b	The higher the international orientation, the higher the propensity to adopt ITL
3c	The greater the ITL experience, the greater the propensity to adopt ITL
3d	The greater the level of satisfaction with current ITL agreements, the higher the propensity to adopt ITL
3e	The greater the awareness of ITL opportunities, the higher the propensity to adopt ITL
4a	The higher the perceived relative benefits of ITL, the higher the propensity to adopt ITL

Regression analysis	Effect of manufacturing capability in the direction proposed but not significant. Two variables measuring marketing capability in the direction proposed but not significant. **Conclusion:** Hypothesis not confirmed.
Regression analysis	Correlation opposite to the direction proposed, and statistically significant at .09 level. **Conclusion:** Hypothesis not supported
Regression analysis	None of the variables measuring international orientation significant at .10 level. **Conclusion:** Hypothesis not confirmed.
Regression analysis	Correlation in the predicted direction and statistically significant at .0000 level. **Conclusion:** Hypothesis supported.
Regression analysis	Correlation is statistically significant at .0000 level and in the predicted direction. **Conclusion:** Hypothesis supported.
Regression analysis	Correlation is in the direction proposed and statistically significant (beta = .18 p = .004) **Conclusion:** Hypothesis confirmed.
Regression analysis	Correlations of three of the relative benefit variables in the proposed direction and statistically significant at .05 level. **Conclusion:** Hypothesis supported.

4b	The higher the perceived relative costs of ITL, the lower the propensity to adopt ITL
5	The greater the perceived environmental hostility, the greater the propensity to adopt ITL
6	The relative impact of variables affecting ITL propensity will differ

Regression analysis	Correlations of two cost variables in the predicted direction, statistically significantly at .01 level. **Conclusion:** Hypothesis supported.
Regression analysis	Correlations for market and technological competition variables in predicted direction, and significant at the .05 level. **Conclusion:** Hypothesis confirmed.
Comparison of beta coefficients of variables that statistically significantly influence ITL propensity	The explanatory power of eight significant variables range from a high of .33 beta to a low of .09 beta. **Conclusion:** Hypothesis confirmed.

Only firm size (SALES) was found to be a statistically significant discriminating variable. The positive coefficient associated with this variable means that licensee firms tend to be larger than non-licensee firms. This gives support to the hypothesis that large firms possess the resources that may be required to implement the licensed technology, and that such firms may be preferred by licensors (Reid and Reid 1988; Shan 1990). Smaller firms may find ITL an attractive option due to their internal resources limitations (Lowe and Crawford 1983; Crawford 1985). However, these same limitations may also be hindrances in their attempts to attract licensors.

Although firm size was the most important discriminator, other firm characteristics such as R & D capability (RDCAP), extent of diversification (EXTDIV), market communication ability (MKTCOMM), and manufacturing capability (MFGCAP) were not significant discriminating variables. This result indicates that non-licensee firms are as confident as their licensee counterparts in assessing their functional competitive capabilities in R & D, manufacturing and marketing. It appears therefore that firm functional capabilities do not help to explain a firm's involvement in ITL. This result fails to support the findings reported by Ford (1985) and others, suggesting that internal functional capabilities are positive correlates of the firm's involvement in ITL. In addition, the result is contrary to the theoretical assertions of a number of researchers which suggest that internal capabilities may predispose the firm's entry into ITL (for example, Gold 1982; Radnor 1991; Teece 1988).

A possible explanation for this contradiction is that , with the notable exception of Reid and Reid (1988), each of the prevoius studies that examined licensee characteristics focused on licensee firms only. In other words, these studies did not employ a control group to allow for a comparative analysis of the licensee

characteristics isolated. Without such an analysis, the validity of the findings of these studies is questionable. While Reid and Reid's study compared licensee and non-licensee firms, the differences between the two groups of firms were not statistically tested. Based on our results, it seems plausible that internal capabilities *per se* do not pre-dispose the firm to enter into ITL. They may however, influence the firm's performance in acquiring and exploiting licensed technologies. This explains why firms with strong R & D, manufacturing and marketing capabilities require fewer assistance from their licensors (Kim 1988), and are therefore preferred by licensors (Lowe and Crawford 1984; Radnor 1991, Shan 1990).

The variable groups with the strongest impact on ITL involvement were management perceived relative benefits and costs of ITL, and management characteristics. For example, the second most important discriminating variable was the number of managers with university education (UNI), one of the four single items measuring "international orientation". This suggests that advanced education and training inculcates into the firm's management a 'network' or 'co-operative' view in their search for new products (Hakansson and Laage-Hellman 1984). Two other single items representing international orientation of management, frequency of overseas travel (TRAVEL) and number of managers with overseas business experience (OVSEAS), ranked fourth and eighth, respectively.

It appears from the foregoing results that managers of licensee firms are more likely to be internationally oriented. They are more likely to have managers with university education, overseas business experience and higher frequency of travelling overseas. These managers are likely to use their experience and personal contacts with overseas companies to facilitate the firm's acquisition of external technology. This finding supports results of other studies, which

suggest that international exposure through overseas visits and experience provides an avenue for ITL opportunities (Parry and Waston 1979; Shahrokhi 1987). In contrast, firms with fewer number of highly educated managers and little international exposure appear to be inward-looking in their NPD efforts. They are less likely to consider external sources of technology.

The third most important discriminating variable was awareness of ITL opportunities (LAWARE2) ($p = .0003$). The positive coefficient associated with this variable indicates that it has a positive impact on the firm's involvement in ITL. It seems that licensee firms are more likely to receive unsolicited ITL offers, and have higher awareness of the successes and problems associated with the ITL endeavours of other companies. This finding is a strong indication that management awareness, in and by itself, is likely to facilitate firms to search for and evaluate the suitability of licensable technologies.

The four variables related to the perceived relative benefits of ITL: faster. low cost market entry (FENTRY); diversification advantage (DIVADV); competitive advantage (COMADV); and access to future technology (ACESFT), ranked fifth, sixth, seventh and tenth, respectively. The negative coefficients associated with all these benefit variables, with the exception of competitive advantage (COMADV), indicate that these benefits do not necessarily explain current involvement in ITL. This is a most intriguing, and potentially useful finding. It suggests that perceived costs of ITL may override perceived benefits in management evaluation of technology licensing .

As expected, non-licensee firms had a higher perceived costs of ITL than licensee firms. However, in all but one case (COMADV), non-licensee firms also had higher mean scores on the perceived benefit variables than licensee firms. The conclusion that can be reached is that for managers of non-licensee

firms, perceived benefits do not necessarily have a positive impact on their willingness to engage in ITL, due to the high perceived costs of the method. In contrast, for managers of licensee firms, costs of ITL do not necessarily lead to a rejection of the method because of their experience its associated benefits. This explains why three perceived relative benefits variables: faster, low cost market entry, diversification advantage and access to future technology advantage have negative coefficients with the discriminant function. It also explains why competitive advantage (COMADV) has a positive coefficient. This was the only perceived benefit variable on which the mean rating of licensee managers was higher than their non-licensee counterparts (Table 4.8b).

These findings provide empirical support for the assertion by Pisano and Teece (1989) that high perceived costs of licensing may lead firms to reject the method, even where other factors (e.g., perceived benefits) warrant its adoption. Despite this support for the result in the literature, the finding still raises three interesting questions:

- Why do non-licensee firms perceive higher benefits from ITL than do licensee firms?
- What factors explain their lack of involvement in ITL?
- To what extent do they use factual and realistic information in forming these opinions?

Only a tentative explanation can be offered. It is possible that the overestimating of the benefits of ITL by non-licensee firms is the consequence of their not being well-informed about ITL benefits. Our findings suggest that managers of non-licensee firms are more optimistic about the benefits of ITL, and more pessimistic about the costs, due to perhaps, their lack of experience with the method. In other words, non-licensee firms may have little actual

knowledge of the benefits and costs of ITL. In contrast, licensee managers may be expected to provide more realistic and critical evaluations of the benefits and costs of ITL, based on their experience. he preceding explanation seems to be supported by the statistically significant mean difference found between licensee and non-licensee managers in terms of awareness of ITL opportunities (LAWARE2) (licensee = 8.8, non-licensee = 6.7, p = .000).

Recall that LAWARE2 was the third most important variable separating licensee and non-licensee firms. The three items in this variable were: frequency of receipt of fortuitous ITL offers; awareness of other firms' successes; and problems with ITL. The differences between the two groups of firms on the latter two items in this variable were examined to throw more light on this issue. Comparing the mean scores, it was found that licensee managers are more likely to be aware of both the ITL successes of other companies (licensee = 4.1, non-licensee = 3.1; p = .000), and the problems that other companies have encountered in ITL (licensee = .3.5, non-licensee = 3.0; p = .052). However, notice that the sharpest difference between the two groups relates to the awareness of ITL sucesses of other firms (p = .000). The difference between the groups in the context of awareness of ITL problems of other companies is less pronouced (p = .052). This analysis suggests that licensee firms are more likely to be aware of the ITL successes of other firms; while non-licensee firms are more likely to be aware of ITL problems.

It appears therefore that non-licensee firms' awareness of problems that other companies have encountered in ITL may impede their use of the method. This interpretation further supports the view that perceived relative costs of ITL may override its benefits. However, these are issues that require further investigation.

Finally, turning to perceived environmental hostility, management's perception of technological competition (TEKCOMP) (ranked ninth) was also an important, significant discriminator. This variable had a positive loading with the discriminant function, suggesting that firms may be involved in ITL due to the perceived intensity of technological competition in their markets (Gold 1975; Wilkinson 1985). The significantly higher rating given to competitive advantage as a benefit of ITL by licensee managers, compared to non-licensee managers, seems to support this interpretation.

The unmistakable conclusion that can drawn from the discriminant analysis results is that management characteristics and perceptions of ITL have stronger influence on the firm's involvement in ITL than firm characteristics. Thus the managerial factors ignored by Reid and Reid (1988), and other researchers, appear to be the major discriminating variables. This result lends credence to Gold's (1975) caution that managerial objectives and preferences need not be ignored in the study of the selection of technology development methods.

5.2 Hypothesis 2: Influence of firm characteristics on propensity to adopt ITL

Collectively, the firm characteristics examined in this study, explained only four percent of the variability in ITL adoption. This result is consistent with that of the discriminant analysis, where it was found that firm characteristics were poor discriminators between licensee and non-licensee firms.

Despite their overall weak impact, the hypotheses regarding individual firm characteristics revealed interesting results. Firm size (SALES) was found to significantly influence future intention to adopt ITL (Hypothesis 2a). This finding was not surprising given the discriminant analysis results which showed firm size as the most important discriminating variable between licensee and non-licensee firms. As stated in the preceding section, it would appear from this result that large firms are more likely to engage in ITL agreements given the resources they possess to successfully implement such agreements (Caves, Crookell and Killing 1983; Ford 1985; Reid and Reid 1988). In addition, large firms are more likely to be the target of the marketing efforts of licensors, especially small firms which lack the resources to commercialise their innovations, since large firms are more likely to possess the specialised complementary assets required for product introductions (Shan 1990).

Hypothesis 2b maintained that propensity to adopt ITL was positively related to the extent of organisational ties. The two measures of this variable, percentage of sales derived from exports (EXPORT) and the extent of foreign ownership in the firm (FOWNER), were negatively related to ITL propensity, but not statistically significant. It seems that firms with greater export involvement are less likely to adopt ITL. This finding is in contradiction to previous research

(Ford 1985; Reid and Reid 1988). It however provides some support for the view that licensee firms are less likely to export due to the restrictions imposed by licensors (Parry and Waston 1979).

The negative relationship of extent of foreign ownership (FOWNER) and propensity to adopt ITL, also gives support to the earlier result by Parry and Waston (1979) that there may be greater technological independence with lower foreign ownership. Firms with large foreign ownership may be prevented by their foreign owners from licensing technology from other organisations. It might also be that such firms may have a ready supply of new products from their foreign owners, and therefore may have no need to seek ITL agreements from independent organisations.

In line with Hypothesis 2d, the firm's capability to achieve its NPD objectives (NPDCAP) has a negative, but statistically in significant impact on propensity to adopt ITL (beta = .10, p = .209). This result is in partial support of previous research findings which suggest that a firm is more likely to license-in technology from other organisations when its internal capability is inadequate to meet its NPD performance goals (Caves, Crookell and Killing 1983; Crawford 1985; Killing 1977). However, the result seems to contradict Reid and Reid's (1988) finding that licensee firms may be more active in NPD and have larger new product introductions than non-licensee firms.

A possible explanation of this contradiction results is that a firm may be active in NPD but will still adopt ITL to gain access to specific products and for specific markets, for which it lacks the necessary skills, in order to meet its overall NPD goals. This is one reason why certain pharmaceutical firms, with strong and effective NPD programs in traditional areas, nevertheless license-in biotechnology products from other firms (Pisano 1990; Shan 1990; Roberts and

Mizouchi 1989). The emphasis of Hypothesis 2d is therefore on the organisation's achievement of its new product performance objectives, rather than on the number of new products *per se*. From this perspective, the result appears to be consistent with the previous literature.

Hypothesis 2e suggested a positive impact of R & D capability (RDCAP) on propensity to adopt ITL. The expectation was that higher R & D capability may facilitate the search for, acquisition and successful implementation of licensed technologies. The statistically significant negative relationship (beta = - .19, p = .0074) suggests that firms with strong internal R & D capability may be capable of generating their own new products and are therefore less likely to license-in technology.

The foregoing finding is contrary to previous findings (Ford 1985; Killing 1977; Parry and Waston 1979; Shahrokhi 1987). A possible explanation for this contradiction lies in the measurement instruments adopted by these scholars. While they used single items, such as R&D expenditure as percent of sales and number of R&D personnel, as proxies for the firm's R & D capability, a composite measure containing six items was used in this research. A second possible explanation for this contradiction is that R & D personnel in firms with high R & D capability may be inward-looking in their NPD efforts. Thus, they may have a higher "not-invented-here" syndrome than their counterparts in other firms.Such people may be less willing to participate in external technology acquisition programs.

Another explanation for this lack of positive relationship between R & D capability (RDCAP) and propensity to adopt ITL might be that high R & D capability may result in greater awareness and understanding of external technology, for imitation or reverse engineering, rather than for acquisition.

This explanation is buttressed by the fact that the firm's R & D unit awareness of ITL (LAWARE1), as measured by the existence of a formal procedure to scan external technological developments, and the extent of R & D interaction with the external technological world, had a negative beta coefficient (though not significant) with propensity to adopt ITL as presented in chapter 4. (Table 4.13).

The positive association between manufacturing and marketing capability on the one hand and propensity to adopt ITL received mixed results. Manufacturing capability (MFGCAP) had a positive but non-significant relationship with the dependent variable, as did one of the three factors measuring marketing capability, market communication ability (MKTCOMM). Product commercialization (PRDCOM) and extent of diversification (EXTDIV) all had negative impact on ITL adoption, but not significant. Although not significant, this suggests that firms with strong market experience as measured by the number of market segments and product line diversity, and those with effective product commercialisation capacities, may be less likely to license-in new products, indicating support for the results of the discriminant analysis. It might be that these capabilities do not necessarily lead to adoption of ITL, but do positively influence firms' performance with the licensed technology. This would explain why licensors look for such capabilities in their prospective licensees (Gold 1982; Lowe and Crawford 1984; Radnor 1991; Shan 1990; Teece 1988).

5.3 Hypothesis 3: Influence of management characteristics on propensity to adopt ITL

As reported in chapter 4, management characteristics explained 25 percent of the variance in the firm's propensity to adopt ITL. Concerning the individual

management characteristics, the expectation that managers with a high degree of risk-aversion (RISKAV) (Hypothesis 3a) will ahow a higher propensity to adopt ITL was not supported. In fact, risk-aversion had a significant negative impact on the dependent variable (beta = -.09, p = .09). It seems that in spite of relatively faster market entry, lower risk, and lower cost advantages, managers consider ITL as a risky venture. For one thing, ITL involves loss of control over the licensed technology and does not guarantee success due to licensor restrictions. In addition, ITL has the potential capacity to hinder the internal skill development of the licensee by adversely affecting internal R & D morale and leading to dependence on the licensor for future technology. (Gold 1982; McDonald and Leahey 1985; Sen and Rubenstein 1989). Thus, while ITL may offer certain benefits over internal R & D, ITL still involves considerable risks

This finding corroborates Lieberman's (1989) conclusion that licensing-in technology may be as risky as internal technology development. This suggests that in order to adopt ITL, a manager must demonstrate a willingness to take some risks. Thus, the conventional wisdom that ITL is a lower risk strategy appears not to be supported by the results of the study.

Although management's international orientation was shown by the discriminant analysis to be important in separating licensee and non-licensee firms, it seems to have little impact on ITL propensity. None of the measures of this variable was significantly related to ITL propensity (Hypothesis 3b). In fact, two of these variables, number of managers with university education (UNI) and overseas business experience (OVSEAS) had negative influence on propensity to adopt ITL, but not significant. This result is surprising given the discriminant analysis results, and those of previous researchers (Carstairs and Welch 1982; Parry and Waston 1979; Shahrokhi 1987).

The result is difficult to explain. It might be that involvement in ITL agreements may lead to an increase in the international orientation of the firm's management to ensure the effective performance with the currently licensed technology. For example, to ensure effective coordination and interaction with current licensors, the management of the licensee firm may have to frequently travel overseas and learn to speak the languages of its licensors. However, this international orientation acquired through current ITL may not necessarily lead to a greater propensity to adopt ITL in the future.

Both Hypotheses 3c and 3d which posited a positive relationship between ITL experience (LAGREE) and ITL satisfaction (ITLSATIS) with the dependent variable were supported. The finding regarding ITL experience, supports the assertion that the increased knowledge and contacts that a firm gains through involvement in ITL agreements provide avenues for future ITL agreements (Crawford 1985; Kim 1988). Further, experienced firms may be more capable of searching for, negotiating, and absorbing licensed technology.

The positive influence of ITL satisfaction on propensity to adopt ITL was not surprising. However, the interesting finding is the power of ITL satisfaction to suppress ITL experience. In the absence of ITL satisfaction, ITL experience had significant influence (Appendix 4). However, in the presence of ITL satisfaction in the regression model its impact was statistically insignificant (Appendix 5). This result makes intuitive sense. Contrary to the suggestions in the literature (Crawford 1985), the number of ITL agreements a firm has do not necessarily give a clear indication of its propensity to use ITL in the future. In brief, it is the nature of management satisfaction or dissatisfaction with the firm's current ITL agreements that is most effective in determining this propensity. This is because ITL experience (as measured by number of ITL agreements), by itself, does not

give an indication of whether indeed the firm is satisfied or dissatisfied with the performance of its licensed technology.

Turning to the last management characteristic, as expected, awareness of ITL opportunities (LAWAEW2) has a statistically significant positive effect on propensity to adopt ITL. This is in complete accord with the discriminant analysis result. This finding, in itself, is not surprising given that the export literature considers awareness of opportunities a most important factor influencing export propensity (for example, Bilkey and Tesar 1977). Unfortunately, management awareness is almost noticeable for its absence in current ITL research. Thus, it appears that this is the first time this important construct has been tested for its impact on ITL propensity.

5.4 Hypothesis 4: Influence of management perceptions of benefits and costs on propensity to adopt ITL.

As indicated in the previous chapter, both hypotheses concerning the positive influence of perceived relative benefits of ITL (Hyopthesis 4a), and the negative effect of perceived relative costs of ITL (Hypothesis 4b), on ITL adoption were confirmed. These findings corroborate the theoretical assertions of researchers like Gold (1975) about the influence of management perceptions on decisions to choose a technology development method. While previous literature only alluded to the effect of perceived relative costs and benefits on ITL adoption (Lowe and Crawford 1983; Killing 1975, 1977), this result provides empirical evidence of the extent of their impact.

More importantly, this result strengthens our rationale for conceptualising ITL adoption as a *behavioral process* involving management evaluation of the benefits and costs method in the light the circumstances of the firm. It also

supports our view that management factors play the most important role in the ITL adoption process. Recall that the discriminant analysis found licensee and non-licensee firms differed mainly on management characteristics and perceptions of the relatve costs and benefits of ITL. The dominant impact of these variables in explaining variability is supported by the regression results. They individually accounted for 26 percent and 25 percent of the variance in ITL adoption, respectively, compared to firm characteristics (4 percent).

5.5 Hypothesis 5: Influence of perceived environmental hostility

Another clear finding of this study is that management perceived environmental hostility has a positive impact on ITL adoption as proposed in Hypothesis 5. While high market competition, especially in technology, opens up new product opportunities, it also increases costs and risks in the NPD process (Olleros 1986). The result regarding this variable suggests that in competitive situations firms are more likely to license technology from other organisations. This finding is consistent with the theoretical assertions of Gold (1975, 1982, 1987) and of Wilkinson (1985). It also conforms to reported anecdotal evidence that compared to internal R & D, the external acquisition of a fully functioning technology is relatively faster in allowing the firm to keep up with threatening competitors (Capon and Glazer 1987; Ford 1985; Lowe and Crawford 1983; Patsalox-Fox 1983).

5.6 Hypothesis 6: Combined influence of the independent variables on propensity to adopt ITL and their relative importance

Finally, we found eight variables from the four groups of variables examined in the study explained a respectable 42 percent of the variance in the dependent variable. Seven of these variables related to management perceptions of ITL

and management characteristics. This provides further support for the power of these variables revealed in both the discriminant analysis and the four earlier regression models. Similarly, we found that the individual variables have different explanatory power. On account of the magnitude of the beta coefficients, the most important variables were ITL satisfaction (ITLSATIS), R & D capability (RDCAP), management awareness of ITL opportunities (LAWARE2), implementation cost (IMPCOST), loss of decision-making autonomy (LOSSDM), diversification advantage (DIVADV), faster, low cost market entry (FENTRY) and risk-aversion (RISKAV), in that order.

Moreover, the results suggest that cost variables, especially implementation cost (IMPCOST), have greater impact on ITL adoption than any of the benefit variables. This conclusion seems to support of Lowe and Crawford's (1983) thesis that cost may be more important than speed benefit factors in the firm's decision to license technology. These results inform ITL theory because they provide the first empirical evidence of the relative impact of variables which affect the adoption of ITL for NPD.

5.7 Summary

The discussion of the results of the study shows some support for, and contradictions with, previous research. In general, however, the regression results are similar to those obtained from the discriminant analysis. First, the power of managerial perceived costs and benefits of ITL in differentiating between licensees and non-licensees, was confirmed in the regression models. These factors explained 26 percent of the variance in ITL adoption. Not surprisingly, four of the eight most important variables that significantly affect ITL adoption, related to management perceived costs and benefits of ITL.

Similar conclusions can be made concerning the influence of management characteristics, which the discriminant analysis showed to be strong variables in separating licensee and non- licensee firms. On their own they accounted for 25 percent of the variability in the firm's propensity to adopt ITL. Additionally, three management characteristics were among the eight most important variables impacting on the firm's propensity to adopt the ITL approach. Further, from the discriminant analysis results it was observed that firm characteristics were poor separators between licensee and non-licensee firms. This was supported by the regression results which indicated that they accounted for only 4 percent of the variance in the dependent variable. Additionally, only one firm characteristic was among the eight most important variables affecting ITL adoption.

Finally, none of the three variables measuring perceived environmental hostility was among the nine most important explanatory variables. They accounted for a mere 3 percent of the variance in the firm's propensity to adopt ITL. This result is also not a surprise as it corroborates the results of discriminant analysis. The strong similarity between the results of the two type of analysis provide some indication of the stability and validity of these findings.

This research appears to be the first to develop multiple measures of the key variables to test an ITL adoption model in a multivariate framework. Given this fact, the results reported in this chapter provide new insights into, and make major contributions to, the understanding of the firm's ITL behavior. In the next chapter, the theoretical, methodological, managerial and public policy implications of the results are discussed. The chapter also presents the limitations of the research and recommendations on future research directions.

Chapter 6 Summary, Implications, Limitations and Future Research Directions

6.0 Introduction

Many marketing writers already accept that ITL, as an external method, can be a viable alternative source of new products to internal R&D. Yet, new product development research focuses on internal development with little attention to external methods like ITL. This research explored the factors that influence the firm's propensity to adopt ITL in new product development. In the following sections of this chapter we present a summary of the research and the implications of its findings. In addition, the limitations and future research directions are also discussed.

6.1 Summary of research

6.1.1 Objectives of the study

The overall aim of the research was to investigate the factors that affect the firm to choose ITL instead of internal R & D in NPD. Specifically, (1) to develop and test the reliability and validity of measures of ITL-related variables , and (2) to use them to test the explanatory power of a model of the firm's propensity to adopt ITL, in a multivariate framework. In the attempt to achieve these objectives, three specific questions were raised and answered:

- What are the differences between licensee and non-licensee firms?
- What is the separate effect of each of firm characteristics; management characteristics; management perceptions of the

relative costs and benefits of ITL; and perceived environmental hostility on the firm's adoption of ITL?

- What is the most parsimonious set of factors influencing ITL adoption and their relative importance?

6.1.2 Literature review

The review of the relevant literature was presented in chapter 2. The major purpose was to identify relevant variables that prior research suggested influence ITL adoption. It was concluded from the review that differences in the firm characteristics, management characteristics, management perceptions of ITL, and perceptions of the external environment may explain why some firms engage in ITL and others do not. Such factors were therefore also likely to influence propensity to adopt ITL in the future.

Further, the review also revealed some gaps in the understanding of the firm's ITL behavior. Of notable importance was first, the lack of studies concerning the examination of the individual and combined influence of various factors on ITL propensity. Second, the literature to date has been merely descriptive and shown little interest in the relative importance of the various factors that impact on ITL adoption. Further, previous research explanations of ITL adoption were based mostly on measures, whose reliability and validity could be questioned.

On the basis of the review of the literature, and its shortcomings, it was argued that an understanding of the firm's ITL adoption behavior required a conceptualisation of ITL adoption as a decision-making process. ITL was viewed as an organisational response to stimuli, both within and without the firm. This reasoning guided the development of a theoretical ITL adoption model and hypotheses to be tested.

6.1.3 Methodology

The methodology of the research was presented in chapter 3. A cross-sectional mail survey was adopted. The single key informant technique was used to collect data. The unit of analysis was the firm, rather than the individual ITL transaction, since the research concerned the factors influencing the firm's decision to engage in ITL in the future. Chapter three also presented the operational definitions and measures of the dependent and independent variables. Of particular note is that most of the variables were measured with multiple items. Finally, the analytical techniques employed to analyse the data collected, were presented.

6.1.4 Research findings

The analysis of the data collected was presented in chapter 4. This was presented in three sections. First, the descriptive statistics of the sample were presented. The second part of the chapter presented the results of the measurement development process. To test the validity of measures in the firm's functional capability, perceived relative costs and benefits scales, the items in these scales were factor analysed. The emergent items in each scale displayed reasonable convergent and discriminant validity by loading heavily on the variables they were supposed to measure, and weakly on the other s.

The reliability of the dependent and independent variables were assessed by computing coefficient alpha, which is the most commonly accepted method of assessing reliability of multiple measures (Peter 1979). With the exception of two variables, all variables had coefficient alphas of over .50, the acceptable standard alpha for research of this nature (Churchill 1979). The third part of chapter 4 presented the results of the hypothesis testing process. The hypothesis that licensee and non-licensee firms differ was tested with discriminant analysis. The results showed that licensee and non-licensee firms differed in

relation to management characteristics, management perceptions of ITL and perceived environmental hostility. Firm characteristics emerged as weak discriminators.

The results of the multiple regression analysis were presented next. The main findings were:

- Firm characteristics have a weak influence on propensity to adopt ITL. The hypothesis predicting a positive relationship between ITL propensity and firm size was supported; while that related to R & D capability was not supported. NPD capability was found to a weak negatively impact on propensity to adopt ITL.
- Management characteristics, as category, had an appreciable impact on propensity to adopt ITL. The positive influences of ITL satisfaction (ITLSATIS) and management awareness of ITL opportunities (LAWARE2) were supported . An interesting finding was that ITL experience (LAGREE), by itself, had a strong positive impact on propensity to adopt ITL. However, this influence paled into insignificance in the presence of ITL satisfaction, suggesting that mere experience does not necessarily lead to future use of ITL approach. Rather, it is the positive beneficial experience *per se* that has the important influence on ITL propensity.
- The variable group with the strongest influence on propensity to adopt ITL appeared to be management perceptions of the relative costs and benefits of ITL. Both hypotheses concerning the positive impact of perceived benefits, and negative impact of perceived costs, on propensity to adopt ITL, were stronlgly supported.
- Perceived environmental hostility as a construct had a weak influence on ITL adoption. However, two variables, namely: market

competition and technological competition, had statistically significant and positive impact on ITL adoption as hypothesized.

- The regression model with the best explanatory power contained eight variables, which explained a respectable 42 percent of the variance in the firm's propensity to adopt ITL. This implies that the explanatory power of the model developed in this study is not very strong. These variables displayed different explanatory powers as hypothesized.

Next the empirical findings were discussed in the light of the previous literature and the model tested, in chapter 5. The discussion showed both support for, and contradictions with, previous research findings. However, there was a strong consistency between the results of the discriminant analysis and those of the multiple regression models. Generally, variable groups that were strong discriminators between licensee and non-licensee firms appeared to have strong influence on the firm's propensity to adopt ITL. In other words, variables that explain current involvement in ITL are also likely to explain future ITL propensity.

6.2 Implications

The major implications of the results of the study are now presented. These are discussed under three headings: theoretical, methodological and managerial.

6.2.1 Theoretical implications

The major theoretical contribution of this study is the rigorous testing of an ITL adoption model derived from empirical studies and theoretical statements on the firm's licensing behavior. The results inform the licensing literature first, because of its broad model specification. The model incorporated many of the

variables suggested in the literature as likely to influence the firm's ITL propensity. No study has tested such a comprehensive model on the firm's use of ITL. Second, several of the theoretical constructs examined in this study have promising potential for development in future research. In particular, the licensee orientation taken in developing the constructs should enhance the development of ITL theory.

The results of the study are also relevant to NPD theory. The current NPD literature has almost an exclusive internal orientation. Conforming to observations by a growing number of scholars (Capon and Glazer 1987; Ford 1988; Gold 1987; Wind and Mahajan 1988), this study demonstrates that firms do consider external sources of technology like ITL in their NPD process. This finding has important theoretical implications for NPD research. It was argued in chapter 2 that current research in NPD is mainly concerned with the activities performed in the process, how well they are executed, the completeness of the process and the success/failure of the outcome. The use of external technology acquisition methods like ITL is barely considered. What this study has shown is that, in practice, managers *do not* consider the NPD process as a rigid, sequential one with all activities performed independently within the firm. External technology acquisition methods provide alternatives for skipping some of the stages of the process. In other words, NPD is a flexible, management controlled process that could be effectively managed to allow short-cuts and other modifications to suit the resources and capabilities of the firm (Wind and Mahajan 1988; Gold 1987).

Such a perspective of the NPD process should enhance a more serious consideration of the entire set of factors that affect the choice of NPD methods, and the success of new products. In short, in the light of the findings of this study, researchers need to re-evaluate the usefulness of the internally-oriented

conceptualisation of the NPD process, if they are to take due cognisance of the plethora of factors influencing the firm's NPD activities. In the words of Wind and Mahajan (1988, p. 310):

> Most academic efforts to date have been on the improvement and development of better research and modelling approaches, with only scant attention to the concepts underlying the entire new product development systems and the need to overhaul them. Yet, it is this latter area of re-examination of the basic tenants of new product development that one finds the potential for improvement and increased value to users.

The findings of this study relating to the strong impact of mangement perceived relative benefits and costs of ITL on its propensity to adopt ITL give some credence to the foregoing viewpoint.

The findings of this study, however, raises a conceptual issue. That is, it is ITL considered by management as an alternative to internal R & D? Apart from the omission of other potential variables that may affect the firm's ITL decision-making, the low R^2s obtained may also be due to the fact that ITL is not considered by management as an alternative, but a supplement to internal R & D. This is perhaps more so in high technology industries whose technologies are licensed to facilitate internal product development. This issue may need to be investigated by future research.

From the technology licensing perspective, this study makes an initial attempt at theory development from the demand side, that is, from the licensee viewpoint. As mentioned in chapter 2, most research in technology barely gives attention to licesee behaviour. Unlike previous research, this research has determined the

extent to which internal and external variables individually and collectively affect ITL propensity. A further theoretical contribution of the research is that for the first time, management characteristics and perceptions, which have been neglected units of attention by previous researchers, have been shown to not only impact on ITL propensity, but have stronger impact than firm characteristics.

The relatively strong explanatory power of management-related variables on ITL adoption reinforces the underlining rationale of the model presented in this research. It was argued that, theoretically, the ITL adoption decision is a behavioral response to external and internal factors. Consequently, its adoption of ITL should be conceptualised as a result of a management evaluation process which leads to ITL as the preferred method of NPD. Such a conceptualisation places management characteristics and perceptions of ITL at the centre of any investigation of ITL adoption. The results of the study confirm the validity of such a conceptualisation.

As previously mentioned, almost two decades ago, Gold (1975, p. 26) suggested that, managerial preferences and the guiding objectives of the individual firms need not be ignored in choosing alternative methods of technology development. Unfortunately, time has not removed the need for this caution. The results of this study show that this appeal is well-founded. They suggest a need for a shift of emphasis from firm to management characteristics and perceptions in ITL research.

A further theoretical contribution is that, for the first time, the construct "propensity to adopt ITL" has been operationalised with multiple items and its reliability shown to be quite high (coefficient alpha = 0.91). The final theoretical contribution relates to the statistical test of differences between

licensee and non-licensee firms. While previous research has provided largely anecdotal evidence of the existence of differences, this research provides statistical confirmation of the differences. The implication is that it is possible to build meaningful profiles of licensee and non-licensee firms. This should enhance licensee segmentation analysis.

6.2.2 Methodological implications

The development of multiple measures of the key variables, and the test of their reliability and validity, seem to represent a major advance in ITL research. Shahrokhi (1987) lamented that it may be impossible for researchers to employ research techniques like regression in technology licensing research due to lack of reliable data. This study has demonstrated that perceptual measures can be reliable alternatives to objective measures, making the use of multivariate techniques in ITL research possible. This suggests that it is possible for researchers to build on current ITL descriptive studies by developing and testing predictive models.

The second major methodological implication of this study concerns the inclusion of non-licensee firms in the sample. The differences found between these two groups of firms give further credibility to the findings concerning the characteristics of licensee firms, and indeed to the robustness of our model. In other words, unlike previous studies, this study employed a control group for comparison. In order to uncover the firm characteristics and managerial factors that impact on ITL propensity, one must identify the characteristics that statistically differentiate between licensee and non-licensee firms. As we argued previously, previous studies concerning the characteristics of firms that correlate with ITL adoption may have been compromised since they looked at licensee firms only (for example, Ford 1985, Parry and Waston 1979, Sharhokhi 1987). The methodological rigour adopted in this study therefore enhances the

validity of its findings. Finally, the test of the explanatory power of the ITL propensity model in a multivariate framework affords the opportunity to examine the combined, as well as the individual effect of variables impacting on ITL propensity.

6.2.3 Managerial implications

The results of this research yield different strategic implications for firms engaged in selling technology (licensors and technology marketing consultants) and those engaged in buying technology (licensees).

6.2.3.1 Implications for licensors (technology sellers)

Previous licensing-out literature suggests that few technology sellers take a strategic and proactive posture towards technology marketing, and that licensees are often the initiators of the process (Ford 1985; Teece 1981; Svensson 1984). Perhaps one reason for this inertia on the part of licensors is the lack of adequate understanding of licensee behavior. If this is so, this research provides a number of important technology marketing implications.

The finding that licensee firms are, in fact, different from non-licensee firms means that meaningful bases for effective market segmentation strategies exist. The initial implication is for segmentation of potential licensee markets. Technology sellers can build a profile of potential licensees, and target their marketing efforts accordingly. As noted in chapter 4, licensee firms are likely to be relatively larger, with managers who are highly educated and internationally oriented. However, they likely to be more critical of the relative benefits and costs of ITL. The results suggest to technology marketers that the firm's functional capabilities may not be as useful segmentation criteria as managerial characteristics and perceptions.

Further, the results concerning the important factors influencing ITL adoption provide some indication of the factors that may be stressed by technology sellers in negotiating with potential licensees. For example, the strong negative impact of perceived costs in undertaking ITL, indicates that licensors may need to adopt effective promotion strategies for altering the perceptions of non-licensee firms about technology licensing, particularly in relation to ITL process costs and risks. Promotion strategies aimed at non-licensees firms may need to emphasise the value of licensor incentives and support in order to allay some of the concerns these firms have of ITL.

Unlike current licensees, the findings indicate that formidable barriers exist in marketing technology to non-licensee firms. As mentioned earlier, the greatest barrier to these firms engaging in ITL appears to be the high perceived costs. Their knowledge of ITL benefits does not necessarily result in pursuit of the ITL approach. The clear implication is that a licensor may need to offer significant benefits and support, especially in the area of implementation, in order to attract these firms.

For current licensees, licensor communication programs should be compatible with their prior expectations of ITL. The result that ITL satisfaction is the most important factor influencing ITL propensity, reinforces the view that technology marketers need to build strong, long-term interactive relationships with their licensees (Welch 1985). Marketing initiatives to these firms may need to emphasise both the immediate and long-term benefits of an ongoing interactive relationship. Licensors should implement 'conflict-reducing strategies' in their relations with their licensees, if they are to enhance their chances of selling technology to them in the future.

This study also sheds light on some management and firm characteristics that may impede entry into ITL. The relatively high importance of the influence of management awareness of ITL opportunities on adoption, suggests that marketing efforts that increase such awareness may help in attracting licensees. For example, reports of cases of successful acquisition and implementation of external technology by other firms may be a powerful means of getting non-licensee firms to consider the approach.

6.2.3.2 Implications for licensees (technology buyers)

Like managers of licensor firms, the research results provide significant implications for managers of licensee firms. They provide these managers with an in-depth insight into the important factors that influence their ITL decisions. This self-awareness may lead to better understanding of the ITL decision-making process and ultimately to better decisions. The findings of this study indicate strongly that firms can use ITL in the NPD process for such benefits as faster, low cost market entry; competitive advantage; diversification advantage, and access to future technology. However, ITL also involves considerable acquisition and implementation costs and risks. The findings related to the perceived relative benefits and costs of ITL provide managers with a useful framework for considering ITL.

Additionally, the results provide some indication of the type of managers and environment that would support successful ITL. For example, management can determine the attractiveness or otherwise of ITL for the firm by examining the characteristics and perceptions of its key managers. The management-related factors which were found to significantly influence ITL adoption were risk-aversion, ITL experience, awareness of ITL opportunities, and perceived

relative benefits and costs. This suggests that in order to facilitate adoption of ITL, firms may need to educate and increase their managers' awareness of ITL, particularly in relation to its costs and benefits vis-a-vis internal R & D. From another perspective, this implies that management is able to identify the factors that are necessary to stress in recruitment, training and education programs to get the firm ready for and/or enhance the effectiveness of current ITL strategy.

6.2.3.3 Implications for policy-makers

Like corporate management, the results of this study have implications for policy-makers. ITL has desirable pay-offs for a country, in terms of introduction of new products, expanded industrial base, employment generation, and favorable balance of payments (Millman 1983; Reid and Reid 1988). The results of this study appear to be very useful for governmental efforts to promote ITL to firms. They show that the reluctance of some firms to adopt ITL may be attributed to lack of awareness of ITL opportunities and negative perceptions about the method. The implication is that educational efforts that emphasise information on ITL opportunities, and raise the expectations of managers concerning ITL as a method of revitalising the firm, will attract firms to adopt the approach.

Although this study ignored government macro-economic initiatives that may impact on ITL propensity, it seems that any measures aimed at improving the overall economic environment to enhance the use of external technology, need to be combined with efforts aimed at individual firms. The strong impact of management characteristics and perceptions on ITL propensity, found in this study, suggests that macro-level measures will not lead to any appreciable

increase in the willingness of firms to acquire external technology unless individual managers are convinced of its usefulness to their organisations.

Finally, promotion efforts to increase awareness of ITL and encourage its use will be more fruitful if firms are carefully selected. This is because the study has shown that firms with certain characteristics and attitudes are more likely to initiate the acquisition of external technology for NPD. The results therefore shed light on the characteristics of firms that are more likely to be receptive to such governmental programs.

6.3 Limitations of the Study

The first limitation of this research concerns its cross-sectional nature. Cross-sectional studies preclude the consideration of events that occur over time. This staticity thus limits the degree to which the results could be generalized to the population under study. Additionally, the limitation of the study's population to only three industries means that the generalisability of the results is yet to be established. Further, the sample was not strictly selected at random. Therefore, the inferences drawn from the results relate to it and not to any population. As mentioned in chapter 3, the selection of the three industries was because of their reported high incidence of ITL agreements. Future studies are encouraged to replicate this study and/or adopt a design including a more varied mix of industries.

The large number of small firms in the study means that the results should be interpreted with caution when dealing with large firms. The next limitation is the lack of distinction between ITL agreements for process and product technologies. It is possible that the factors discussed in this research may have

varied influence depending on whether ITL propensity is in relation to process or product technology.

Another limitation of the research is the use of a single informant to collect data on a subject that involves group decision-making (Ford 1985). Although there was a strong justification for the use of the CEO as the key informant in this research, the results should be viewed in the light of the constraints imposed by this data collection approach. Finally, the study is limited by the choice of variables included in the theoretical research model. We included many of the variables that current literature suggests are likely to influence ITL adoption. However, other variables like organisational culture, and government technology licensing regulations and incentives ignored in this study may be investigated.

6.4 Future research directions

Seven directions for future research are possible. First, this research should be replicated in other industries and countries to test the robustness of the model presented, and to improve the generalisability of the findings. The measures of the ITL-related variables should be seen to represent an initial attempt at developing reliable and valid measures in the technology licensing literature. Thus, a second future research recommendation is that these measures require further refinements and enhancement. Future researchers may, for example, add new items to the scales presented to improve their reliability, and/or develop additional measures of the dependent and independent variables.

A third direction for future research concerns the other explanatory variables that may have been ignored in this research. Although the model tested here was very broad, and had a respectable 42 percent explanatory power, as

mentioned previously, other potential explanatory factors may need to investigated.

The unit of analysis employed in this research was the firm. Future research could adapt the model to investigate the factors that influence the decision of firms to enter into ITL agreements for specific products (transaction level analysis). For example, do the same factors influence the decision to license industrial and consumer products, or high technology and low technology products or process and product technology?

The strong influence of ITL satisfaction on the firm's propensity to adopt ITL opens up another avenue for future research. Several questions need future investigation. For example, what factors influence success or failure of an ITL agreement? What is the role of licensor and licensee in ensuring success and thus, satisfaction? What is the role of licensor-licensee conflict? A comparative research design investigating successful and unsuccessful ITL agreements will help provide answers to these questions.

Further research into the effect of firm characteristics and environmental factors on ITL adoption is needed. The weak explanatory powers of these two groups of variables suggest that other potential variables were not considered in this study. Given the strong theoretical arguments for their impact on the firm's propensity to adopt ITL (Capon and Glazer 1987; Gold 1982; Killing 1977; Radnor 1991), our results seem surprising. Future studies could increase the number of firm structural and enviromental variables, and generate new items for measuring them.

Finally, although the hypotheses tested in this study imply that the factors affecting ITL adoption are distinct in their effect, it needs to be noted that they

may interact. For example, we showed the power of ITL satisfaction over ITL experience whem both are in the same regression equation. While both variables in the absence of each other have significant impact on ITL adoption, the effect of ITL experience is insignificant in the presence of ITL satisfaction. In theory therefore, additional hypotheses could be generated to reflect the complexity of such interactions. It could be suggested, for example, that mangement perceived relative benefits and costs of ITL are probably dependent upon their own characteristics and those of the firm. It is hoped that the empirical findings reported here will encourage efforts directed at developing and testing higher order interactions among the factors that impact on the firm's propensity to adopt ITL as an alternative to internal R & D.

The findings of this study are a step forward toward the development of ITL models with important practical implications for technology marketing through licensing. Although somewhat limited in its sample, the empirical results perovide a much needed basis for further development of knowledge in this critically important method of NPD.

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Appendix 1
Overview of Relevant Empirical ITL Studies

Author/ Date	Sample	Measurement	Statistical Analysis	Results
Sen and Rubenstein 1989	Convenience sample of 31 companies. Interviews/questionnaire	Likert and scales	Box plots, correlation Wilcoxon	List of ITL problems. Competent R&D unit facilitates acquisition and implementation of external technology. A number of organizational and personal factors prevent R&D unit's involvement in external technology purchase.
Reid and Reid 1988	230 firms. 29 licensees and 201 non-licensees. Response rate 22% for 1057 firms receiving questionnaires. Mail survey	Nominal scales	Comparison of frequencies	Licensee and non-licensee firms differ on a number of characteristics. Licensee firms more likely to be younger, larger in size, have greater number of new product introductions, internally developed knowledge, distribution and manufacturing agreements, trained personnel, and higher economic performance.
Shahrohki 1987	51 licensee firms. Mail survey and interviews. Response rate of 43% for 118 firms receiving questionnaires.	Nominal likert scales validity- Delphi technique. Reliability - (Spearman-Brown formula)	Chi square, Gamma measure of association	1. Licensee motivations - avoid R&D risk, supplement own R&D, acquire right to operate, diversify and expand operations, cash in on name and product of licensor. - major disadvantage was dependence on licensor and "NIH" syndrome.

Kim 1988	Mail survey 28 firms. - Response rate of 90% for 31 firms receiving questionnaires	Likert scales. Respondents rate extent of services received from licensor, on a scale 0-5. Objective measures of absorptive capacity (for example marketing skill measured by advertising expenditure as percent of total sales.)
Crawford 1985	40 firms 17 licensees 13 licensors 10 licensees/licensors Case analysis Questionnaires/interviews	Ex post facto classification of responses and content analysis of cases. - tallies of interview responses

Combination of Regression Analysis of variance and correlation	- Licensee's absorptive capacity indicated by manufacturing experience, product diversity, technical skills, marketing skill and management capability influence capability to license technology. - personal contact important source of technology licenses. - future licensing opportunity an important consideration for firms' entry into ITL
No statistical analysis	Licensee motives - build on in-house skills, augment declining product range, fill product gaps, speed of developing new products. Overcome completion, high cost of internal R&D, use manufacturing capacity fully, develop interval capability.

Ford 1985	152 firms 25% response rate for 600 firms receiving question-naires	Nominal scales
Lowe and Crawford 1984	183 firms. 105 licensing. 78 firms not involved in licensing. Combination of mail survey and interview 24% response rate for 750 firms receiv ing questionnaires.	Single proxy items and nominal scales
Svensson 1984	50 cases of licensing relationships and 5 cases of licensees	Nominal and likert scales of success and failure factors

Cross tabs chi square frequency counts	Licensee characteristics - high export propensity, large size, high R&D expenditure as percent of sales, high technology sale and joint venture agreements. Problems with Licensing - long negotiations - Disputes over delivery, follow up service, cost of technology, quantity and quality
Comparison of frequency distributions	Licensee firms more likely to have high R&D expenditure, joint venture agreements, technology sale deals.
Contingency analysis discriminant analysis.	Licensee motives evoked by internal problems or a need on an existing market. Licensing involves substantial development and adaptation cost.

Caves, Crookell and Killing 1983	Mail survey/interview of 34 firms. Response rate not reported	Nominal
Thunman 1983	Case study of 3 firms	Ex post facto classification of responses.
Parry and Waston 1979	196 firms 67 licensees of non-affiliate companies Response rate of 27% for 735 firms receiving questionnaires for which the study was applicable	Ordinal scales

Cross tabulations. Chi-square test	Licensee motives - product skill, production skill, diversification, dev elop and extend in house skills, speed (reduce delay and risk). Licensing involves restrictions on market, production location technology grant backs.
No statistical tests. Content analyses of cases.	Licensee motives - acquire production and product design skills
Correlation analysis	Significant positive correlation between licensing in firm non affiliates and (a) outward licensing number of R&D personnel, R&D budget. Significant inverse correlation between extent of non-affiliate licensing and proportion of foreign ownership and exports.

Killing 1977/1978 (two studies)	Interviews of 40 firms. 82 licensing agreements	Single objective measures (e.g. R& D competence measured by percent of engineers and scientists of total employees)
Killing 1975	Personal interviews of 40 companies	Single proxy items (e.g., R&D competence measured by percentage of engineers and scientists to total employees.

Frequency counts	Licensee-motives-product design skill, R&D competence, and marketing skill, upgrading exsiting skills, keep abreast of market developments, development blocked by à patent, adopting industry standard.
	Product licensed related to current operations and skills.
Cross tabulations	Motives for ITL relate to lack of internal skills and firms' strategic objectives. Type of ITL agreement depends on the objective sought.
	External factors such as competition influence ITL decisions.

Appendix 2

Summary of Key Variables used in Data Analysis

	Dependent Variable	Definition	Label
1.	Propensity to adopt ITL	Whether or not a firm is currently involved in ITL	--
2.	Propensity to adopt ITL	Firm's intention to use ITL in the future	ITLPROP
Independent Variables			
	Firm Characteristics		
1.	Firm size	Annual sales	SALES
2.	Extent of foreign ownership	Percentage of the firm owned by foreigners	FOWNER
3.	Extent of exporting	Percentage of sales derived from exports	EXPORT
4.	Organicity of structure	The extent to which the organisation's structure allows participatory decision-making	ORGAN
5.	Overall NPD performance capability	Perception of management as to the success of the firm's NPD efforts.	NPDCAP
6.	R&D capability	Management perception of the resources put into R&D and the results of the firm's R&D efforts relative to competition	RDCAP

Appendix 2 (Cont'd.)

7.	Marketing communication capability	Perceived capability of the firm in communicating with market relative to competition	MKTCOMM
8.	Product commercialisation capability	Perceived capability of the speed and quality of the firm's product introductions relative to competition	PRDCOM
9.	Extent of Diversification	Perceived market experience as reflected by extent of product range and market segments served	EXTDIV
10.	Manufacturing capability	Perceived quality and effectiveness of the firm's manufacturing relative to competition	MFGCAP

Management Characteristics

1.	Risk aversion	The extent to which management of the firm has low risk-taking propensity	RISKAV
2.	International Orientation	Management awareness of foreign technological developments (represented by four single items)	
	• Number of managers with university education		UNI
	• Number of managers with overseas business experience		OVSEAS

Appendix 2 (Cont'd)

		• Number of managers who speak a foreign language	SPEAK
		• Frequency of overseas travel	TRAVEL
3.	ITL experience	Management experience in using ITL (represented by the number of agreements)	LAGREE
4.	ITL satisfaction	Management satisfaction with the performance of the firm's licensed technologies	ITLSATIS
5.	Awareness of ITL opportunities	The extent to which R&D department and general management are aware of opportunities for ITL	LAWARE1 LAWARE2
Management Perceptions of ITL			
1.	**Perceived Relative Benefits**		
a.	Diversification advantage	Perceived benefit of using ITL to diversify	DIVADV
b.	Competitive advantage	Perceived benefit of using ITL to compete	COMADV
c.	Access to future technology	Perceived benefit of ITL in providing access to future technology	ACESFT
d.	Faster market entry	Perceived benefit of ITL in ensuring speedy market entry	FENTRY

Appendix 2 (Cont'd)

2.	**Perceived Relative Costs**		
a.	Implementation cost	Perceived problems and costs in utilising licensed technology	IMPCOST
b.	Loss of decision-making authority	Perceived loss of decision-making in the use of the licensed technology as a result of licensor restrictions	LOSSDM
c.	Entry and exist barriers	Perceived difficulty in entering and terminating licensing agreements	EEBARR

Perceived Environmental Hostility

a.	Market competition	Perceived intensity of market competition in the firm's industry	MKTCOMP
b.	Technological competition	Perceived rate at which technology changes in the firm's industry	TEKCOMP
c.	Government regulations	Management perception of the effect of government regulations on the firm's NPD effort.	GOVREGU

Appendix 3

CORRELATION MATRIX OF INDEPENDENT VARIABLES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1. ITLPROP	1.00																														
2. NPDCAP	-0.12	1.00																													
3. SALES	0.13	0.06	1.00																												
4. FOWNER	-0.15	0.15	0.19	1.00																											
5. EXPORT	-0.03	0.33	0.05	0.17	1.00																										
6. RDCAP	-0.15	0.43	0.18	0.20	0.39	1.00																									
7. MKTCOMM	-0.05	0.20	0.24	0.23	0.17	0.43	1.00																								
8. EXTDIV	-0.09	0.14	0.16	0.09	0.16	0.27	0.33	1.00																							
9. PRDCOM	-0.13	0.48	0.01	0.06	0.19	0.36	0.33	0.23	1.00																						
10. MFGCAP	-0.03	0.43	0.17	0.08	0.22	0.46	0.22	0.17	0.35	1.00																					
11. ORGAN	0.00	-0.02	-0.20	-0.02	0.03	-0.03	-0.11	-0.12	-0.01	-0.16	1.00																				
12. UNI	0.12	-0.01	0.34	0.17	0.15	0.28	0.10	0.04	-0.10	-0.04	0.04	1.00																			
13. OVSEAS	0.07	0.13	0.25	0.20	0.20	0.16	0.05	0.10	-0.06	0.00	-0.04	0.44	1.00																		
14. SPEAK	0.13	0.08	-0.17	0.12	0.07	0.06	-0.02	0.01	0.04	0.11	0.10	0.16	0.28	1.00																	
15. TRAVEL	0.10	0.15	0.32	0.24	0.18	0.20	0.23	0.07	-0.02	0.16	-0.06	0.14	0.18	-0.01	1.00																
16. LAGREE	0.37	0.02	0.44	0.05	0.00	0.07	0.04	0.07	-0.06	0.05	-0.12	0.24	0.17	-0.04	0.28	1.00															
17. ITLSATIS	0.49	0.05	0.35	-0.05	-0.05	0.06	0.09	0.07	-0.01	0.10	-0.08	0.25	0.12	0.00	0.26	0.58	1.00														
18. LAWARE1	0.01	0.21	0.16	0.05	0.23	0.41	0.05	0.06	0.03	0.17	-0.04	0.23	0.22	0.15	0.06	0.16	0.02	1.00													
19. LAWARE2	0.30	0.22	0.39	0.04	0.20	0.29	0.21	0.15	0.04	0.14	-0.02	0.30	0.17	-0.04	0.22	0.34	0.30	0.36	1.00												
20. RISKAV	-0.03	-0.13	0.15	0.08	-0.14	-0.18	-0.02	0.06	-0.09	0.08	-0.26	-0.11	-0.07	-0.18	-0.01	-0.01	0.01	-0.12	-0.02	1.00											
21. FENTRY	0.13	-0.05	-0.05	-0.04	-0.04	0.01	0.18	0.05	-0.08	0.04	0.02	-0.09	0.03	0.09	0.01	-0.03	-0.23	0.08	0.04	0.03	1.00										
22. DIVADV	0.11	0.03	-0.07	-0.02	-0.06	0.01	-0.01	0.05	-0.02	0.08	-0.04	-0.05	0.02	0.18	-0.05	-0.12	-0.18	0.05	0.08	0.03	0.50	1.00									
23. COMADV	0.38	0.06	0.02	-0.06	-0.11	-0.07	0.00	0.00	-0.04	0.07	0.01	-0.02	0.06	0.11	0.14	0.17	0.25	-0.09	0.11	0.02	0.37	0.22	1.00								
24. ACESFT	0.09	0.01	-0.02	0.06	-0.14	0.03	0.23	0.06	-0.03	0.13	-0.05	-0.10	-0.03	0.04	0.12	0.07	-0.12	0.09	0.04	-0.03	0.41	0.26	0.26	1.00							
25. IMPCOST	-0.45	-0.01	-0.03	-0.03	0.04	0.02	-0.02	0.01	-0.01	-0.06	-0.06	-0.04	-0.11	-0.07	-0.02	-0.27	-0.47	-0.03	-0.18	-0.02	-0.11	-0.01	-0.39	-0.02	1.00						
26. LOSSDM	-0.39	0.05	-0.07	0.03	-0.01	0.02	-0.07	0.03	-0.01	-0.12	-0.08	-0.04	-0.06	0.01	-0.09	-0.24	-0.31	0.03	-0.12	0.05	0.09	0.18	-0.13	0.07	0.43	1.00					
27. SCOST	-0.26	-0.02	-0.14	-0.04	0.03	0.00	-0.08	-0.13	-0.07	-0.09	-0.08	-0.15	-0.12	-0.03	-0.07	-0.30	-0.48	0.04	-0.12	0.00	0.12	0.19	-0.22	0.18	0.62	0.35	1.00				
28. EEBARR	-0.05	0.02	-0.03	-0.07	0.04	0.11	0.12	0.08	0.11	-0.13	-0.13	0.08	0.03	-0.01	-0.09	-0.10	-0.11	0.02	0.02	-0.08	-0.01	0.09	-0.06	0.05	0.26	0.20	0.23	1.00			
29. MKTCOMP	0.13	0.13	0.04	0.02	0.00	-0.06	-0.04	0.23	0.12	0.07	-0.13	-0.08	-0.05	0.03	-0.01	0.02	0.15	-0.14	0.14	0.15	-0.02	0.14	0.21	0.04	-0.11	0.04	-0.03	-0.01	1.00		
30. TEKCOMP	0.17	0.07	0.06	0.08	0.05	-0.05	-0.13	-0.03	0.00	-0.07	0.01	0.22	0.15	0.22	0.08	0.16	0.15	0.22	0.23	-0.17	-0.18	0.01	0.06	-0.09	-0.03	-0.03	-0.02	-0.03	0.20	1.00	
31. GOVREGU	-0.05	0.09	-0.19	0.06	-0.06	-0.17	-0.15	-0.03	0.10	0.01	-0.06	-0.18	-0.20	-0.02	-0.04	-0.12	-0.04	-0.13	-0.04	-0.02	0.00	0.06	0.09	0.14	0.08	0.17	0.19	0.02	0.23	-0.08	1.00
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Appendix 4

Stepwise Regression Analysis: Testing for the effect of ITL experience (LAGREE) on Propensity to Adopt ITL

Multiple R	.44
R^2	.19
Adjusted R^2	.18
Standard Error	5.39
F Statistic	12.22
Significance	0.00

Variables in the Equation

Variable (Order of entry)	Standardised Beta	T	Sig
ITL experience (LAGREE)	.29	4.35	0.0000
Management awareness of ITL opportunities (LAWARE2)	.27	3.75	0.0002
R&D awareness of ITL opportunities (LAWARE1)	-.14	-2.06	0.0408
Number of managers who speak a foreign language (SPEAK)	.12	1.90	0.0584
(Constant)		7.83	0.0000

Variables not in the Equation

Frequency of overseas travel (TRAVEL)	-.01	-.19	0.8474
Risk Aversion (RISKAV)	-.04	-.68	0.4979
Number of managers with university education (UNI)	.03	.38	0.7043
Number of managers with overseas business experience (OVSEAS)	-.02	-.25	0.8070

N = 206

Appendix 5

Stepwise Regression Analysis: Testing for the power of ITL Satisfaction over ITL Experience when both are in the same equation

Multiple R	.50
R^2	.25
Adjusted R^2	.25
Standard Error	5.17
F Statistic	34.33
Significance	0.00

Variables in the Equation

Variable (Order of entry)	Standardised Beta	T	Sig*
ITL satisfaction (ITLSATIS)	.41	6.52	0.0000
Management awareness of ITL opportunities (LAWARE2)	.18	2.891	0.0043
(Constant)		8.26	0.0000

Variables not in the Equation

ITL experience (LAGREE)	.08	1.08	0.2830
R&D awareness of ITL opportunities (LAWARE1)	-.06	-.95	0.3458
Number of managers who speak a foreign language (SPEAK)	.09	1.42	0.1583
Frequency of overseas travel (TRAVEL)	.00	.06	0.9512
Risk aversion (RISKAV)	-.04	-.71	0.4768
Number of managers with university education (UNI)	-.00	-.10	0.9196
Number of managers with overseas business experience (OVSEAS)	.00	.15	0.8803

N = 206

Appendix 6

Cover Letter

Dear Executive,

The Potential Role of Inward Technology Licensing Agreements in Australian Firms.

I am a Lecturer at the University of Wollongong currently completing a study on "The Role of Inward Technology Licensing Agreements in Australian Firms".

It is well known that organisations in countries like Japan, Sweden, Taiwan, and recently South Korea have stimulated growth and export expansion through the acquisition of technology licenses for products and processes from overseas firms. Little is known about the phenomenon in Australia.

This questionnaire has been sent to you with the fervent hope that you will kindly assist me in this research project. Your contribution will be invaluable in understanding the importance of inward technology licensing agreements in Australia.

Because I want this research to be as comprehensive as possible in its coverage, I would ask that you complete it, even if your company does not engage in inward technology licensing agreements.

I appreciate the heavy schedule you have, especially in these hard economic times. My pre-testing of the questionnaire among executives shows that it should take you no more than 20 minutes to complete. Your responses will be treated as **confidential** and aggregated with all other responses to form an overall picture.

In return for your contribution you will receive a non-confidential copy of an Executive Summary of the research findings. I am sure you will find it very useful in thinking about inward technology licensing agreements.

I thank you for your support and co-operation regarding this important subject.

Yours sincerely,

Kwaku Atuahene-Gima

p.s. If you have any questions about this questionnaire, please call me on (042) 213642.

A STUDY OF THE POTENTIAL ROLE OF INWARD TECHNOLOGY LICENSING AGREEMENTS IN AUSTRALIAN FIRMS

Please read the following descriptions of:

1. **Inward technology licensing**
2. **Unaffiliated company**
3. **Company**

Inward technology licensing (or licensing-in technology) refers to a contract agreement by your company to ACQUIRE the rights to manufacture or use technology in the form of a completely developed product or manufacturing process. This right may be in the form of a patent for a product or process, design/information for a product, technical knowledge, a trademark, and/or marketing know-how from an overseas **unaffiliated company.**

An Overseas Unaffiliated company refers to an overseas company that has no controlling interest in your company, **i.e. an independent** company.

Where applicable the word "COMPANY' also refers to a division or strategic business unit.

How to complete this Questionnaire

In most cases I would like you to CIRCLE a number which best reflects your opinion or behaviour. In one instance you are asked to supply a short written answer. If you

SECTION 1: YOUR COMPANY'S INWARD LICENSING EXPERIENCE

Q 1. Has your company entered into an Inward Licensing Agreement to acquire technology (product or process) from an unaffiliated company? Simply CIRCLE one number.

YES	1	NO.....	2	If NO please go to Q. 6

Q 2 How many Inward Technology Licensing agreements does your company have?

Write number here _____

Q 3 What percentage of your Company's sales revenue for the LAST FINANCIAL YEAR was derived from licensed-in products and/or products manufactured with licensed-in process technology? Simply CIRCLE one number.

Less than 1%	1	16 – 20%	5
1 – 5%	2	21 – 25%	6
6– 10%	3	26 – 30%	7
11 – 15%	4	If over 30%, please write % here _____	

Q.4 Please indicate the extent to which you AGREE OR DISAGREE WITH EACH OF THE FOLLOWING STATEMENTS.

Simply CIRCLE one number which best reflects your opinion.

STATEMENT	STRONGLY DISAGREE						STRONGLY AGREE
A Top management is very satisfied with the performance of technologies (product or process) licensed-in by this company	1	2	3	4	5	6	7
B Licensed-in technologies (product or process) have enabled my company to increase its profitability	1	2	3	4	5	6	7
C Overall my company's involvement in Inward technology licensing agreements has been a rewarding experience	1	2	3	4	5	6	7

Q 5 How important is each of the following factors in your company's decision to consider licensing-in technology instead of developing it "in-house"?

Simply CIRCLE a number for each factor which best reflects your opinion.

FACTOR	MODERATELY IMPORTANT						EXTREMELY IMPORTANT
A Increase sales and expand the market	1	2	3	4	5	6	7
B Keep pace with the competition	1	2	3	4	5	6	7
C Gain time by increasing speed of market entry	1	2	3	4	5	6	7
D Upgrade the company's technical skills	1	2	3	4	5	6	7
E Reduce risk in product or process development	1	2	3	4	5	6	7
F Patent for technology held by the licensor	1	2	3	4	5	6	7
G Adopt an industry standard	1	2	3	4	5	6	7
H Availability of proven product and process	1	2	3	4	5	6	7
I Future licensing opportunites from the licensor	1	2	3	4	5	6	7
J Gain advanced technical knowledge quickly	1	2	3	4	5	6	7
K Save resources for other in-house developments	1	2	3	4	5	6	7
L Secure products to fill product gaps in the company's product portfolio	1	2	3	4	5	6	7
M Gain competitive advantage	1	2	3	4	5	6	7
N Utilize spare capacity	1	2	3	4	5	6	7
O Diversify product range	1	2	3	4	5	6	7
P Gain faster return on investment	1	2	3	4	5	6	7
Q Lower cost of licensing technology	1	2	3	4	5	6	7

PLEASE CONTINUE ON WITH Q 7

SECTION 2: YOUR GENERAL PERCEPTIONS ABOUT INWARD TECHNOLOGY LICENSING

Q 6 ANSWER Q 6 ONLY IF YOU ANSWERED NO TO Q 1

The following statements relate to your perceptions of the **potential benefits** of inward technology licensing versus internal development.

Please indicate the extent to which you AGREE or DISAGREE with each of the statements.

Simply CIRCLE a number for each statement which best reflects your opinion.

STATEMENT COMPARED TO INTERNAL R&D, INWARD TECHNOLOGY LICENSING CAN ALLOW A FIRM TO	STRONGLY AGREE						STRONGLY DISAGREE
A Increase sales and expand the market	1	2	3	4	5	6	7
B Keep pace with the competition	1	2	3	4	5	6	7
C Gain time by increasing speed of market entry	1	2	3	4	5	6	7
D Upgrade the company's technical skills	1	2	3	4	5	6	7
E Reduce risk in product or process development	1	2	3	4	5	6	7
F Secure patent for technology held by the licensor	1	2	3	4	5	6	7
G Adopt an industry standard	1	2	3	4	5	6	7
H Secure proven cost-saving process	1	2	3	4	5	6	7
I Obtain future licensing opportunites from the licensor	1	2	3	4	5	6	7
J Gain advanced technical knowledge quickly	1	2	3	4	5	6	7
K Save resources for other in-house developments	1	2	3	4	5	6	7
L Secure products to fill product gaps in the company's product portfolio	1	2	3	4	5	6	7
M Gain competitive advantage	1	2	3	4	5	6	7
N Utilize spare capacity	1	2	3	4	5	6	7
O Diversify product range	1	2	3	4	5	6	7
P Gain faster return on investment	1	2	3	4	5	6	7
Q Lower cost of obtaining technology	1	2	3	4	5	6	7

Q 7 A How strong is the need or desire for your company to license-in technology (product or process) from an unaffiliated company?

NOT STRONG VERY STRONG

1 2 3 4 5 6 7

B To what extent is your company likely to seek a licensing agreement for technology (product or process) from an unaffiliated firm in the next two years?

NO EXTENT GREAT EXTENT

1 2 3 4 5 6 7

C What is the likelihood that your company will enter new markets with products licensed-in from unaffiliated companies?

NOT LIKELY						VERY LIKELY
1	2	3	4	5	6	7

D What is the likelihood that your company will expand your current markets with products licensed-in from unaffiliated companies?

NOT LIKELY						VERY LIKELY
1	2	3	4	5	6	7

Q 8 I would now like to understand your perceptions of the potential costs and obstacles involved in Inward Technology Licensing.

Please indicate the extent to which you AGREE or DISAGREE with each of the following statements.

Simply CIRCLE one number for each statement which best reflects your opinion.

FACTOR	STRONGLY DISAGREE						STRONGLY AGREE
A Inward technology licensing involves extensive and costly searches to locate potential licensors	1	2	3	4	5	6	7
B The paperwork involved in inward technology licensing is overwhelming	1	2	3	4	5	6	7
C Negotiations for Inward technology licensing take too long and are very costly	1	2	3	4	5	6	7
D Choosing among alternative technologies can be a complex process	1	2	3	4	5	6	7
E With inward technology licensing you are never sure you have made the right decision	1	2	3	4	5	6	7
F It is relatively difficult for a company to go in and out of a licensing agreement	1	2	3	4	5	6	7
G Licensing-in technology is just too complicated to be bothered with	1	2	3	4	5	6	7
H The high cost of adapting a licensed-in technology to a company's operations makes it not worthwhile	1	2	3	4	5	6	7
I It is difficult to gain competitive advantage with licensed-in technology	1	2	3	4	5	6	7
J Inward technology licensing involves too many restrictions to make it worthwhile	1	2	3	4	5	6	7
K It costs too much to license-in technology from an unaffiliated company	1	2	3	4	5	6	7
L The cost of terminating an inward technology licensing agreement is usually high	1	2	3	4	5	6	7
M Inward technology licensing discourages internal R&D staff from developing new technological skills and products	1	2	3	4	5	6	7
N Grant back of improvements in the licensed technology to the licensor lead to the surrender of future competitive advantage to the licensor	1	2	3	4	5	6	7
P Restrictive clauses in Inward technology licensing lead to loss of control over the licensed technology	1	2	3	4	5	6	7
Q Margins on licensed-in products are lower compared to internally developed products	1	2	3	4	5	6	7

SECTION 3: YOUR PERCEPTIONS ABOUT THE ENVIRONMENT IN WHICH COMPANY OPERATES

Q 9 How would you describe the following conditions in the industry in which your company operates?
Simply CIRCLE a number which best reflects your opinion.

CONDITION	MODERATELY HIGH						EXTREMELY HIGH
A Intensity of market competition	1	2	3	4	5	6	7
B Price competition	1	2	3	4	5	6	7
C Product quality competition	1	2	3	4	5	6	7
	LOW						HIGH
D Frequency of new product introduction	1	2	3	4	5	6	7
E Rate of technological change	1	2	3	4	5	6	7
F Rate of product obsolescence	1	2	3	4	5	6	7

Q 10 For the next few statements, please indicate the extent to which you AGREE or DISAGREE. Simply CIRCLE one number which best reflects your opinion.

STATEMENT	STRONGLY DISAGREE						STRONGLY AGREE
A Government offers little incentive to encourage internal R&D	1	2	3	4	5	6	7
B Patent law in this country does not offer enough protection for new products from imitation	1	2	3	4	5	6	7
C Increasingly stringent product liability laws make internal new product development very risky	1	2	3	4	5	6	7
D In general, government regulations hinder my company's efforts to develop new products	1	2	3	4	5	6	7
E The external environment in which my company operates is very safe and poses little threat to the well-being of my company	1	2	3	4	5	6	7
F The external environment in which my firm operates is rich in investment and marketing opportunities	1	2	3	4	5	6	7
G The external environment in which my company operates is one that my company can control and manipulate to its own advantage	1	2	3	4	5	6	7

SECTION 4: BACKGROUND ABOUT YOUR COMPANY AND YOUR MANAGERS

This data is needed to check the representativeness of the sample. IT WILL BE COMBINED WITH OTHERS, ENSURING COMPLETE ANONYMITY.

Q 11 Please indicate how you perceive the STRENGTHS and WEAKNESSES of your company's SKILLS AND CAPABILITIES relative to those of **your competition**.

Simply CIRCLE a number which best reflects your opinion.

SKILL/CAPABILITY	MY COMPANY IS ..... MUCH WEAKER						MUCH STRONGER
A Quality of Customer Service	1	2	3	4	5	6	7
B Advertising effectiveness	1	2	3	4	5	6	7
C Quality of salespersons	1	2	3	4	5	6	7
D Network of distribution	1	2	3	4	5	6	7
E Advertising expenditure as percent of sales	1	2	3	4	5	6	7
F Number of market segments	1	2	3	4	5	6	7
G Product line diversity	1	2	3	4	5	6	7
H Skill of R&D personnel	1	2	3	4	5	6	7
I Number of R&D personnel	1	2	3	4	5	6	7
J Patents held by the company	1	2	3	4	5	6	7
K Expenditure on R&D as percent of sales	1	2	3	4	5	6	7
L New product development success	1	2	3	4	5	6	7
M Technology licenses sold to other companies	1	2	3	4	5	6	7
N Quality of manufacturing technology	1	2	3	4	5	6	7
O Effectiveness of cost containment	1	2	3	4	5	6	7
P Skill of manufacturing personnel	1	2	3	4	5	6	7
Q Use of modern manufacturing technology such as CAD/CAM, JIT	1	2	3	4	5	6	7
R Cost of production	1	2	3	4	5	6	7
S Market research capability	1	2	3	4	5	6	7
T Ability to differentiate products	1	2	3	4	5	6	7
U Speed of new product introduction	1	2	3	4	5	6	7

Q 12 Please, for each of the following statements indicate the extent to which you AGREE or DISAGREE.

Simply CIRCLE a number which best reflects your opinion.

STATEMENT	STRONGLY DISAGREE						STRONGLY AGREE
A My company is heavily involved in joint ventures with overseas firms	1	2	3	4	5	6	7
B There exists a formal procedure in my company to scan external technological developments	1	2	3	4	5	6	7
C My company is heavily involved in distribution agreements with overseas companies	1	2	3	4	5	6	7
D My company's R&D unit keeps a close watch on outside technological developments	1	2	3	4	5	6	7
E We often receive unsolicited offers for Inward Technology Licensing	1	2	3	4	5	6	7
F This company is aware of success of other companies in Inward Technology Licensing	1	2	3	4	5	6	7
G This company is aware of problems other companies have encountered with Inward Technology Licensing	1	2	3	4	5	6	7
H We seem to adopt a rather conservative view when making major decisions	1	2	3	4	5	6	7
I In my company new projects are approved on a stage to stage basis rather than by a blanket approval	1	2	3	4	5	6	7
K We have a tendency to market proven products and avoid high risk products	1	2	3	4	5	6	7
K My company's operations can be generally characterised as high risk	1	2	3	4	5	6	7

IN GENERAL THE OPERATING MANAGEMENT PHILOSOPHY OF MY COMPANY FAVOURS ....

STATEMENT	STRONGLY DISAGREE						STRONGLY AGREE
M – Highly structured channels of communication and highly restricted access to important financial and operating information	1	2	3	4	5	6	7
N – a strong insistence on a uniform managerial style throughout the firm	1	2	3	4	5	6	7
O – a strong emphasis on giving most say in decision-making to formal line managers	1	2	3	4	5	6	7
P – a strong emphasis on holding fast to tried and true management principles despite any changes in business conditions	1	2	3	4	5	6	7
Q – a strong emphasis on always getting personnel to follow the formally laid down procedures	1	2	3	4	5	6	7
R – tight formal control of most operations by means of sophisticated control and information systems	1	2	3	4	5	6	7
S – a strong emphasis on getting line and staff personnel to adhere closely to formal job descriptions	1	2	3	4	5	6	7

Q 13 Your perceptions of your company's 'IN HOUSE' new product development performance. Simply circle one number which best reflects your opinion.

A. To what extent has your company's new product development program met its performance objectives over the last five years?

Fell short of objectives	1 2 3 4 5 6 7	Exceeded objectives

B. How important has your new product development program been in generating sales and profits for your company over the last five years?

Not Important	1 2 3 4 5 6 7	Critical

C. Relative to your competition, how would you rate the success of your firm's new product program?

Much worse than competition	1 2 3 4 5 6 7	Much better than competition

Q 14 Please answer this question with reference to ONLY these four managers: the Managing Director/Chief Executive Officer, Marketing Director/Manager, Production Manager, and R&D Manager.

A How many of these managers have University education?

Write number here .....

B How many of these managers have lived and worked overseas for a year or more?

Write number here .....

FOR THE FOLLOWING QUESTIONS SIMPLY CIRCLE ONE NUMBER FOR YOUR ANSWER

C What is the average age of these managers?

25 – 34 years 1
35 – 44 years 2
45 – 54 years 3
55 – 64 years 4

D On average how frequent ly do these managers travel overseas?

never 1	5 - 6 times a year.....4
1 – 2 times a year 2	7 – 10 times a year 5
3 – 4 times a year 3	over 10 times a year 6

E How many of these managers speak a foreign language?

Write number here .....

Q 15 Approximately, how many people are employed by your company?

0 – 99 1	300 – 399 4
100 – 199.....2	400 – 499.....5
200 – 299 3	500 and over.....6

Q 16 What was your company's sales turnover LAST FINANCIAL YEAR?

under $5 million.....1	$51 – 75 million.....4
$6 – 25 million.....2	$76 – 100 million.....5
$26 – 50 million.....3	$ over 100 million.....6

Q 17 What percentage of this sales revenue for the LAST FINANCIAL YEAR was derived from **exports?**

Write answer here .....%

Q 18 Please describe the nature of your company's primary business activities

.....

.....

.....

Q 19 What percentage of your company is foreign owned?

Write number here .....%

Q 20 What is your position in your company? .....

Q 21 Would you like to receive an Executive Summary of the research findings?

Yes.....1 No.....2

If YES, please provide your name and address below:

Your name _____

Organisation _____

Address _____

_____

_____

THANK YOU VERY MUCH FOR YOUR ASSISTANCE AND CO-OPERATION.

Please put the questionnaire in the envelope provided.