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A 'HOLISTIC' STUDY FROM MULTIPLE
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THE DEVELOPMENT of MARKET EFFICIENT TECHNOLOGICAL INNOVATION: A 'HOLISTIC' STUDY FROM MULTIPLE PERSPECTIVES

By

Ferdane Nukhet Harmancioglu

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ABSTRACT

THE DEVELOPMENT of MARKET EFFICIENT TECHNOLOGICAL INNOVATION: A 'HOLISTIC' STUDY FROM MULTIPLE PERSPECTIVES

By

Ferdane Nukhet Harmancioglu

The primary objectives of this dissertation correspond to the three lenses through which technological innovation development is examined: (1) the scholarly stream of research on innovation, (2) internal and (3) external product development. The focus of this dissertation is on the contribution of both internal and external new product innovation development to firm performance and market value. The three studies in this research provide innovation researchers with a theory-driven meta-analysis of the innovation literature; offer to practitioners an exhaustive list of factors important both for the internal and external development of technological innovation; and finally, advance the methodological stature with which determinants of innovation success are examined.

STUDY #1. To serve as a theoretical foundation for the subsequent studies in the thesis, the first lens scrutinizes 'new product innovation' by conducting a meta-analysis on marketing, management and engineering studies that have examined empirically the relationships of innovation with its antecedents and outcomes. This first study provides researchers with objective empirical generalizations, as well as investigates sources of inconsistencies in the literature. Substantive or methodological notions that vary across studies are tested to determine whether they moderate the relationships identified (i.e., moderate the effect sizes).

STUDY #2. In the new product literature, resources, capabilities and strategic orientations have been directly linked to positional advantages and performance outcomes. However, the implementation of these orientations and process activities

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has generally been neglected in new product development models. The key to innovation success is acknowledged to be the match between what is needed and what can be developed internally. In light of the findings from the meta-analysis, the second lens focuses on internal development of technological innovation at the project level and provides an operationalization of this match. Due to the complexity of the proposed model, hypotheses are explored through partial least squares analysis (PLS). This analysis also provides practitioners with a comprehensive list of internal, environmental and supply-chain related factors important for successful development.

STUDY #3. The third lens concerns external innovation: through technology outsourcing, firms develop capabilities and flexibilities they lack or have lost due to technological discontinuities and globalization. Despite its importance, little attention has been paid to empirically validating risks and benefits of strategic outsourcing relationships in the context of modular systems and global technology intensive markets. Event study analysis of abnormal stock returns was used to examine the value of external innovation development through technology outsourcing.

CONTRIBUTIONS. This dissertation constitutes a comprehensive study on the outcomes of technological innovation, providing implications from three lenses: the extant research, internal and external development. The three studies employ three types of data (i.e., the literature, primary and secondary data) and use multiple methodologies (i.e., meta-analysis, PLS and event study). Thus, this research offers cumulative insights from the innovation literature, empirically investigate models of the 'values' of both internal and external innovation, and uses diverse analysis techniques in a comprehensive investigation of the determinants of new product innovation success.

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DEDICATION

This dissertation is dedicated to my parents, Nilgun and Omer Harmancioglu and my grandparents, Neriman Bayraktar, Bedia and Mustafa Harmancioglu with gratefulness for the endless love I have received, the wonderful life I have lived and for the person I have become. It is also dedicated to M. Berke Gur with thankfulness for all the meaning he has added to my past and my future.

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ACKNOWLEDGEMENTS

Having completed my studies at Michigan State University, I would like to express my appreciation to those who supported me during my doctoral studies. First, I would like to acknowledge my committee: Dr. Cornelia Droge, my advisor, for her constant support and encouragement. She challenged me to pursue better ideas, better analyses, and better writing from the very beginning. She never hesitated to provide me with her guidance about analysis and writing as well as professionalism and academia. As she said, she has become 'a second mother' to me. I extend my gratitude to my committee co-chair: Dr. Roger J. Calantone for providing me many professional opportunities, and most of all, making me feel cared and supported whenever I needed it the most. I am also very grateful to Dr. Tamer Cavusgil for believing in me from the start. Without his appreciation, I would not have accomplished any of what I achieved. I would also deeply thank Dr. David A. Griffith for his support, suggestions and constant offers for help.

Several other people supported me throughout my studies. I present my sincere appreciation to my advisor during my Masters studies at Bosphorus University, Dr. Muzaffer Bodur. She encouraged me to take this journey of continuing my studies in the U.S. I would also like to thank Dr. Seyda Deligonul. He gave me immeasurable morale support during my first year. Dr. Regina McNally and Dr. Chris White provided valuable advice on my thesis ideas as well as my career path. My friends at MSC (Zeynep, Carol, Berk, Mike, Steven, Joey, Billur and Wessley) made this process both enjoyable and bearable. I will miss our conversations about simply everything. Moreover, the MSC office staff has also been very helpful throughout my Ph.D. studies. Financial support was received from MSC, PDMA and AMS.

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My family -- Nilgun and Omer Harmancioglu, Neriman Bayraktar, Bedia and Mustafa Harmancioglu -- continuously provided me with unconditional love and always expresses their pride in whatever I chose to do. I love you more than anything in my life and am very grateful for all the sacrifices that you have made and will make for my education, happiness and future. I have been very blessed with amazing friends. Words cannot express my love and gratitude to M. Berke Gur -- he brought light to my days; Zerrin and Kenan Cosguner and Cigdem Haser -- they made East Lansing a home. My friends in Turkey: Didem Aksoy, Muzeyyen Isler, and Gamze and Onur Kutlukaya always called, sending their good thoughts and energies whenever I needed them. Special thanks goes to my friends at the Academy of Dance Arts – for always cheering me on.

Finally, as a woman, a teacher and a researcher, I am indebted to Mustafa Kemal Atatürk, the founder of Turkish Republic, for his encouragement for Turkish women and his belief in education, science and teachers.

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CHAPTER 1
DISSERTATION INTRODUCTION

New product innovations have the capacity to alter market dynamics and create or increase environmental turbulence (Chandy and Tellis 2000; Gatignon and Xuereb 1997; Han et al. 1998). However, they are also seen as the source of competitive advantage and a response to economic recession, and particularly, a survival mechanism against fierce competition from lower-cost producers in Asia (Garcia and Calantone 2002; Hurley and Hult 1998). The findings of a PDMA study of best practice firms show that nearly half of their sales are derived from new product innovations (Di Benedetto 1999). Companies operating in a variety of industries including Microsoft, Canon, Toyota, Samsung, Apple and Coca-cola are heavily focused on new product innovations and spend immensely on research and development rather than on low cost initiatives. Others such as Procter & Gamble and General Electric have chosen to collaborate with academic scholars to develop their own approaches to new product development (NPD).

Meanwhile, the failure rate is as high as nearly 50% of the products introduced in the market. As an illustration, the pharmaceutical business requires massive investments -- it costs more than $800 million to develop and market the average new drug -- but the marginal cost of producing an extra pill approaches zero (21 July 2003; The Wall Street Journal). Competitive pressures in most industries have created a tradeoff between time to market and product quality and performance. Many firms have responded to this pressure by sacrificing quality of execution for the sake of speed and skipping NPD process activities, or resorting to external sources for components and product technologies through outsourcing. While efforts in shortening the NPD processes and focusing on rapidly executable (incrementally innova

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innovative) development projects may lead to the sacrifice of necessary information in the rush to accelerate schedules and the missing of opportunities for more profitable 'breakthrough' innovations, outsourcing has created investors' concerns regarding the intellectual property rights. Despite this, the technology outsourcing market is continuously expanding: HP, Cisco, Lucent Technologies, Ericsson and Nokia have preferred outsourcing for flexibility, less cost and timing advantages.

Therefore, in the contemporary business environment characterized by escalating environmental uncertainty, a firm's survival depends on understanding how to be innovative and commercialize innovative products (Kotabe and Swan 1995; Rowley, Behrens et al. 2000). Due to the current environment of escalating uncertainty, the importance given to innovation and innovative capabilities has dramatically risen. This interest is further reflected in the academic literature: studies on customer-relevant innovation and NPD processes are among the Marketing Science Institute's (MSI) most recent research priorities (2004-2006). Accordingly, this dissertation centers on the development of 'market efficient' technological innovation, that is, the allocation of resources and investing in newness in the right places and at the right time for maximum value. Referring to Garcia and Calantone (2002), technological innovation is defined as an iterative process concerning the technological development of an invention -- initiated by the perception of a new market and/or service opportunity for the invention (p. 112). This innovation process comprises all activities from the market introduction of the invention though diffusion and adoption, including all development, production, and marketing tasks necessary for its commercial success (Garcia and Calantone 2002, p 112).

The primary objectives of this dissertation correspond to the three lenses through which technological innovation development are examined: (1) the scholarly

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stream of research on innovation, (2) internal and (3) external product development. The three studies in this research provide innovation researchers with a theory-driven meta-analysis of the innovation literature; offer to practitioners an exhaustive list of factors important both for the internal and external development of technological innovation; and finally, advance the methodological stature with which determinants of new product innovation success are examined by using partial least squares (PLS) and event study analysis techniques.

The first lens scrutinizes 'new product innovation' by conducting a meta-analysis on marketing, management and engineering studies that have examined empirically the relationships of new product innovation with its antecedents and outcomes. This study extends previous meta-analytic works by drawing upon 46 independent samples from 43 studies (published from 1970-2004), with a total sample size of 4801. The goals are to derive generalizations from the marketing, management and new product literatures, as well as to investigate sources of inconsistencies in the findings. Selected substantive or methodological artifacts that vary across studies are tested to determine whether they moderate model relationships (i.e., the effect sizes of relationships of interest). The overall objective is to propose a synthesized model that permits evaluation of key mediators and moderators. Using structural equation modeling technique, a 'theory-driven' model that includes customer orientation, competitor orientation, organizational structure, technological turbulence, market turbulence, innovation, and new product performance (as well as the moderating artifacts) is examined. Through this, the first study provides researchers with objective empirical generalization from a theory-driven meta-analysis, as well as investigates sources of inconsistencies in literature.

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The second lens focuses on internal development of technological innovation and aims to elucidate the notion of 'fit' from firm and customer perspectives. Until recently, the latter has been mostly neglected in the organizational innovation literature. For innovation development success, synergistic fit with the firm's existing marketing and technical skills and resources, as well as its fit with customers' needs and skills are mandatory. Moreover, this study develops measures to assess 'fit' by indicating the degree of new resources and capabilities required for the product and the extent of synergy the project entails with the existing structure (as opposed to measures such as "having more than adequate resources" in prior literature) (Song and Parry 1997). Referring to Day and Wensley's (1988) source-position-performance framework, the overall objective is to develop and test an exhaustive model on determinants and outcomes of market efficient innovation development. In parallel to the four major categories of new product success determinants identified by Calantone and Montoya-Weiss (1994) in their meta-analysis, this research focuses on how *internal factors* (i.e., strategic fit of the project, project related sources of advantages and proficiency in NPD process) influence *positional advantage* and *performance of the project*, determined by *external environmental factors*. Thus, this analysis will also provide practitioners with a comprehensive list of internal, environmental and supply-chain related factors important for successful development.

The third lens concerns external innovation: through outsourcing, firms develop capabilities and flexibilities they lack or have lost due to technological discontinuities and globalization. Despite its importance, little attention has been paid to empirically validating risks and benefits of strategic outsourcing relationships in the context of modular systems and global technology intensive markets. Buyers generally strive to minimize the likelihood of opportunistic expropriation of tacit techn

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technological knowledge, eliminate the difficulties of monitoring partners due to geographical or cultural distance, and avoid switching costs. Thus, grounded in the marketing, management, and international business literatures, the primary objective of this third study is to develop and test a model on the determinants of the market value of external innovation development. These antecedents are classified according to the *task characteristics* (i.e., degree of modularity, strategic importance of the development project, size and duration of the contract, geographic dispersion, cultural proximity and role of a legal advisory), *switching costs* (i.e., component purchase concentration, degree of supplier involvement, asset specificity, project related know-how of the buyer, and overall product cost of the buyer) and the *degree of environmental uncertainty* (i.e., technological heterogeneity and discontinuity). This research also provides implications for managers on the returns and risks of global strategic outsourcing. The focus is on the unique consequences of loosely coupled systems, i.e., modular systems employed in external innovation development. Event study analysis of abnormal stock returns is used to examine the value of external innovation development through technology outsourcing.

TABLE 1-1. THE INTENDED CONTRIBUTIONS OF THE STUDIES

	For academics:	For practitioners
1st study	Cumulative results of published studies and sources of inconsistencies in the literature	Simplification of an extensive and complex literature
2nd study	An empirical investigation of internal technological innovation development success	*What works if the goal is internal development*
3rd study	Extension of existing research by an event study analysis of the impact of outsourcing agreements on the market value of companies	*Whether* and *under what conditions* to develop externally

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Overall, this dissertation constitutes a 'holistic' study on the development of technological innovation providing implications from three lenses, i.e., the extant research, internal development and external development. The three studies span different models, three types of data (i.e., the literature, primary and secondary data) and use multiple methodologies (i.e., meta-analysis, PLS and event study). Thus, this research offers cumulative insights from the innovation literature, empirically investigates models of the 'values' of both internal and external innovation development, and uses diverse analysis techniques in a comprehensive investigation of the determinants of innovation success.

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CHAPTER 2

INCONCLUSIVE INNOVATION "RETURNS": A META-ANALYSIS OF RESEARCH ON INNOVATION IN NEW PRODUCT DEVELOPMENT

2.1 INTRODUCTION

Innovation in new product development (NPD) is addressed in large amounts of research in the marketing, management and new product literatures. Deriving substantive conclusions from this body of research acquires urgency in the face of a business environment characterized by escalating environmental uncertainty and the increased rates of product innovation required to survive (Kotabe and Swan 1995; Rowley et al. 2000). However researchers obtain different results due to the difficulty of controlling research environments, the lack of acknowledged common definitions, and the variety of methods and settings employed (Hedges and Olkin 1982). Literature reviews attempt to achieve consensus in disparate findings, but ordinary reviews can be dependent on subjective selections and evaluations of the researchers, resulting in inconsistent interpretations across different reviewers (Wolf 1986). Reviews also preclude the empirical analysis of the impact of study characteristics. Meta-analysis however allows more objective and rigorous evaluation of a body of literature by standardizing results across studies and controlling for various substantive and methodological characteristics.

There are two key problems that meta-analysis can address. The first is that disparate results may be due to methodological or substantive moderators (or "artifacts" as defined by Hunter and Schmidt 1990). Meta-analysis allows examination of the underlying grounds for inconsistencies and their impact on the strengths of the relationships (i.e., effect sizes; Wolf 1986; Rosenthal 1991; Hunter and Schmidt 1990). In particular, the **level of analysis**, the **perspective**, and the **measurement** of the new product innovation construct are examined; the first two are

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substantive moderators while the latter is a methodological moderator. Regarding the level of analysis, researchers have studied the phenomenon either at the project/product level or the firm/ SBU/ program level (Johne and Snelson 1988), the difference being that the latter's domain includes multiple projects/products. Regarding perspective, the firm (i.e., internal) versus the customer (i.e., external) perspective can be contrasted, while some researchers propose that innovation be investigated from a combined perspective. In addition, the operationalization of innovation is often unidimensional and categorical, particularly in the earlier literature (Danneels and Kleinschmidt 2001; Garcia and Calantone 2002), but Green, Gavin and Aiman-Smith (1995) and others argue that innovation or innovativeness should be seen as a continuum with multiple dimensions. Classifications of projects, such as radical versus incremental or technological versus administrative, may be oversimplifying the construct.

The second key problem that meta-analysis can address is amalgamating causal relationships (Garcia and Calantone 2002; Kotabe and Swan 1995). The innovation construct has been specified as an independent variable, a dependent variable or a moderator (Kleinschmidt and Cooper 1991; Danneels and Kleinschmidt 2001). In the new product development (NPD) literature, the diverse labels, categorizations and the differences in causal role have resulted in significant inconsistency in actual empirical results (Garcia and Calantone 2002; Kotabe and Swan 1995; Danneels and Kleinschmidt 2001). For instance, the effects of innovation on success or performance outcomes as well as its relationship with organizational structure are rigorously debated in the literature. Meta-analysis permits synthesis and re-testing of these relationships with cumulative data to unveil overall tendencies (Vismesvaran and Ones 1995). This study aims to investigate relationships that have not necessarily been empirically examined in the same model or manuscript. Using structural equation modeling, an overall model that includes customer orientation, competitor orientation, organizational structure, technological turbulence, market turbulence, new product innovation, and new product performance, as well as the moderating variables described previously, are explored.

Other meta-analyses, primarily of new product success factors, have been performed. The first meta-analysis was by Montoya-Weiss and Calantone (1994), who examined 18 determinants of new product success using average effect sizes (i.e., correlations), and summary counts. Later, Henard and Szymanski (2001) collected 41 studies published through January 1999. While they examined measurement of new product success and sample characteristics as moderators, they did not investigate possible moderating effects of substantive issues. They also did not explore any mediating relationships within an overall model of the antecedents of new product success. This study extends these works by providing a meta-analysis of marketing, management and new product studies (1989-2004) that have examined the relationships of innovation with either antecedents (e.g., customer orientation) and/or outcomes (new product performance). The overall goal is to propose a synthesized model that permits evaluation of key mediators and moderators.

Brief descriptions of the potential moderators are first presented, followed by the key hypotheses that provide the scaffold for the overall model to be explored. Next the methodology, included the literature base examined and analyses performed are described. Finally, the results and their implications for future research are discussed.

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2.2 SOURCES OF INCONSISTENCIES: POTENTIAL MODERATORS

Three potential moderators are proposed to affect the degree to which "innovation" is related to its antecedents and outcomes in this study: level of analysis (project/ product level versus firm/ SBU/ program level); firm versus customer perspective; and operationalization. These moderators were identified from an initial review of 113 articles published in 12 peer reviewed marketing, new product and management journals from 1970 to 2004 (a full description of the journals and the articles selected is in 'Methodology' below).

2.2.1 Level of Analysis: Potential Substantive Moderator

Studies at the product/project level conceptualized new product innovation as an iterative process initiated by the perception of a new market and/or service opportunity, which leads to development, production, and marketing tasks striving for the commercial success (Garcia and Calantone 2002). Researchers employing this level of analysis examine activities needed to design, produce and deliver a new product as well as all product/project characteristics that determine success. The independent variables typically include: product characteristics, that is, product superiority, complexity, advantage, newness, degree of customization; and project characteristics, such as the way firms organize NPD projects, the formality of the NPD process, the extent of actual use of the innovation, NPD management, and application of NPD tools (Spivey et al. 1997; Srinivasan et al. 2002; Song and Montoya-Weiss 1998; Sethi et al. 2001; Veryzer, Jr. 1998; Kessler and Chakrabarti 1999; Bonner et al. 2002).

On the other hand, at the firm/ SBU or program level, researchers have analyzed innovation on a broader scale as 'a means of changing an organization, whether as a response to changes in its internal or external environment or as a preempti

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emptive action taken to influence an environment' (Damanpour 1991, p. 556). This encompasses both actions taken by the firm, such as the number of and changes in new products or services introduced and also the attitude of the firm as indicated by the emphasis on R&D, technological leadership and new product innovation (Calantone et al. 1994; Hultink et al. 1997; Ozsomer et al. 1997; Brown and Eisenhardt 1995). On the whole, the studies at the firm/SBU/program level have investigated the effects of firm strategies, orientations, resources, capabilities, size and innovation environment on new product innovation or on firm performance, often moderated by type of innovation and/or environment.

2.2.2 Perspective: Potential Substantive Moderator

The perspective (firm *versus* customer) is the other dimension that has led to disparate definitions, operationalizations and empirical results. First, the customer perspective was often conducted by studying usage patterns (Gatignon and Xuereb 1997; Kotabe and Swan 1995; Danneels and Kleinschmidt 2001; Cooper 2000). It sought to differentiate the types of innovation by how drastically the product was changed: either evolutionary versus revolutionary innovation (Lynn and Akgun 2001) or radical versus incremental (Etllie et al. 1984). Overall, a customer perspective focuses on the degree to which new products are perceived as totally different and requiring major changes in customers' thinking and behavior; or on dramatic leaps from current customer consumption requirements and experiences, and thus the degree of learning effort required by customers (Atuahene-Gima 1996; Sengupta 1998; Michael et al. 2003).

Within the firm perspective, major new product innovations are seen as requiring a great variety of resources and a departure from existing technology and practices; and hence are inherently more uncertain than incremental advances

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(McDermott and Colarelli O'Connor 2002). Studies that have employed this perspective have delineated the extent to which the product technology involved is different from prior technologies, and/or the skills and processes necessary for development and commercialization are different (Chandy and Tellis 2000; McDermott and Colarelli O'Connor 2002; Veryzer, Jr. 1998; Micheal et al. 2003; Ottum and Moore 1997; Sethi 2000; Kessler and Chakrabarti 1999). Based on this logic, most of the studies within this perspective have scrutinized the impact of the NPD processes, strategic orientations and organizational capabilities on product innovation (Kessler and Chakrabarti 1999; Sethi et al. 2001; Gatignon and Xuereb 1997; Lukas and Ferrell 2000; Atuahene-Gima and Ko 2001) and/or on success (either firm or project) (Song and Montoya-Weiss 1998; Olson et al. 1995; Bonner et al. 2002; De Brentani 2001; Atuahene-Gima 1995).

2.2.3 Operationalization of Innovation: Potential Methodological Moderator

No consensus exists regarding the operationalization of the innovation construct. An area of disagreement is the use of categorical versus continuous variables (Garcia and Calantone 2002). In the sample of articles in this analysis, studies using categorical measures generally split samples into the resultant categories (such as radical vs. incremental, discontinuous vs. continuous, architectural vs. modular, administrative vs. technical) to scrutinize the moderating effect of innovation (e.g., Song and Montoya-Weiss 1998). Garcia and Calantone (2002) highlight that this method limits external validity, further comparison to another study, and integration for a combined analysis. Meanwhile, continuous measures generally used 1-5 or 1-7 Likert scale items, operationalizing new product innovation as a perceptual variable (Olshavsky and Spreng 1996; Sahay and Riley 2003; Waarts et al. 2002). Among the studies that have employed continuous measures, some used singl

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single items such as frequency count measures of new product introductions (e.g., Markham and Griffin 1998), while others utilized multidimensional scales assessing the degree of creativity, newness (to the firm and/or customer), fit/synergy (to the firm and/or customer), uncertainty and advantage the new product entails (e.g. Moorman, Miner 1997; Atuahene-Gima and Ko 2001).

Green, Gavin and Aiman-Smith (1995) argue that new product innovation should be seen as a continuum with multiple dimensions and that classification as radical or incremental (as opposite ends of a continuum) is an oversimplification. Montoya-Weiss and Calantone (1994) assert that little attention has been paid to construct validity and that there is no consistency in operationalization in terms of categorical versus continuous measurement (Garcia and Calantone 2002). This lack of consistency may have led to contradictory results and confusing implications. Accordingly, this study examines whether the linkages of innovation to antecedent and outcome variables vary based on how innovation was operationalized.

2.3 HYPOTHESES

Having defined the potential moderators, selected antecedents and outcomes that are associated with "new product innovation" in the literature are discussed in this section. Based on the conducted review, new product innovation is defined in this study as a process comprising the technological development and market commercialization of an invention -- initiated by the perception of a new market and/or service opportunity. This process covers all development, production, marketing tasks and the adjustments made in the organization for the market introduction of the invention to the end users through to its diffusion and adoption (Garcia and Calantone 2002). Accordingly, studies that have conceptualized innovation as familiarity (i.e., the product's familiarity/ synergy with the firm's prior custon

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customers and technologies) and as synergy (fit with the firm's marketing and technical resources and skills) are included in this analysis (Danneels and Kleinschmidt 2001).

A model that is rooted in the resource-based theory (RBV) and contingency framework of industrial organization (IO) paradigm is built and empirically tested. These theories, which take into account the influential factors on the conduct of firms' competitive actions and performance, are generally viewed as complementary (Mahoney and Pandian 1993; Barlett and Goshal 1991; Barney 2001; Zou and Cavusgil 2002). While IO focuses on industrial and product market factors as the determinants of the firm's strategy, which in turn impact firms' economic performance, RBV views the distinctive ways by which firms manage their resources and capabilities as the enduring sources of competitive advantage (Porter 1981; Peteraf 1993; Day 1994; Mahoney and Pandian 1993; Madhok 2002).

The basic tenet of RBV is that firms with superior – namely, rare, non-imitable and non-substitutable- resources gain sustainable competitive advantages in the marketplace (Peteraf 1993, p 180). In other words, internal organizational resources and capabilities are strong determinants of the firms' strategy and performance. Correspondingly, the innovation researchers that draw upon RBV have advocated the notion that a company creating a superior, unique and novel product should enjoy competitive advantage in the market and, hence commercial success (Friar 1995; Gatignon and Xuereb 1997). The contingency (i.e., strategy-structure-performance) framework of IO comprises that external factors determine the firms' competitive actions as well as the strategies potentially available to the firm (Porter 1981; Miller 1987; Miles et al. 1978; McKee et al. 1989). Strategy is the firms' response to the environmental dynamics and focuses on adapting to their industry.

Thus, the fit of the firm's strategy and structure to the external environment engenders superior performance (Covin and Slevin 1989; Miller and Friesen 1982). NPD studies that refer to the contingency framework focus on the influence of strategies, organizational structures and processes on the development and marketing of products (Li and Atuahene-Gima 2001; Gatignon and Xuereb 1997; Atuahene-Gima and Ko 2001). Accordingly, in this study, the relationships of new product innovation with market and technological turbulence, with customer and competitor orientation, with organizational structure, and with new product performance are examined. The baseline hypotheses, as well as hypotheses concerning whether a potential moderator *actually* moderators a particular baseline hypothesis, are summarized in Table 2-1. The baseline hypotheses are labeled H1 through H6; the hypotheses concerning moderation are labeled H1a, b, c through H6a, b, c.

2.3.1 Antecedent to Innovation: Environmental Turbulence (Market and Technological)

Turbulent environments imply dynamic and volatile conditions as a result of uncertain and unpredictable changes in demand and growth rates, continuously emerging or eroding competitive advantages, and low barriers to entry/exit, all of which continuously change the competitive structure of the industry (Miller and Friesen 1978; Bourgeois and Eisenhardt 1988; Covin and Slevin 1989; Atuahene-Gima 1995; Ozsomer et al. 1997). Such conditions may further lead to difficulties for the firm in obtaining accurate and timely information, render obsolete a firm's formal assessment system and/or signal the opening of product opportunities (Calantone et al. 1997). Two main sources for turbulence are identified in the literature: first, technological innovations which accelerate the rate of change in the marketplace and cause product obsolescence to occur more quickly; and second, continuous changes in customers' preferences/demands, in price/cost structures, and in the dynamics of com

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competition (Cooper and Kleinschmidt 1987; Calantone et al. 1994; Li and Calantone 1998; Moorman and Miner 1997; Han et al. 1998; Mullins and Sutherland 1998; Souder et al. 1998).

TABLE 2-1. KEY CONSTRUCTS AND HYPOTHESES

PREDICTOR	CRITERION	PROPOSED MODERATORS	HYPOTHESES	
Market	**New Product**		H1	Positive
Turbulence	**Innovation**	Level of Analysis	H1a	No
		Perspective	H1b	Yes
		Operationalization	H1c	Yes
Technological	**New Product**		H2	Positive
Turbulence	**Innovation**	Level of Analysis	H2a	No
		Perspective	H2b	Yes
		Operationalization	H2c	Yes
Customer	**New Product**		H3	Positive
Orientation	**Innovation**	Level of Analysis	H3a	No
		Perspective	H3b	Yes
		Operationalization	H3c	Yes
Competitor	**New Product**		H4	Positive
Orientation	**Innovation**	Level of Analysis	H4a	No
		Perspective	H4b	Yes
		Operationalization	H4c	Yes
Organizational	**New Product**		H3	Negative
Structure	**Innovation**	Level of Analysis	H3a	Yes
(mechanical)		Perspective	H3b	Yes
		Operationalization	H3c	Yes
New Product	**New Product**		H6	Positive
Innovation	**Performance**	Level of Analysis	H6a	Yes
		Perspective	H6b	Yes
		Operationalization	H6c	Yes

As per RBV and contingency theories suggest, firms attempt to pursue emerging opportunities and thus place greater emphasis on new product innovation in order to establish competitive advantage in rapidly changing environments (Calantone et al. 2003; Atuahene-Gima and Ko 2001). Such environmental settings also bring about new venture opportunities as a result of emerging new, unserved customer needs and benefits. However, in an environment with sudden and dramatic changes, a dela

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delay in action may inhibit success (Ozsomer et al. 1997; Bourgeois and Eisenhardt 1988; Calantone et al. 2003). Thus environmental turbulence will lead to both initiation of innovative projects and an innovative posture across the firm.

In this analysis, it is posited that level of analysis will not moderate the relationship between environmental turbulence dimensions and new product innovation. However, these linkages may vary due to perspective. In studies that use a firm perspective, interest often lies in technology push and thus the effect of technological turbulence on new product innovation may be stronger; whereas in studies that employed a customer perspective, the focus is often on market turbulence (i.e. fluctuations in customer demand and unpredictable competitor actions) and thus the path from market turbulence may be greater. Operationalization of innovation may also moderate these relationships. Thus:

H1: The relationship between market turbulence and new product innovation will be positive. This relationship (a) should hold irrespective of (i.e. not moderated by) the level of analysis, however, may be moderated by (b) the perspective and (c) the operationalization of innovation.

H2: The relationship between technological turbulence and new product innovation will be positive. This relationship (a) should hold irrespective of (i.e. not moderated by) the level of analysis, however, may be moderated by (b) the perspective and (c) the operationalization of innovation.

2.3.2 Antecedent to Innovation: Market Orientation (Customer and Competitor)

Radical product innovations incorporate substantially different core technologies and provide substantially higher customer benefits relative to previous or competing products. The creation of new product innovations that can easily be differentiated by customers encourages firms to be market oriented. Thus the exam

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examination of the strategic orientations of the firm (both customer and competitor) plays a crucial role to enhanced understanding of the product innovation process and the factors leading to higher performance (Atuahene-Gima and Ko 2001; Gatignon and Xuereb 1997).

Researchers pursuing a cultural view of "orientation" have defined the construct as the pattern of shared values and beliefs that help individuals understand organizational functioning and provide norms for behavior (Deshpande and Webster 1989; Desphande et al. 1993). "Orientation" has been viewed as a capability enabling a business to anticipate changing conditions and to respond to market requirements (Lukas and Ferrell 2000) and facilitating innovation via understanding the articulated needs of customers and the actions of competitors (Han et al. 1998). According to Narver and Slater (1990), market oriented firms most effectively and efficiently create superior value for customers and achieve competitive advantage; the necessary behaviors associate with *customer orientation* (i.e., the understanding of the current and latent needs of target customers to be able to create superior value for them) and *competitor orientation* (i.e., a constant monitoring of the short-term strengths and weaknesses and long-term capabilities and strategies of both current and potential competitors).

Customer and competitor orientations have been linked to new product innovation in several studies. Lukas and Ferrell's (2000) findings indicated that customer and competitor orientations jointly increase the introduction of new-to-the-world products, while competitor orientation alone increases the introduction of me-too products. Gatignon and Xuereb (1997) found that higher customer and competitor orientations allowed firms to develop more radical, less costly and thus higher performing innovations. However, Han, Kim and Srivastava's (1998) results show a posi

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positive relationship between customer orientation and innovation, but not between competitive orientation and innovation. This may be because the former two studies incorporated the perspective of the customer, whereas the latter adopts a firm (that is, an internal) perspective. These studies also diverge in their operationalizations of the innovation construct.

On the other hand, customer and competitor orientations should each have a positive impact on innovation both at the project and program level. To be ahead of the competition and meet customers' expectations, firms will aspire to develop unique and highly differentiated products and also achieve lower cost and more effective information sharing through process innovations. While moderation is not expected by level of analysis, perspective may moderate the relationship between these orientation constructs and innovation: this positive relationship may be weaker in studies with a firm perspective compared to those with a customer perspective. A technology push or an internal need may also trigger the development of an innovative product or the implementation of novel processes. Consequently, customer and competitor orientation may explain less of the variation in the innovation construct conceptualized with an internal firm perspective. Finally, different operationalizations of innovation may also lead to discrepancies in the results. Specifically, categorical and/or unidimensional measurements may result in the loss of variance in the innovation construct. Thus:

H3: Customer orientation will have a positive influence on new product innovation. This relationship (a) should hold irrespective of (i.e. not moderated by) the level of analysis, however, may be moderated by (b) the perspective and (c) the operationalization of the innovation construct.

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H4: Competitor orientation will have a positive influence on new product innovation. This relationship (a) should hold irrespective of (i.e. not moderated by) the level of analysis, however, may be moderated by (b) the perspective and (c) the operationalization of the innovation construct.

2.3.3 Antecedent to Innovation: Organizational Structure

Miller (1987) defined organizational structure as the 'enduring allocation of work roles and administrative mechanisms that allow organizations to conduct, coordinate, and control their work activities and resource flows' (p 8). A critical problem for organizations is to create and work within structures that effectively coordinate the NPD process, facilitate the sharing of information and other resources across functional areas, and provide mechanisms for decision-making and conflict resolution (Crawford 1984; Achrol 1991; Ottum and Moore 1997; Song et al. 1997; Jassawalla and Sashittal 1998; Song and Montoya-Weiss 1998; Song et al. 1998; Souder et al. 1998; Maltz and Kohli 1996; Adams et al. 1998; Troy et al. 2001). RBV and industrial organization perspectives corroborate that strategy generally determines structure (Miles, Snow et al. 1978; Miller and Friesen 1982). Structure is considered the result of a firm's strategic focus on the external environment and market dynamics (Calantone et al. 1994; Day 1994; Matsuno et al. 2002; Calantone et al. 2003).

Structure has been classified as organic versus mechanistic: tasks with high uncertainty supposedly require organic structures, whereas tasks with low uncertainty require mechanistic approaches in order to be successful. Based on this notion, uncertain tasks such as complex innovation projects cannot be successfully pursued in highly centralized, formal, and bureaucratic structures (i.e., mechanistic). Such structures overburden CEOs with time pressure or lack of assistance to initiate complex innovation, and inhibit creativity and input from diverse sources (Miller et al. 1988;

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al. 1988; Covin and Slevin 1989; Hage and Dewar 1973). But flexible organic structures enhance receptivity to new technology and facilitate new product innovation (Olson et al. 1995; Utterback and Abernathy 1975; Knight 1987; Griffin and Hauser 1996; Matsuno et al. 2002; Sethi et al. 2001).

Surprisingly, in the innovation literature, findings from empirical studies regarding the impact of different dimensions of organizational structure on successful innovations have been mixed. Miller and Friesen (1982) and Meyers et al. (1999) contended that centralization may *facilitate* (rather than hinder) innovation by reducing conflict and ambiguity, leading to a more uniform response to the incoming technology. In contrast, Dewar and Dutton (1986) claim that decentralization provides individuals greater autonomy to decide and act, leading to more exchange of ideas, and thus familiarizing employees and decreasing the uncertainty associated with technological change. Interestingly, all results of these studies show that centralization was not a significant predictor of new product innovation, regardless what the authors argued. Similarly, several studies on the impact of formalization hold opposing views. For instance, Bonner et al. (2002) and Ayers et al. (1997) have asserted that formalized procedures can regulate the tasks people perform and the role responsibilities in the NPD process. Tatikonda's (1999) results indicated that formality of the project execution is positively (*not* negatively) related to new product innovation.

In addition to these contradicting results, different types of organizational structures expand the debate on structural solutions to effectively coordinate new product development. It may be possible that there is no one specific structural solution: mechanistic *versus* organic (e.g., centralization versus decentralization, formal versus informal) may not constitute substitutes, but rather complements. This notion is c

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notion is consistent with the organizational control literature, which supports the use of a portfolio of controls (Eisenhardt 1985; Jaworski 1988; Jaworski et al. 1993). Functional organizations were the acknowledged organizational structures in the earlier literature (Olson et al. 1995; Achrol 1991; Ayers et al. 1997; Griffin and Hauser 1996). However, they were later thought to discourage cooperation across functions, rather than to resolve conflicts and create harmony. Other organizational structures, such as matrix organizations and project teams, have been advocated to increase integration across functions and overcome the weaknesses of traditional structures (Achrol 1991; Workman Jr. 1993). These new structures are designed to: reduce differences between functional responsibilities, allowing processes to be executed and resolving conflicts; improve decision-making; encourage the cross-functional development of innovative products; and enhance the likelihood of product development success. In the NPD literature, other alternatives have been proposed for the management of product development; for example, a formal management process (e.g., stage-gate processes) in which the required tasks, their sequence and the employees responsible for their completion are specified explicitly over a time sequence (Griffin and Hauser 1996).

These conflicting results in the new product innovation literature may be primarily due to the level of analysis employed. Even though, on the whole mechanistic approaches may hinder new product innovation, they may be beneficial at the program level in coordinating multiple product development initiatives, making priorities and goals explicit to project teams. By building consensus, such approaches may allow more effective innovative strategies overall and foster an innovative posture (i.e., a culture that nurtures integrated innovation). However, formalized and centralized structures may freeze the status quo and inhibit the diffusion and communic

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communication of ideas among the project team members. Thus at the project level, organic structures characterized by cross-functional teams and informal social networks may generate creativity by facilitating information and resource flows (Montoya-Weiss and Calantone 1994; Olson et al. 1995). Decentralization, autonomy and empowerment may lead to conflict resolution and effective decision-making at the project level.

Moreover, divergent rationales and results may be due to the perspective employed in conceptualizing innovation. Studies employing a purely internal, firm focus may have endorsed centralization as beneficial for conflict resolution, whereas other studies with an external, customer perspective may have defended an organic structure for more creative customer solutions. Finally, the operationalization of the construct may have an impact on the strength of the organizational structure- new product innovation linkage. Thus:

H5: Mechanical organizational structure will be negatively related to new product innovation. This relationship will be moderated by: (a) the level of analysis, (b) the perspective and (c) the operationalization of the innovation construct.

2.3.4 Outcome of New Product Innovation: New Product Performance

The effect of new product innovation on performance outcomes is debated in the literature. For some researchers, innovative products create more opportunities for differentiation, hence have relative advantage over existing products or competitors (Gatignon and Xuereb 1997; Kleinschmidt and Cooper 1991; Song and Parry 1996; Ali et al. 1995). However, new product innovation also constitutes a response to the uncertainties in a firm's entrepreneurial environment (Han et al. 1998; Hurley and Hult 1998). Therefore, a focus on innovation might provide a firm with the means for achieving higher returns (Firth and Narayanan 1996; Griffin and Page 1996).

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Drawing upon RBV, some studies have maintained that innovating firms with unique knowledge and resultant capabilities, as well as superior and novel products, enjoy high performance (Calantone and Di Benedetto 1988; Ozsomer et al. 1997; Han et al. 1998; Friar 1995). More innovative products provide value to customers and are differentiated from competitors; consequently, competitive advantage is greater (Ettlie and Rubenstein 1987; Kleinschmidt and Cooper 1991; Gatignon and Xuereb 1997; Sengupta 1998). Other studies have concluded that less innovative products are more familiar, less uncertain, may have higher synergies and hence greater success. However, Tatikonda (1999) and Calantone et al. (1994) demonstrate no significant relationship between the degree of innovation and performance.

These discrepancies may be due to the level of analysis employed. Extraneous factors not considered at the project level (such as product characteristics) may exert an effect on the performance of a particular project. On the other hand, in studies at the program level, an innovative posture or strategy on a broader scale may entail competitive advantage and success. Moreover, the relationship between new product innovation and performance may also vary due to the perspective (firm versus customer). Innovation constructs developed with an internal focus may not explain much of the variation in the performance outcomes. Finally, operationalization of the construct may affect the strength of this linkage. Hence:

H6: The relationship between new product innovation and new product performance will be positive. This relationship will be moderated by (a) level of analysis, (b) perspective and (c) operationalization of innovation the construct.

2.4 METHOD

Meta-analysis is an objective and efficient way to summarize and make sense of large literatures (Wolf 1986; Rosenthal 1991). It integrates results, revealing cumulative knowledge and general principles (Hunter and Schmidt 1990). It can also highlights gaps, provide new research directions by examining possible moderating and/or mediating variables, and help pinpoint the underlying reasons for contradictory conclusions. The key concerns are relationship robustness and the specification of conditions that limit generalizability: both relationship trends and the potential substantive or methodological moderators of effect sizes[1] (such as disparate definitions, unit of analysis, methodological designs or samples) can be recognized.

2.4.1 Sample of Articles

New product innovation has been described as radical, incremental, really-new, imitative, discontinuous, architectural, modular, evolutionary, administrative and technical, innovativeness, advantage and newness (see e.g., Garcia and Calantone 2002), although the distinctions among some of these terms are sometimes vague. Using JSTOR and ProQuest (ABI Inform) databases, articles containing these keywords and published in scholarly and peer reviewed marketing, new product and management journals from 1989 to 2004 were searched. The journals were: *Journal of Marketing, Journal of Marketing Research, Journal of Product Innovation Management, Organization Science, Management Science, Academy of Management Journal, Strategic Management Journal, Administrative Science Quarterly, Journal of Business Research, European Journal of Marketing, Industrial Marketing Management, IEEE Transactions on Engineering Management* and *Journal of Business and Industrial Marketing.* Literature reviews were also gathered and reviewed for additional references. Thus, some articles, a few prior to the 15-year range (back until 1970s), were found because they were referenced in another article.

[1] Effect size is defined as the degree to which the phenomenon is present in the population or the degree to which the null hypothesis is false. It indicates the magnitude of the relationship or treatment, in the form of either the degree of associations between two variables as assessed by Pearson Product Moment Correlation coefficient, or, the difference of means between two groups as measured by Student's t-test (Wolf 1986; Rosenthal 1991).

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To create the data set of articles, articles that examined the adoption of innovative products by consumers were first excluded. As a result, of 143 articles gathered, 113 were eligible for inclusion. Second, the 113 were evaluated as to whether they operationalized innovation and empirically tested relevant relationships. Some oft-cited articles were excluded either because they did not report correlations or examine relevant hypotheses: 89 contained empirical analyses, 48 of these reported correlations and 43 had hypotheses of interest. Two articles (Song and Montoya-Weiss 1998; Yoon and Lilien 1985) conducted t-tests and reported the difference of means as effect sizes; these studies were added by converting effect sizes into correlations (as in Cooper 1998; Hunter and Schmidt 1990). Several studies split samples into groups and reported correlations for each group (e.g., Miller and Friesen 1982; Tatikonda 1999), while one employed two different sampling frames to test the same model (i.e., Yoon and Lilien 1985). These studies were treated as independent. This procedure resulted in 46 data entries with total sample size of 4801; these articles are starred in the Reference list. The characteristics of this subset of articles were similar to those of the entire sample (see Table A-1).

2.4.2 Variable Coding and Data Analysis

This present meta-analysis was conducted using correlations at the test level rather than study level following the procedure proposed by Hunter and Schmidt (1990). The technique and statistic[2] for detecting outlier coefficients in meta-analytic data sets proposed by Huffcut and Arthur (1995)[3] was employed. For the 46 independent samples, reported correlations were corrected for attenuation using

[2] Sample adjusted meta-analytic deviancy (SAMD) statistic, which is derived by dividing the difference between the value of each individual correlation coefficient and the sample weighted mean coefficient computed without the study correlation by the standard error of the difference.
[3] This procedure led to eliminate only one correlation for the relationship between organizational structure and new product innovation.

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Hunter and Schmidt's (1990) artifactual distribution approach[4], in which mean values of reliabilities are employed. Each reported correlation (r_{XY}) was corrected using the following formula:

$$r_c = \frac{r_{XY}}{\sqrt{r_{XX}} \cdot \sqrt{r_{YY}}}$$

where: r_c is the corrected correlation;
r_{XX} and r_{YY} are the reported reliabilities for each scale

Then, each correlation was then corrected for sampling error and weighted average correlations were calculated based on sample sizes for each of the relationships using (Table 2-2):

$$\bar{r} = \Sigma w_i r_i / \Sigma w_i = \Sigma\left[N_i r_i\right] / \Sigma N_i$$

where: $\bar{r}$ is weighted average correlation;
N is the sample size reported in the corresponding study

To study the moderating impact of the three proposed substantive and methodological artifacts, the remaining variance after correction for sampling error was first gauged by subtracting variance due to sampling error ($S^2_e = (1-\overline{r^2})^2 / \overline{N}$) from total variance in individual correlations ($S_r^2 = \Sigma\left[N_i\left(r_i - \bar{r}\right)^2\right] / \Sigma N_i$). Hunter and Schmidt (1990) suggest the analysis of the effect of research artifacts if this remaining variance is nontrivial (p. 110). The remaining variance in the sample correlations less the variance due to sampling error was large for all hypothesized relationships (at least 60%; except for competitor orientation-new product innovation). Thus, the analysis of moderating effect of the proposed substantive (i.e., level of analysis and perspective) and methodological (i.e., measurement of new product innovation) artifacts was supported. The data was then

[4] The underlying reason is that Cronbach's alpha values were not available in every study and were reported sporadically.

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partitioned into different groups based on the three moderators proposed: (1) the level of analysis, i.e., organization/ SBU level/ program versus project level; (2) perspective, comprising firm versus customer; and (3) operationalization of innovation, comprising categorical-unidimensional versus continuous-multidimensional. Sample size weighted average correlations were calculated for each subgroup.

TABLE 2-2. WEIGHTED AVERAGE CORRELATIONS: THE OVERALL SAMPLE

		1	2	3	4	5	6	7
1	**NP Performance**	1.00						
2	**Innovation**	0.39	1.00					
		(24)						
3	**Market Turbulence**	0.01	0.08	1.00				
		(10)	(14)					
4	**Technological Turbulence**	-0.01	0.14	0.30	1.00			
		(6)	(6)	(5)				
5	**Organizational Structure**	-0.36	-0.20	-0.11	-0.01	1.00		
		(3)	(12)	(2)	(1)			
6	**Customer Orientation**	0.30	0.26	0.03	0.10	-0.42	1.00	
		(14)	(18)	(7)	(5)	(7)		
7	**Competitor Orientation**	0.30	0.24	0.17	0.10	-0.79	0.74	1.00
		(4)	(6)	(3)	(2)	(3)	(4)	
	STANDARD DEV	1.84	1.53	1.05	1.69	1.21	1.48	1.94

Note: The numbers in parentheses indicate the number of correlations obtained for calculation.

To test the hypotheses, the overall sample (N = 4801) was first analyzed in a structural equation model using the mean sample size (n = 200) on which the individual correlations were based (Henard and Szymanski 2001). Subsequently, this analysis was repeated for each moderator group by splitting the overall mean sample size in proportion to each group sample size, i.e., 'level of analysis' (n= 200 * 3361/4801= 140 for program level and n = 200 * 1440/4801 = 60 for project), 'perspective' (n= 200 * 3843/4801 = 160 for firm and n = 200 * 958/4801 = 40 for customer).

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2.5 RESULTS

Using the correlations as inputs, structural equation modeling technique was employed for the overall sample and then a 2-group path analysis for each of the split groups (Bollen 1989; Hoyle 1995; Duncan et al. 1999). The fit statistics for all models are in Table 2-3; the results for the overall sample are in Figure 2-1 and the results for each of three split groups are in Figures 2-2, 2-3, 2-4. The conclusions from the hypothesis tests are summarized in Table 2-4.

TABLE 2-3. FIT STATISTICS FOR STRUCTURAL EQUATION MODELS

	STRUCTURAL MODEL ON OVERALL SAMPLE (n=200)	MULTI-GROUP MODEL BASED ON LEVEL OF ANALYSIS [n(program) = 140; n(project) = 60]	MULTI-GROUP MODEL BASED ON PERSPECTIVE [n(firm) = 160; N(customer) = 40)	MULTI-GROUP MODEL BASED ON OPERATIO-NALIZATION [n(categorical-singular) = 20; n(continuous-multiple) = 180)
χ^2	19.955 (df = 3; p=.0002)	43.701 (df = 17; p=.0004)	164.306 (df = 12; p=.000)	68.704 (df = 16; p=.000)
NFI	.958	.911	.820	.886
CFI	.963	.940	.825	.906
RMSEA	.169	.126	.181	.182

2.5.1 Baseline Model: Context for Hypothesis Testing

All hypotheses were tested within the context of the baseline model shown in Figure 2-1. This model specified the effects of environmental turbulence on orientations, organizational structure and new product innovation, all of which in turn influenced new product performance. Thus: (1) the environmental turbulence constructs were modeled as completely exogenous (environment comes first in the traditional hierarchy); (2) the strategic orientation constructs are antecedents to organizational structure, new product innovation and performance (strategy precedes structure) and hence strategic orientation was modeled as a partial mediator of the relationships of environmental turbulence with organizational structure and new product innovation; and (3) organizational structure and new product innovation were modeled as partial mediators of the relationships between customer and competitor orientations and new product performance. Finally, the effects of environmental turbulence variables on new product performance were specified as completely mediated by strategy, structure and innovation.

TABLE 2-4. OVERVIEW OF THE RESULTS OF HYPOTHESIS TESTING

RELATIONSHIP	PROPOSED MODERATORS	HYPOTHESES and FINDINGS	
Market Turbulence		H1: +	not supported
to New Product Innovation	Level of Analysis	H1a: no	not supported
	Perspective	H1b: yes	Supported
	Operationalization	H1c: yes	not supported
Technological Turbulence		H2: +	supported
to New Product Innovation	Level of Analysis	H2a: no	not supported
	Perspective	H2b: yes	Supported
	Operationalization	H2c: yes	not supported
Customer Orientation		H3: +	not supported
to New Product Innovation	Level of Analysis	H3a: no	not supported
	Perspective	H3b: yes	not supported
	Operationalization	H3c: yes	Supported
Competitor Orientation		H4: +	not supported
to New Product Innovation	Level of Analysis	H4a: no	not supported
	Perspective	H4b: yes	Supported
	Operationalization	H4c: yes	Supported
Structure (mechanical)		H5: -	not supported
to New Product Innovation	Level of Analysis	H5a: yes	Supported
	Perspective	H5b: yes	Supported
	Operationalization	H5c: yes	Supported
New Product Innovation		H6: +	Supported
to New Product	Level of Analysis	H6a: yes	not supported
Performance	Perspective	H6b: yes	Supported
	Operationalization	H6c: yes	not supported

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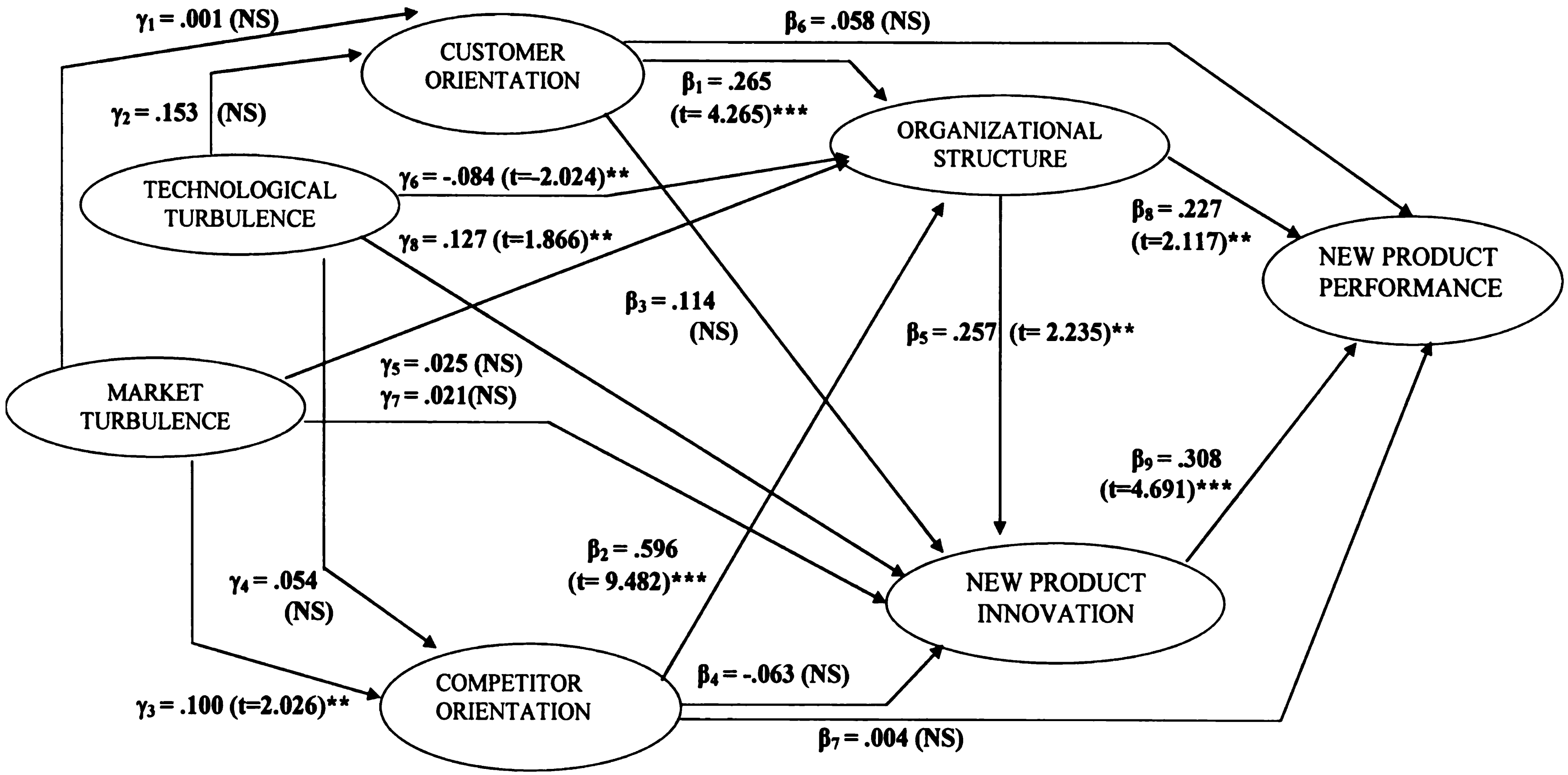
The fit was good when tested with the overall sample: Bentler-Bonett normed fit index (NFI), comparative fit index (CFI) and RMSEA value were 0.958, 0.963 and 0.169, respectively (see Table 2-3). Nine out of 17 specified paths were significant at $\alpha \leq 0.05$ or better (Figure 2-1). Market turbulence did not exert a significant impact on either customer orientation or organizational structure (γ_1 = .001; γ_5= .025), but was positively related to competitor orientation (γ_3=.100). In contrast, technological turbulence was not significantly related to customer or competitor orientation (γ_2= .153; γ_4= .054), but negatively affected organizational structure (i.e., mechanistic) (γ_6= -.084). The relationship between market turbulence and new product innovation was not significant (γ_7= .021; failing to support H1). Technological turbulence, on the other hand, had a positive impact on new product innovation (γ_8= .127, as in H2), meaning that technological turbulence encouraged innovation. Both customer and competitor orientation were related positively to organizational structure (i.e., mechanistic) (β_1= .265; β_2= .596; respectively), however, neither were significantly related to new product innovation (β_3= .114; β_4= -.063; failing to support H3 and H4) or to new product performance (β_6= .058; β_7= .004). Mechanical structures had a positive impact on new product innovation (β_5 = .257, contrary to expectations in H3) and on new product performance (β_8 = .227). As expected in H6, new product innovation was positively linked to new product performance (β_9 = .308).

2.5.2 Hypothesis Testing

2.5.2.1 Environmental Turbulence and New Product Innovation. As shown in Figure 2-1, technological turbulence, not market turbulence was significantly and positively related to new product innovation, supporting *H2* and not *H1* (see Figure 2-

FIGURE 2-1. STRUCTURAL EQUATION MODEL ON THE OVERALL SAMPLE **(n=200)**

FIGURE 2-1. STRUCTURAL EQUATION MODEL ON THE OVERALL SAMPLE (n=200)



NOTE: * indicates 0.1 significance level;
** 0.05 significance level and
*** 0.01 significance level.

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1 and Table 2-4). The market turbulence-new product innovation link was significantly moderated by 'level of analysis' and 'perspective,' indicating a positive relationship for the program level versus n.s. for the project level and positive for the firm perspective versus negative for the customer perspective (see Figure 2-2 and 1-3). This supports *H1b* but not *H1a*. Similarly, 'level of analysis' and 'perspective' moderated the relationship between technological turbulence and new product innovation (positive for the program level versus n.s. for the project level and n.s. for firm versus positive for customer perspective), as in *H2b* but contrary to *H2a*. Finally, 'operationalization' did not moderate either of these paths and thus *H1c* and *H2c* are not supported (see Figure 2-4).

2.5.2.2 Customer Orientation and New Product Innovation. *C*ustomer orientation did not exert a significant impact on new product innovation in the overall sample (see Figure 2-1 and Table 2-4), failing to support *H3*. This relationship was moderated by 'level of analysis' and 'operationalization' supporting *H3c,* but not *H3a or H3b* (see Table 2-4; H3a proposed no moderation when in fact there is, and thus H3a is not supported). The relationship between customer orientation and new product innovation was positive at the program level versus negative at the project level (Figure 2-2) and positive in categorical-unidimensional as opposed to n.s. in continuous-multidimensional (Figure 2-4). The strength of this relationship did not vary across 'perspective' groups (see Figure 2-3).

2.5.2.3 Competitor Orientation and New Product Innovation. Similarly, H4 was not supported with a nonsignificant effect of competitor orientation on new product innovation in the overall sample (Figure 2-1). This relationship was moderated by all proposed moderators, supporting *H4b and H4c,* but not *H4a* (see Table 2-4; H4a proposed no moderation when in fact there is, and thus H4a must be rejected). The strength o

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strength of this relationship varied across program vs. project, i.e., it was positive at project level as opposed to n.s. at program level (Figure 2-2). The relationship between competitor orientation and new product innovation was stronger in the 'firm' perspective (vs. customer, where it was negative; see Figure 2-3) and categorical-unidimensional operationalization (vs. 'continuous-multidimensional', where it was n.s.; see Figure 2-4).

2.5.2.4 Organizational Structure and New Product Innovation. The impact of organizational structure on new product innovation was positive overall (Figure 2-1), contradicting H5 (which proposed a negative relationship). This relationship was moderated by 'level of analysis,' 'perspective' and 'operationalization', supporting *H3a, H3b, and H3c*. Mechanical organizational structure had a positive influence on new product innovation in the 'project level' versus a nonsignificant impact in the program level group (Figure 2-2). 'Perspective' moderated both the strength and the directionality of the effect – negative for the 'firm perspective', whereas positive for 'customer perspective' (Figure 2-3). This path was positive in the 'categorical-unidimensional' group, but n.s. in the 'continuous-multidimensional measurement' group (Figure 2-4).

2.5.2.5 New Product Innovation and New Product Performance. In the overall sample, the relationship between new product innovation and new product performance was significant and positive, supporting *H6*. The strength of this relationship was significantly moderated by only 'perspective': greater when a customer perspective was employed (Figure 2-3). It did not vary across 'level of analysis' or 'operationalization' (see Figure 2-2 and 1-4). Therefore, *H6b,* not *H3a* and *H3c* was accepted (Table 2-4).

FIGURE 2-2. MULTI-GROUP MODEL BASED ON LEVEL OF ANALYSIS ($n_{program}$ = 140; $n_{project}$ = 60)

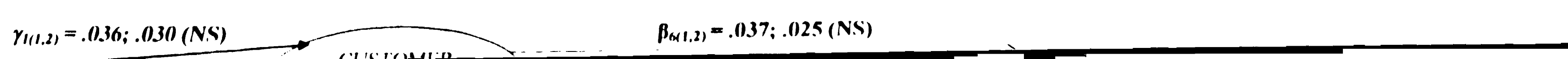
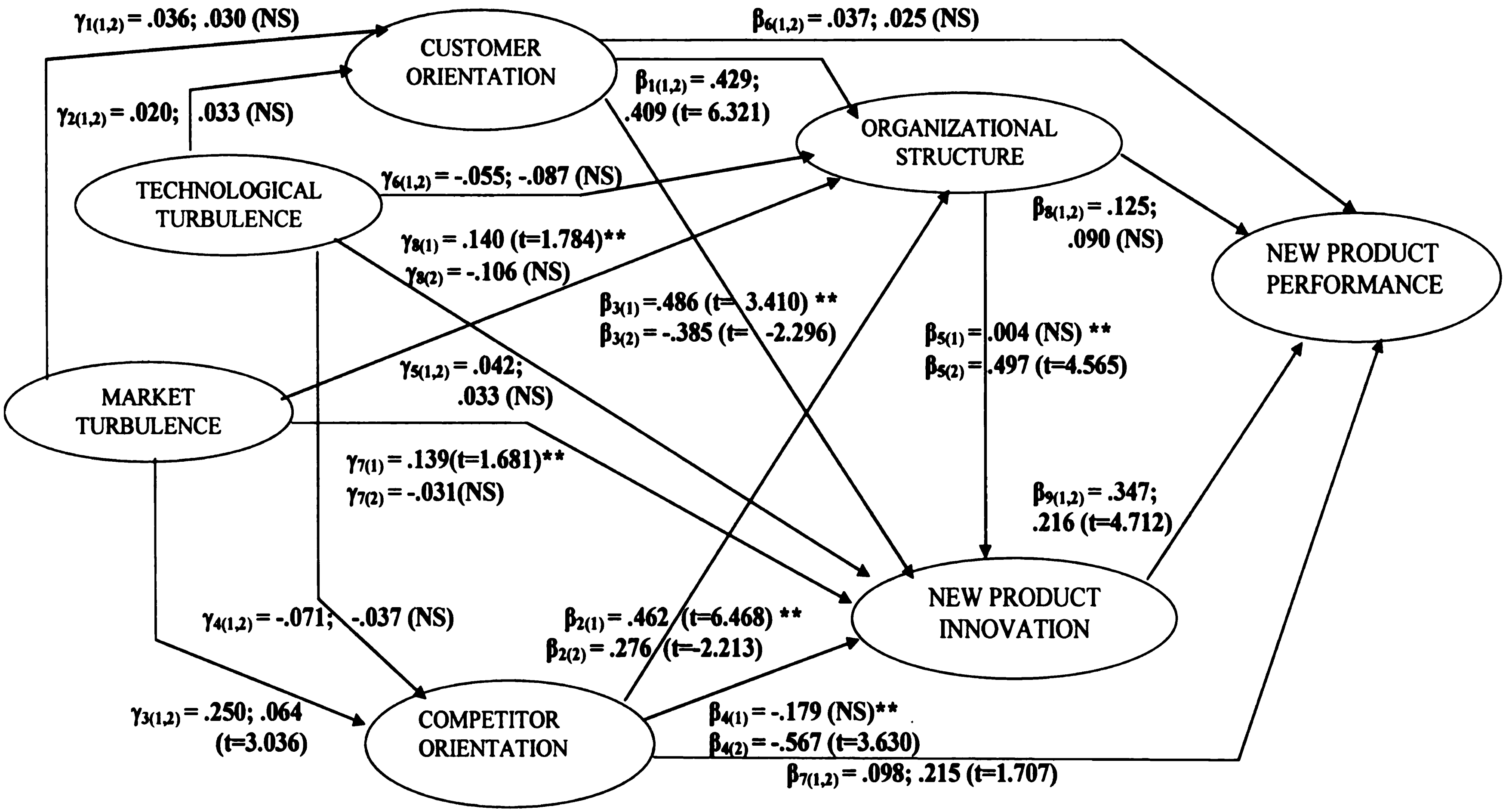


FIGURE 2-2. MULTI-GROUP MODEL BASED ON LEVEL OF ANALYSIS ($n_{program}$= 140; $n_{project}$ = 60)



NOTE: ** indicates relationships that are moderated by the proposed variables at 0.05 significance level. Entries are the standardized path coefficients for program and project level group, respectively, with t-values in parentheses.

FIGURE 2-3. MULTI-GROUP MODEL BASED ON PERSPECTIVE (n_{firm} = 160; $n_{customer}$ = 40)

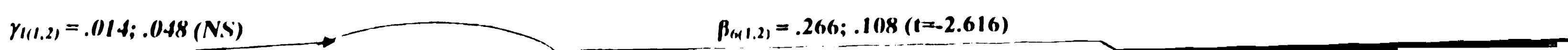
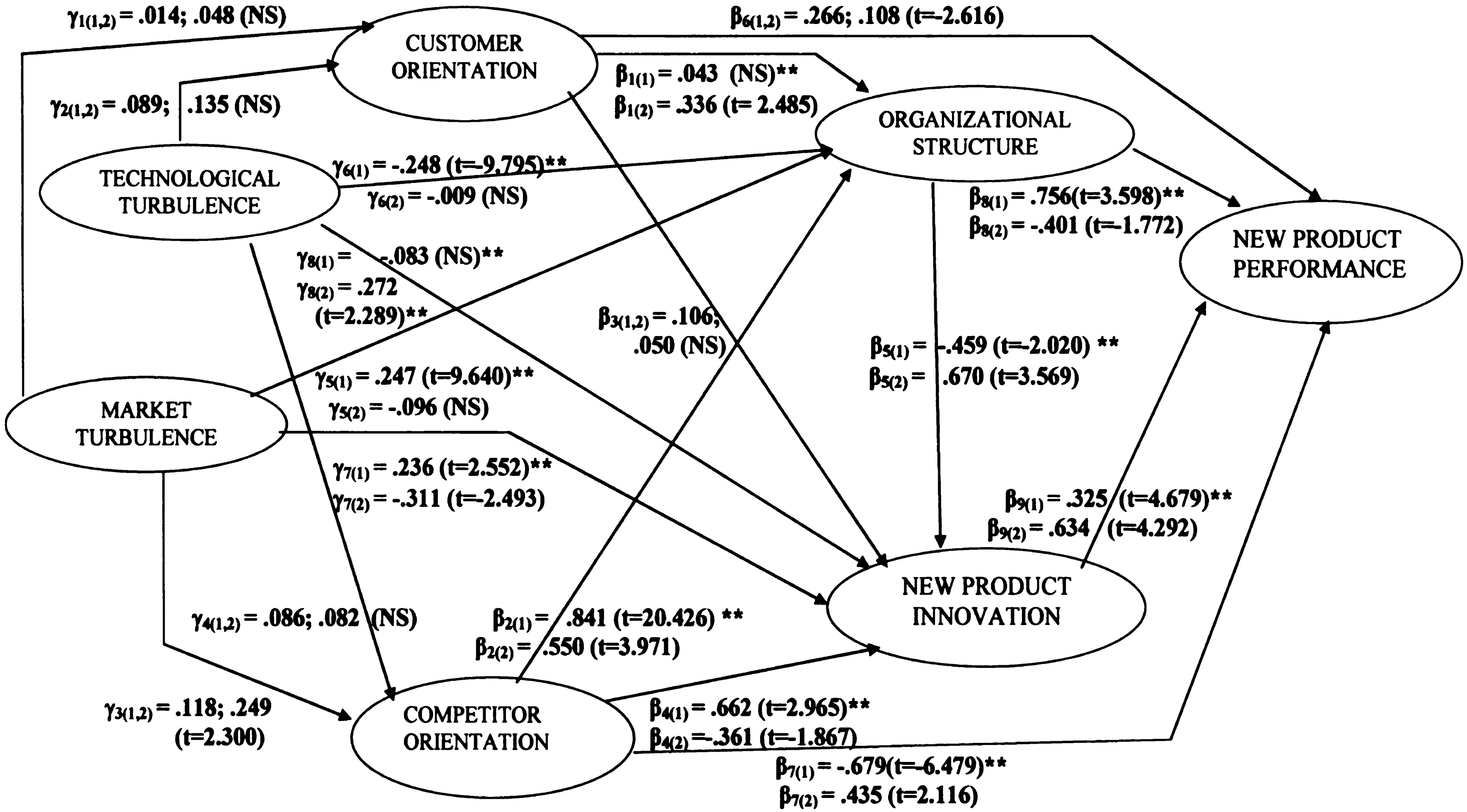


FIGURE 2-3. MULTI-GROUP MODEL BASED ON PERSPECTIVE (n_{firm} = 160; $n_{customer}$ = 40)



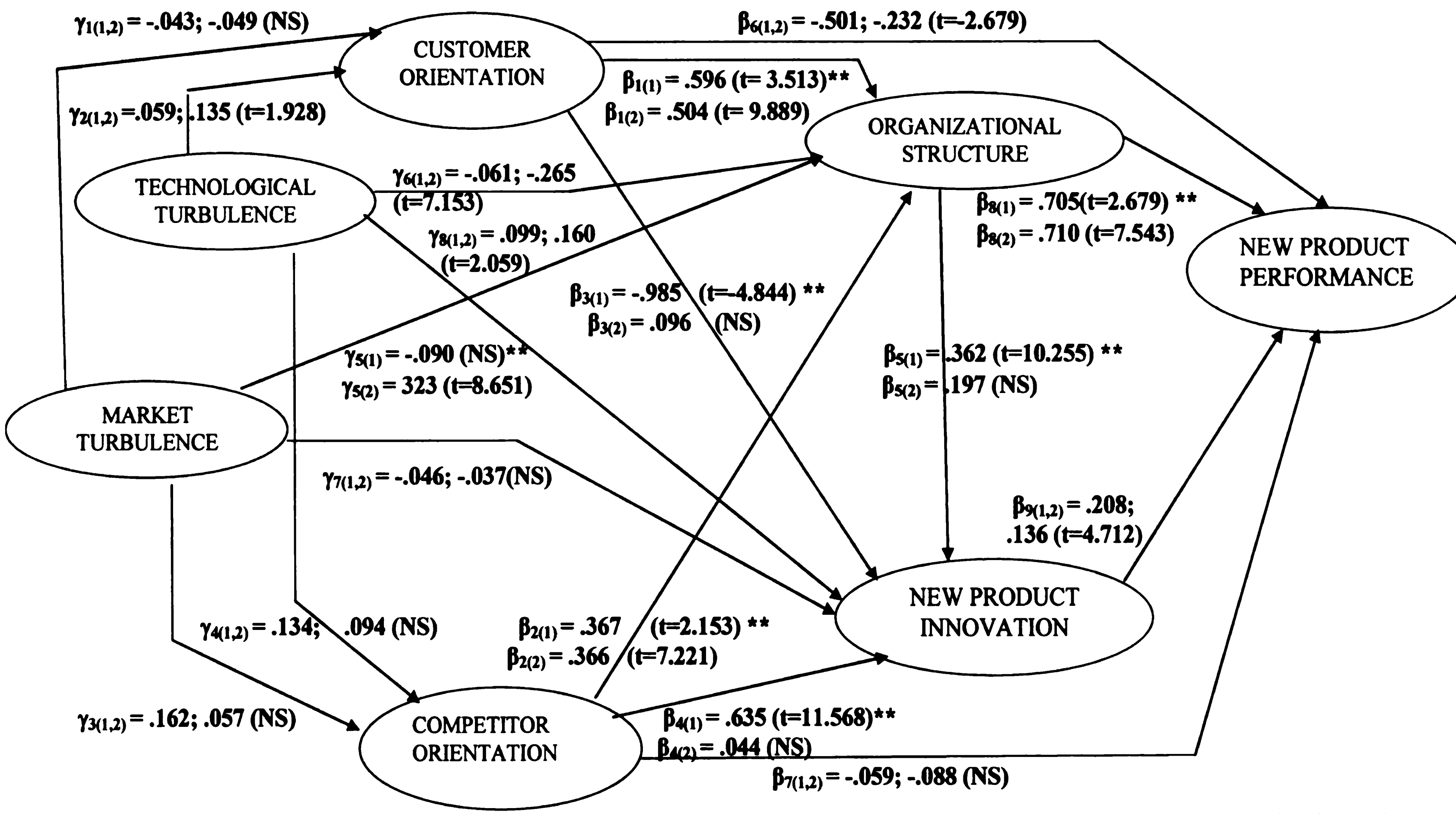
NOTE: ** indicates relationships that are moderated by the proposed variables at 0.05 significance level. Entries are the standardized path coefficients for firm and customer perspective group, respectively, with t-values in parentheses.

FIGURE 2-4. MULTI-GROUP MODEL BASED ON OPERATIONALIZATION ($n_{categorical\&single}$ = 20; $n_{continuous\&multiple}$ = 180)

$\gamma_{(1,2)}$ = -.043; -.049 (NS)

$\beta_{6(1,2)}$ = -.501; -.232 (t=-2.679)

FIGURE 2-4. MULTI-GROUP MODEL BASED ON OPERATIONALIZATION ($n_{categorical\&single} = 20$; $n_{continuous\&multiple} = 180$)



NOTE: ** indicates relationships that are moderated by the proposed variables at 0.05 significance level. Entries are the standardized path coefficients for categorical-unidimensional and continuous-multidimensional group, respectively, with t-values in parentheses.

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2.6 DISCUSSION AND CONCLUSION

The innovation literature comprises ambiguous findings regarding not only the influence new product innovation exerts on new product outcomes, but also the degree to which certain intraorganizational factors, such as orientations and structure, lead to new product innovation. Consequently, a meta-analysis was conducted and structural equation modeling analyses were performed to derive empirical generalizations, to investigate mediating relationships, and to scrutinize possible moderators that may have lead to the discrepancies across studies.

2.6.1 Baseline Model: The Interrelationship Among Constructs

Using the entire sample, the hypotheses were first tested in the context of the baseline model in Figure 2-1. Market turbulence was positively related to competitor orientation, however, technological turbulence did not exert a significant impact. Thus, rising hostility in a firm's market environment, but not technological advancements in its industry, increases the importance given to monitoring of competitor actions and strategies. This finding is supported in the industrial organization (IO) paradigm (Porter 1981; Grant 1991), which views strategy as a firm's response to the competitive industry environment. On the other hand, neither market nor technological uncertainty affected customer orientation. This may signal that firms focus on and are responsive to their customers irrespective of the level of turbulence in their environment.

Technological turbulence was negatively related to mechanical structures and had a positive impact on new product innovation. Hence, rapid technological advancements led firms to become more organic and to innovate. Market turbulence did not exert any significant influence on either organizational structure or new product innovation. On the other hand, both market and technological turbulence had

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indirect effects on new product innovation through either strategic orientation constructs and/or organizational structure. Customer orientation and competitor orientation also preceded new product innovation indirectly through mechanical structures. These findings are contrary to the contingency framework, which proposes that firms adopt less centralized, more organic structures in dynamic, uncertain environments (Covin and Slevin 1988; Bourgeois and Eisenhardt 1988). The results suggest that firms in turbulent environments create internal administrative structures, which allow them to efficiently manage any necessary adjustments. In uncertain environments that demand fast reactions, building consensus may take too much time, thus requiring a continual crisis orientation, a centralized approach and formalized processes. Centralization and formalization may facilitate implementation by reducing conflict and ambiguity, leading to a more uniform response to the changes in the environment (Meyers et al. 1999).

Moreover, the effects of customer and competitor orientation on new product performance were strictly indirect through both organizational structure and new product innovation. The direct paths from customer orientation and competitor orientation to new product performance were nonsignificant. This result generally supports the three-tier contingency model with structure and innovation as complete mediators of the strategy-performance relationship. This finding also confirmed the basic tenet of RBV, that is, firms may achieve superior performance if they can utilize their internal resources and capabilities in distinctive ways (Penrose 1959; Day 1994; Mahoney and Pandian 1993; Grant 1991). This study focused on customer and competitor orientations but an entrepreneurial or technological orientation may play a similar role as complete mediator.

Mechanical structures had a positive impact on new product innovation (contrary to what was expected), and also on new product performance. This may indicate that innovation requires more mechanistic approaches, through which (1) possible conflicts in NPD processes can be prevented, and (2) integrated and harmonious operations can be implemented across functions. Finally, as expected, innovation was positively linked to new product performance.

2.6.2 Moderator: Program Versus Project Level of Analysis

Level of analysis was the first substantive moderator. The findings indicated that it moderated five of the six hypothesized paths, as well as many of the other interrelationships among constructs in the baseline model (such as competitor orientation to organizational structure, for example; see Figure 2-2). New product innovation was positively linked with new product performance regardless of level the analysis. Comparing these patterns, the results exhibit that with the exception of the relationship from mechanical structures and competitor orientation to new product innovation, the strengths of the paths from a program level analysis are greater or equal in rank order to the strengths of the paths from a project level analysis. This conclusion holds for the hypothesized paths as well as for the other interrelationships among constructs in the baseline model.

Splitting the entire sample into program vs. project level groups provided interesting results and signified the influential factors on new product innovation at these two distinct levels. At the program level, both market and technological turbulence are significantly and positively related to new product innovation (at the project level, both were nonsignificant). Therefore, environmental turbulence directly impacts program level new product innovation (which subsequently increases new product performance), supporting the literature that states that rising environmental uncertainty increases the rate and level of innovation required to survive (e.g., Kotabe and Swan 1995). Market turbulence also had an indirect influence on new product performance through competitor orientation. On the whole, it can be concluded that the way for the program to succeed in turbulent markets is monitoring of competitor actions and implementing innovative strategies. Customer orientation also engenders new product innovation at the program level: focus on customers' existing preferences may lead to bold actions and organizational focus on new product innovation. Moreover, customer orientation has a strictly indirect effect on new product performance through new product innovation, as proposed in the principles of RBV theory and the three-tier contingency model of the strategy-performance relationship (as in the baseline model findings). This suggests that a market focus may only engender superior performance for programs through the development or improvement of new product innovation processes and new methods for doing business.

At the project level, customer and competitor orientations as well as organizational structure were influential on new product innovation. Moreover, the impacts of customer and competitor orientations on innovation were partially mediated by organizational structure (i.e., there were direct effects on innovation, as well as indirect effects on innovation through structure). Stating it differently, strategic orientation precedes innovation, both directly and indirectly through structure. Therefore, focus on either customer needs or competitors lead firms to centralize and formalize their processes and activities at the project level. Subsequently, this match between strategic orientations and internal structure engenders new product innovation.

The negative direct linkage between customer orientation and innovation at the project level may be explained if the focus on customers' existing preferences leads to reactive strategies and incrementally innovative products, rather than bold and radical ones. For projects to be perceived as new, exploration and proactiveness may be required; thus innovation may be negatively related to orientations that emphasize the contrary. Finally, market turbulence has a significant influence on new product innovation (and new product performance) only through competitor orientation. Thus, lower level decision processes in new product projects regarding new product innovation are affected by market turbulence only through competitor oriented strategies.

The finding that mechanical structures-new product innovation link is n.s. at the program level but positive at the project level suggests that lower level decision processes and product development activities require formalization and/or centralization. The involvement of top management (i.e., centralization) may be beneficial in reacting in a timely and integrated manner, since conflicts and ambiguities are reduced through a higher locus of control (Miller and Friesen 1982; Meyers et al. 1999). This may lead to faster decision-making, the building of consensus, and enhanced sharing and interaction across different departments. The greater efficiency of formal and/or centralized mechanisms with regards to time and functional disagreement resolution may result in more proficient processes (Olson et al. 1995). A protocol or formal agreement on product performance specification (i.e., a product charter or business plan) may minimize mismatches, conflicts and misunderstandings among team members (Crawford 1984). Therefore, all these factors would further facilitate innovation at the project level.

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2.6.3 Moderator: Firm versus Customer Perspective

Perspective was the second substantive moderator, and the results show that it does indeed moderate five of the six hypotheses (the exception is the positive path from customer orientation to new product innovation). In addition, it moderates six of the 11 other paths comprising the baseline model, for a total of 11 of 17 paths.

As for the directionalities proposed in the six original hypotheses, the results for the firm perspective show that four were supported and positive as hypothesized (the links from customer orientation and technological turbulence to new product innovation were n.s.). Examining the customer perspective, the results of hypothesis testing show three unexpected results. First, market turbulence was positively linked with new product innovation when the firm perspective is taken, but negative when customer perspective is adopted. This suggests that market turbulence may engender new product innovation in the presence of high competitive intensity and frequent shifts in competitor actions and strategies. However, it may decrease innovation when the customer perspective is taken due to rapid product obsolescence and changes in customers' perceptions of innovativeness of product and companies. Similarly, competitor orientation was negatively linked with new product innovation in the 'customer perspective' subgroup, suggesting that monitoring of competitor actions may lead to reactive strategies and incrementally innovative products rather than bold and radical ones. Interestingly, from a firm perspective, mechanical structures were negatively linked with new product innovation; however, it positively affects innovation when a customer perspective is taken. This suggests that more formalization and centralization, which entail efficiency in decision making and in responding to their environment, may enable innovations that are viewed by customers as new in the market.

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In particular, from the customer perspective, the direct path from customer orientation to new product innovation was not significant while its relationship with organizational structure was significant. This supports the traditional strategy-structure link in the contingency framework of IO paradigm. Since organizational structure then influenced new product innovation, it would mean that structure is a complete mediator of the strategy-new product innovation relationship. Lastly, the new product innovation- new product performance has more explanatory power when tested from the customer perspective.

2.6.4 Moderator: Operationalization of the New Product Innovation Construct

One methodological moderator was investigated in this analysis -- namely, operationalization of the innovation construct – and found that it moderate four of the hypothesized paths (the relationships being significant only in the 'categorical single item' subgroup). This demonstrates that measurement can have a major impact on the results of a structural model including one of new product innovation. The paths from customer and competitor orientations and organizational structure to new product innovation were nonsignificant in the case of continuous/multiple measures of new product innovation. Thus, operationalization of new product innovation using a categorical single item appears to exaggerate the strength of these relationships. The technological turbulence - new product innovation and new product innovation-new product performance links were positive and significant regardless of type of operationalization of innovation.

Finally, for three of the baseline model paths of the interrelationships among constructs, the strengths of the paths were different but the signs were the same and both were significantly different from zero (except for market turbulence-organizational structure link, which was n.s. in 'categorical unidimensional' group).

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On the whole, the evaluation of the findings of the two substantive moderators and the six core hypotheses (Table 2-4; five concerned antecedents to new product innovation and one dealt with the relationship between new product innovation and new product performance) provides interesting insights. First, market turbulence is overall not a direct antecedent to new product innovation, but for program or firm level analysis, this relationship may be positive. Second, technological turbulence is overall positively related to new product innovation. But researchers examining particular projects or taking a firm perspective may find this relationship nonsignificant. Third, customer orientation is not overall a direct antecedent of new product innovation, but program research may find this path positive while project research may find it negative. Fourth, competitor orientation is not overall a direct antecedent to new product innovation, however it may be positive for project or firm oriented research. Fifth, mechanical structures encourage new product innovation overall, but not in program level research (n.s.), nor in firm-level analysis. Finally, new product innovation is a direct antecedent to new product performance, and this holds for program or project level research and for firm or customer oriented research. Thus, a synthesis of the innovation research corroborated the premises of the two major theoretical foundations (i.e., RBV and contingency frameworks) regarding the determinants and outcomes of new product innovation.

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CHAPTER 3
MARKET EFFICIENT TECHNOLOGICAL INNOVATION: A DETAILED MODEL WITH MARKETING IMPLICATIONS

3.1 INTRODUCTION

The key to maintaining a competitive position in the marketplace is the ability to repeatedly commercialize successful new products (Griffin and Page 1996). However, due primarily to the escalation of research and development (R&D) costs, rapid and radical technological developments, the shortening of product life cycles and intensified international competition, returns on new product development (NPD) investments are often ephemeral, imitable or not satisfactory (Li 1999; De Brentani 2001). The failure rate of NPD activities is as high as 50% (Wind and Mahajan 1997; Rindfleisch and Moorman 2001), and consequently, internal innovation development is perceived as high risk and difficult (Calantone and Di Benedetto 1988; Song and Montoya-Weiss 1998). The most prevalent reasons for product failures include not only the lack of certain technical product features, but also the inability to meet the customer needs and the poor administration of marketing activities (Cooper and Kleinschmidt 1987; Calantone and Di Benedetto 1988; Atuahene-Gima and Ko 2001). Meanwhile, the existence of environmental threats increases the rate of innovation required to survive (Kotabe and Swan 1995; Rowley et al. 2000). This situation has led firms to invest in internal resources, competencies and activities for developing unique and qualified products, to speed product development, and to improve process efficiency and effectiveness (Olson et al. 1995; Li and Calantone 1998).

Research on NPD projects has focused on the internal factors, i.e., factors under managerial control (Di Benedetto 1999; Montoya-Weiss and Calantone 1994). Resources, capabilities and strategic orientations have been directly linked to position

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positional advantages and performance outcomes. Implementation (or execution) however has generally been neglected in NPD models, but a recent press release claims that the chances of success are enhanced not through investing in brainstorming and experimentation, but through implementation of the generated ideas[5].

The overall objective of this research is to develop and test a model grounded in Day and Wensley's (1988) source-position-performance framework. The model should be useful for both the prediction and the understanding of market efficient innovation development at the project level. This study focuses on how internal factors (i.e., the strategic fit of the project, project related sources of advantages, and implementation proficiency in NPD process) influence positional advantage and performance of the project, and include the role of environmental factors. More specifically, this study investigates whether the strategic fit of the project and project specific advantages have direct impacts on positional advantages and project performance, or an indirect effect mediated by the proficiency in their implementation. The major categories of NPD success determinants identified by Montoya-Weiss and Calantone (1994) in their meta-analysis are included.

Successful innovation may depend on familiarity (i.e., close to the firm's prior customers and technology) and on synergy (fit with the firm's resources and capabilities) (Danneels and Kleinschmidt 2001). In other words, the key is a match between what is needed (i.e., market pull) and what can be developed internally (i.e., technology push) (Day 1994; Li and Calantone 1998). Yet, the operationalization of this match is a frontier issue in innovation research. Therefore, this essay aims to elucidate the notion of 'fit' both from the firm and the customer perspectives. The

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[5] The Key to Innovation: Overcoming resistance, *CIO magazine,* October 15, 2005

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latter has generally been neglected in the prior innovation literature. Moreover, this study develops measures to assess 'fit' through the degree of new resources and capabilities required for the product and the extent of synergy the project entails with the existing structure (as opposed to measures such as "having more than adequate resources" in prior literature) (Song and Parry 1997).

The essay will begin with an overview of the model and by defining model constructs. Hypotheses are then developed and are tested (for direct versus indirect paths and for moderation). The presentation of the results is followed by a discussion of managerial and theoretical implications.

3.2 BACKGROUND AND MODEL OVERVIEW

3.2.1 Theoretical Background

There is a rich stream of literature, employing diversity of perspectives and theories that focuses on the determinants of new product success. Some NPD literature has supported the notion that ongoing success in innovation development depends on implementing the right mix of new product strategy, competencies and climate for innovation (Gatignon and Xuereb 1997; Barczak 1995). Many studies have reported significant positive relationships between new product success and the firm's (1) *marketing resources and skills* (i.e., marketing research, advertising and promotion, and sales force and distribution), and (2) *technical resources and skills* (i.e., R&D, engineering, and production (Cooper 1979; Cooper and Kleinschmidt 1987; Song and Parry 1996; Montoya-Weiss and Calantone 1994). Others analyzed impact of structural elements, such as senior management commitment, effective teamwork and cross-functional integration, on NPD outcomes (Cooper and Kleinschmidt 1995; Ottum and Moore 1997; Ayers et al. 1997; Atuahane-Gima 1996; Song et al. 1997). Furthermore, *positional advantages*, which include measures of product

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product differentiation (i.e., product uniqueness, superiority and quality) and the product's capability to reduce consumer costs or solve a customer problem, were also identified as important determinants of success (Cooper 1979; Kleinschmidt and Cooper 1991; Li and Calantone 1998).

Aside from direct linkages, few studies also analyzed mediating relationships between skills/resources and product advantage (i.e., the impact of quality of execution of NPD process activities; Calantone et al. 1996; Song and Parry 1997). These notions were corroborated in Day and Wensley's (1988) source-position-performance (SPP) framework, which proposes a *mediating* impact of the quality of tactics and implementation on the conversion of superior skills and resources into based on cost and/or product differentiation. Positional advantages in turn impact strategic and financial performance outcomes (Song and Parry 1997; Hult and Ketchen 2001). More specifically, they contend that superior skills and resources are not automatically converted into positional advantages or bring about a certain performance payoff, but are mediated jointly by the quality of tactics, implementation, and timing. Thus, in the NPD context, SPP framework suggest that the performance of a new product innovation in the market is influenced by firm's marketing and technical resources and skills, but only through the quality of NPD process execution.

Furthermore, contingency theory focuses on the *moderating* effect of environmental variables (such as, market potential and competitive intensity) (Covin and Slevin 1989; Atuahene-Gima 1995; Calantone et al. 1997; Song and Parry 1997; Souder and Song 1998; Calantone et al. 2003). Uncertainties in the environment are consequences of market forces and technological advancements, and create impetus for firms to implement changes and invest in internal resources. The challenge is to create a linkage between internal organization and the external environment and to struc

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structure accordingly: managers must allocate their marketing and technical resources and skills efficiently in order to develop what is desired by the market (Di Benedetto 1999). In this study, skills and needs alignment[6] is defined as the fit between project requirements and functional skills (Song et al. 1997; Atuahene-Gima 1996; Cooper and De Brentani 1991); 'fit' implies neither too little nor too much of the appropriate skills (Souder et al. 1997).

3.2.2 Model Overview and Model Constructs

Song and Parry (1997) contend that the SPP framework incorporates much of the recent literature on NPD success determinants, these being: the firm's internal environment (i.e., marketing and technical resources), NPD process factors, product competitive advantage and the competitive environment (Cooper 1979). Moreover, applications of contingency theory notions to NPD have been widely used to analyze the impact of the dynamics of a firm's target market on the effectiveness of its NPD decisions and skills. Accordingly, referring to the SPP and contingency frameworks, constructs scrutinized in this study are: (1) *Strategic fit*: manufacturing, marketing, supply chain, and research and development fit; (2) *project-specific sources of advantage*, such as project climate and project formality (project definition/ protocol); (3) *proficiency in NPD process:* idea development and opportunity analysis, technical assessment and testing, product development activities, speed to market and development costs; (4) *positional advantage of product differentiation*, i.e., degree of customer need met, uniqueness, technology advancement degree, degree of customization and sustainable advantage to the firm; and (5) *market environment*, specifically, market potential and market competitiveness. The *performance outcomes* variables focus on whether the firm's profitability, sales and technical objectives were

[6] Also identified as 'innovation-firm synergy' in the literature (Cooper and Kleinschmidt, 1987; Atuahene-Gima, 1996; Song and Parry, 1996; Danneels and Kleinschmidt 2001)

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met (Hultink and Robben 1995; Cooper and Kleinschmidt 1987; Griffin and Page 1996; Song and Parry 1996; Atuahene-Gima 1995). Table 3-1 presents conceptual definitions of all constructs.

TABLE 3-1. CONSTRUCT DEFINITIONS

Constructs	***Definitions***	
Strategic Fit	indicates the degree to which the internally available marketing, manufacturing, supply-chain and R&D capabilities match the requirements for the new product project.	
	Supply-chain Fit	indicates fit of the project with existing distribution channels, target market and market demand.
	Marketing Fit	signifies the fit in terms of advertising, market research and promotional requirements.
	R&D Fit	incorporates the fit of the project requirements with the existing R&D expertise, the current level of R&D expenditures and R&D personnel training.
	Manufacturing Fit	entails the fit with regards to development requirements, existing plants and technologies.
Project-specific Sources of Advantage	*Project Formality*	refers to the formal design of roles and mechanisms to control and integrate work activities and resource flows.
	Project Climate	Defined as the degree of commitment and collaboration among the members having an active role in the project.
NPD Process Implementation Proficiency	the quality of implementation of marketing activities (i.e., exploration, concept development, market research and analysis); technical activities (i.e., developmental stages of prototype development, prototype testing, manufacturing start-up, pilot and full production); and finally, timeliness and development cost.	
Positional Advantages/ Product differentiation	*Degree of Customer Need Met*	indicates whether the product offers potential for reducing consumer costs and expanding consumer capabilities.
	Product Advantage	denotes whether the product offers improved quality, superior technical performance, and a higher benefit-to-cost ratio.
Project Performance	the overall performance of the project relative to technical, financial and marketing objectives.	
Market Environment	*Market Size*	indicates the attractiveness of a target market in terms of number of potential customers.
	Market Growth	incorporates the demand in the market and the importance to customers of products addressing their needs.
	Market Competitiveness	refers to the concentration and intensity of rivalry within the firm's target market.

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The model is depicted in Figure 3-1. The strategic fit of the project (H1-H4) and project-related sources of advantage (H5-H6) are hypothesized to enhance the proficiency in implementation of NPD processes. NPD implementation proficiency then influences product positional advantages (H7-H11). Note that no direct effect between strategic fit and NPD implementation proficiency is hypothesized (dotted line in Figure 3-1). In other words, NPD implementation proficiency is modeled as a complete mediator of model relationships. Proposing and then testing this complete mediation (versus partial mediation) is one important contribution of this research.

Positional advantages are hypothesized to impact project performance (H12-H13), but these relationships are moderated in part by factors not under the control of decision-makers. Environmental factors (i.e., market potential and market competitiveness) will determine the strength of these paths. In general, this moderation effect is supported by NPD contingency theory; that is, the relationships *from* internal factors *to* new product success are contingent upon environmental turbulence (Atuahene-Gima 1995; Calantone et al. 1997; Souder and Song 1998; Calantone et al. 2003). Testing moderation is a second important contribution of this research. The next sections develop hypotheses of how these constructs relate to one another (Figure 3-1).

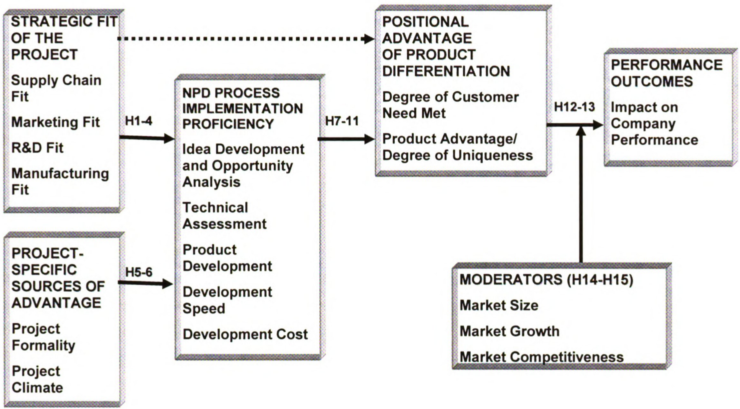
3.3 RESEARCH HYPOTHESES

3.3.1 Sources of Advantage

Successful new products result from processes and activities that allow effective allocation and use of firm's existing resources and capabilities (Gupta et al. 1986; Wheelwright and Clark 1992; Moorman 1995). As per Day and Wensley (1988) suggest, firms may achieve performance superiority through their distinctive competencies in deploying their resources and skills (also see Peteraf 1993; Prahalad

FIGURE 3-1. HYPOTHESIZED MODEL SHOWING MEDIATION BY NPD PROCESS IMPLEMENTATION AND MODERATION BY MARKET FACTORS

FIGURE 3-1. HYPOTHESIZED MODEL SHOWING MEDIATION BY NPD PROCESS IMPLEMENTATION AND MODERATION BY MARKET FACTORS



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and Hamel 1990; Day 1994). Firms utilize their capabilities to cultivate rent-generating resources and match them to external conditions to gain sustainable competitive advantages (Friar 1995; Li and Calantone 1988; Atuahene and Ko 2001). These suggest that firm-specific advantages enable effective NPD processes (Li 1999; Song and Parry 1997). Following Song and Parry (1997), this research distinguishes between *function-specific sources of advantage* (that is, strategic fit of the project across all functions) and *project-specific sources of advantages.*

3.3.1.1 The Effects of Strategic Fit (Function-Specific Sources of Advantage) (H1- H4)

In the NPD literature, resources are classified as: (1) *market resources and activities*, which include preliminary market research, sales projections, market plan development, sales-force, promotion/advertising efforts; and (2) *technical resources and activities*, consisting of production resources, engineering and R&D efforts (Calantone and Di Benedetto 1988). Strong marketing and technical resources enable better performance of marketing and technical activities in particular those related to innovative products, beginning with idea generation and ending with a product launch (Barzcak 1995; Atuahane-Gima 1996; Veryzer 1998; Song and Montoya-Weiss 1998; Calantone et al. 1997).

Accordingly, the literature differentiates between *technological fit*, that is, between the product's technology and the technological skills of the firm and *marketing fit*, that is, between marketing, salesforce and distribution requirements and the available skills (Cooper and Kleinschmidt 1987; Song and Parry 1996, 1997). 'Strategic fit' in this research includes all functions (i.e., marketing, manufacturing, supply-chain and R&D) that play a role in innovation development. The definition is based on Venkatraman's (1989) conceptualization of "fit as matching"'[7], in which "fit is a theoretically defined match between two related variables" (p 430).

In other words, 'strategic fit' is defined as the degree to which the internally available marketing, manufacturing, supply-chain and R&D capabilities match the requirements of the new product project (also refer to Table 3-1). Accordingly, fit is evaluated based on the extent to which the capabilities available for developing a product technology match its requirements or important characteristics. More specifically, supply-chain fit taps the suitability of the project to the distribution channels, target markets and demand forecasts that the firm employed in previous development projects. Marketing fit signifies the match of the current project to existing advertising, market research and promotional activities and skills. R&D fit incorporates the match in terms of R&D expertise, the current level of R&D expenditures and R&D personnel training. Finally, manufacturing fit entails fit with regards to development requirements, existing plants and technologies. Overall, prior research has shown that projects considered successful entailed higher synergy (Cooper 1979; Zirger and Maidique 1990). Therefore, if a firm can draw on its existing marketing, manufacturing, supply-chain and R&D competences to execute the NPD project, it is more likely to be successful.

Technological innovations require new skills, processing abilities and systems and entail less synergy with prior technologies and practices (Ottum, and Moore 1997; Sethi 2000; Veryzer, Jr. 1998; Song and Montoya-Weiss 1998; McDermott and O'Connor 2002). Highly innovative products represent significant threats and uncertainties since their degree of fit with the existing knowledge structures and with the design, manufacturing and marketing practices of the firms is likely to be very

[7] 'Fit as matching' is derived based on underlying theory without reference to a criterion/ performance variable, although subsequently, its effect on a set of criterion variables could be examined. (Venkatraman 1989, p. 430).

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low. Lack of fit requires shifts in market understanding and changes in new processing abilities and systems (McDermott and O'Connor 2002). On the other hand, the adoption and development of products that build on the firm's existing firm capabilities engender higher success (Day and Wensley 1988; Song and Parry 1996, 1997). A close fit enhances the project team's ability to gather and interpret market and competitive information (Song et al. 1997). This generates greater insight for idea generation and screening and into business and market opportunity analysis (Calantone et al. 1996; Cooper 1979). Accumulated expertise leads to efficient technical assessment and development and effective product commercialization, permitting the efficient use of technical and marketing resources.

Cooper and Kleinschmidt (1987) compared success rates among new product types based on project fit and familiarity and found only modest differences; they concluded that synergy may not be particularly significant in success/failure prediction. Unfortunately, they did not distinguish between different dimensions of fit. Song and Parry (1996; 1997) incorporated both technological and marketing dimensions of synergy, both of which exhibited significant positive effects on performance through their influence on the proficiency of development activities. Increases in a project's fit led to improvements in the quality of implementation during the NPD process (Song and Parry 1997).

Moreover, Ali et al., (1995) and Kessler and Chakrabarti (1999) found that firms pursuing to develop a unique and differentiated product took longer time and that the amount of change attempted in a project is negatively related to speed. Since radical changes and projects entail greater complexity, risk and uncertainty, the information needs, workloads, and the number of people involved in projects are greater, and thus the cost of development is higher (Kessler and Chakrabarti 1999).

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When the firm relied on technology never previously used, development activities such as idea development and screening, technical development, and strategic planning need to be executed more effectively and timely (Lee and O'Connor 2003; Song and Montoya-Weiss 1998). In light of these findings, higher fit of a development project with the firm's existing resources and skills is expected to decrease the amount of reinterpretations and reconfigurations of prior experiences while executing the NPD process. This signifies proficient, timely and less costly execution of NPD process activities such as idea development, technical assessment and production.

Thus, fit vis-à-vis *supply chain, marketing, R&D* and *manufacturing* should lead to more proficient activities, increased speed and decreased cost. However, supply-chain and market fit should not influence technical assessment proficiency since the resources associated with these functions are not employed in this stage. Therefore:

H1. Supply chain fit is positively related with proficiency in (a) idea development and opportunity analysis (b) product development, and (c) development speed, but (d) is negatively related with development cost.

H2. Marketing fit is positively related with proficiency in (a) idea development and opportunity analysis, (b) product development, and (c) development speed, but (d) is negatively related with development cost.

H3. R&D fit is positively related with proficiency in (a) idea development and opportunity analysis, (b) technical assessment, (c) product development and (d) development speed, but (e) is negatively related with development cost.

H4. Manufacturing fit is positively related with proficiency in (a) idea development and opportunity analysis, (b) technical assessment, (c) product development and (d) development speed, but (e) is negatively related with development cost.

Day and Wensley (1988) argue that information resources and skills are only 'means to an end' and that competitive advantages and performance outcomes are what managers are mostly concerned about. Thus, these sources of advantages apply to activities, and these activities should be implemented effective and efficiently.

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They also advocate that the role of implementation in models of the conversion of advantages into payoffs has generally been neglected in the marketing literature (Day and Wensley 1988, p. 5). In innovation research, few studies test the impact of implementation proficiency or quality of NPD process activities on the extent to which sources of advantages lead to performance advantages. As an illustration, Calantone, Schmidt, and Song's (1996) results indicate that proficiency in marketing and technical activities mediate relationships between marketing, R&D, engineering and technical resources and skills and new product success. The proficiency of technical and market-oriented activities allow firms to ensure that they employ their functional expertise most effectively; for example, firms do not introduce technologically advanced products for technology's sake (Barzcak 1995).

Relevant information resulting from marketing activities about the market, consumer preferences, competitive products and strategies, can be utilized in more adept decision-making (such as how much promotional or distribution support to render, what product concepts to bring to prototype, or what features to build into the final product) (Calantone and DiBenedetto,1998). According to the NPD literature, gathering information on the quality of current competitive products brings about opportunities to improve firms' own product offerings (Song and Parry 1996). Technical development proficiency is also strategically important since R&D of new products can shorten cycle and lead times of entry, bringing about positional advantages. Consequently, as Day and Wensley (1988) suggest, marketing and technical development proficiencies, speed and cost can be interpreted as 'mediating events' between the firm's internal resources (advantages) and its (external) competitive advantages (p. 6). Thus, sources of advantage are expected to influence positional advantages *only through* the proficiency of NPD process activities.

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H1. NPD process implementation proficiency completely mediates the relationship between supply chain fit and (f) the degree of customer need met and (g) product advantage.

H2. NPD process implementation proficiency completely mediates the relationship between marketing fit and (f) the degree of customer need met and (g) product advantage.

H3. NPD process implementation proficiency completely mediates the relationship between R&D fit and (f) the degree of customer need met and (g) product advantage.

H4. NPD process implementation proficiency completely mediates the relationship between manufacturing fit and (f) the degree of customer need met and (g) product advantage.

3.3.1.2 The Effects of Project-Specific Sources of Advantage (H5, H6)

Teamwork, top management support and commitment, formal process use and cross-functional integration are cited among important determinants of NPD success (Song et al. 1997; Cooper and Kleinschmidt 1987; Veryzer 1998). Workman, Homburg, Gruner (1998) classifies organizational dimensions in two categories, that is, *structural* and *nonstructural dimensions*. *Structural dimensions* comprise aspects of organizational structuring, such as reporting relationships, and bureaucratic dimensions including formalization, and standardization. *Nonstructural dimensions* consist of the use of cross-functional teams and organizational forms that are more adapted to rapidly changing environments (Achrol 1991; Day 1994; Germain et al. 1994; Olson et al. 1995; Hurley and Hult 1998; Kahn 1996). Accordingly, project-specific sources of advantage are categorized into two groups, *project formality* (structural dimensions) and *project climate* (nonstructural dimensions).

In the studies linking organizational aspects to new product success (Jassawalla and Sashittal 1998; Song et al. 1998; Song et al. 1997; Ottum and Moore 1997; Olson et al. 1995; Li 1999; Ayers et al. 1997; Maltz and Kohli 1996; Adams et al. 1998; Souder et al. 1998), it is generally agreed that in order to effectively coordinate the NPD process, structures must encourage the sharing of information and other resources across functional areas, and provide mechanisms for decision-making and conflic

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and conflict resolution. Referring to Olson et al.'s (1995) definition of structure, *project formality* is conceptualized in this study as the formal design of roles and mechanisms to control and integrate work activities and resource flows (p.49). Particularly, the stage-gate (phase review) process of Cooper, a well-known and enduring of mechanisms used to attain these goals, provides a formal and sequential flow of phases.

Veryzer (1988) found that half of sample firms followed a formal and consistent process for managing discontinuous NPD efforts. However, in general, more innovative firms are believed to be loosely structured, implementing flexible coordination mechanisms (Calantone et al. 1995). It has generally been advocated that in order to be efficiently and effectively executed, highly uncertain tasks required structures characterized by fluidity and flexibility in the task execution, decentralized decision-making and few formal procedures. Moreover, as Mintzberg (1979) and others point out, mechanistic structures restrict the ability of functional specialists to communicate directly and share resources with one another, inhibit communication, creativity and input from diverse sources (Covin and Slevin 1989; Miller et al. 1988). The uncertain tasks in idea generation and opportunity analysis phases may not be effectively pursued in mechanistic and bureaucratic structures. Informal and flexible structures, on the other hand, provide individuals greater autonomy to decide and act, and lead to more exchange of disperse ideas (Dewar and Dutton 1986; Hage and Dewar 1973; Tatikonda 1999). Consequently, flexibility may decrease perceived uncertainty related to technological change, enhance the receptivity to new technology, and facilitate creativity and idea generation (Utterback and Abernathy 1975; Griffin and Hauser 1996; Knight 1987; Matsuno et al. 2002; Sethi et al. 2001).

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In contrast, the greater efficiency of formal mechanisms with regards to time and functional disagreement resolution may result in more proficient process activities (Olson et al. 1995). Ayers et al. (1997) assert that such formalized procedures can regulate the tasks people perform and assign role responsibilities, and thus facilitate input and involvement from other departments whenever necessary. Moreover, following a formal process coupled with clear time based goals and a clear product concept leads to decreased cycle time and development costs and increased success of the products (Cooper and Kleinschmidt 1987, 1995; Griffin 1997; Kessler and Chakrabarti 1999). Therefore, cost and time efficiencies may be achieved by formalizing development activities, whereas information sharing and creativity result from keeping the process open and flexible. As Johne and Snelson (1988) assert, idea generation requires freedom of thought and autonomy for action, whereas the implementation of NPD process requires unified purpose. To achieve balance between formality versus flexibility, Johne (1984) suggests use of informal and unstandardized procedures in the initiation phase but more formal and rigid controls as the development reaches its commercialization. Thus:

H5. Project formality is related with proficiency in (a) idea development and opportunity analysis negatively; (b) technical assessment positively; (c) product development positively; (d) development speed positively and (e) development cost negatively.

By *project climate*, this research refers to the degree of commitment and collaboration among the members playing an active role in the project. Song and Parry (1997) define *internal commitment* as the existence of a group of individuals (including members of top management, project leaders, project team members, and other product champions) who push a development project forward toward successful execution a

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execution and commercialization (Johne and Snelson 1988; Clark and Fujimoto 1990; Griffin and Hauser 1996). Teams can be composed of individuals from a variety of functional areas, such as marketing, research and development (R&D), manufacturing, and purchasing (Sethi 2000). Visionary leaders and committed team members ensure that the project is viewed as high priority and that operating procedures are executed without any impediments (Souder et al. 1997; Lee and Na 1994; Le and O'Connor 2003). Top management and project leaders ensure the flow and adequacy of resources, motivate team members, reduce delays and costs by providing timely decisions, and facilitate the assimilation and application of technical and market-oriented knowledge (Ali et al. 1995; Kessler and Chakrabarti 1999). These advantages raise the level of marketing and technical development proficiency, increase speed, and improve cost structure.

Cross-functional integration or collaboration is defined as the interdependency, information sharing and cooperation among departments that is required to achieve unity of effort (Song and Parry 1997; Ayers et al. 1997; Souder et al. 1998; Li 1999; Olson et al. 2001). It is generally operationalized in terms of communication, transfer of information, and/or the degree of cohesion across functional departments (Ottum and Moore 1997; Song et al. 1997). Collaboration integrates knowledge of what is needed in the market with knowledge of how to create a product to meet that need (Griffin and Hauser 1996; Song et al. 1997; Li 1999). Other benefits of cross-functional integration include information gathering and dissemination skills affecting product design and launch (Song and Parry 1997), the generation of new product ideas, the development of effective sales forecasts, product testing and modifications. A multifunctional team promotes cross-fertilization of ideas and iterative learning, which contributes to the establishment of common goals. As Calantone, Vickery and Droge (1995) assert, a time-based NPD advantage generally involves the combination of inputs from various functional areas. Thus, collaboration during the NPD process plays an important role in improving the quality of product development execution as well as enhancing the firm's market position through decreasing development time and costs (Norton, Parry, and Song 1994). Consequently, it is hypothesize that:

H6a. Project climate is positively related with proficiency in (a) idea development and opportunity analysis; (b) technical assessment; (c) product development; and (d) development speed; but (e) negatively related with development cost.

3.3.2 NPD Process Implementation Proficiency

3.3.2.1 The Effects of NPD Activities (H7, H8, H9)

NPD activities are defined as 'value-generating subprocesses' that aim to accomplish a functional commercial benefit to the customers (Cooper and De Brentani 1991; Kleinschmidt and Cooper 1991; Song et al. 1998). Development projects progress though a series of stages, such as opportunity identification, concept development, product design, process design and commercialization (Atuahene-Gima 1996; Barczak 1995; Calantone et al. 1997). 'Stage gate' systems, originally developed by Dr. Robert G. Cooper, divide the development process into a set of stages, each composed of a group of activities (Griffin 1997). The early stages consist of *idea development and screening* (that is, generation and evaluation of potential solutions to the identified strategic opportunities), *business and opportunity analysis* (activities that involve converting new product ideas into well-defined product attributes that meet market demand) and *technical assessment* (designing, engineering, testing and building desired physical product entity) (Veryzer 1998; Song and Montoya-Weiss 1998). Thus, early in the process, the concept is evaluated with respect to the market opportunity and customer needs. The concept is then refined, its technical feasibility is examined, and the design phase begins (Griffin and Hauser 1996; Meyers et al. 1999).

Many studies identify different NPD activities as important determinants of innovation success (Cooper and De Brentani 1991; Cooper and Kleinschmidt 1987; Dwyer and Mellor 1991; Song and Parry 1996, 1997; Di Benedetto 1999; Veryzer 1998; Souder and Jenssen 1999). Studies report positive and significant correlations between new product success and development proficiency measures, which include idea generation, market research, predevelopment planning, concept definition and evaluation, technical assessments, product development and test-marketing (Cooper 1979; Song and Parry 1996). Cooper's (1979) results point to proficiencies in conducting marketing and development activities as important discriminators of new product success and failure.

In the early stages of the process, product ideas are generated based on internal sources and market needs. After screening of the potential projects, a priority list is generally formed and concept development is initiated. The concepts are evaluated with respect to market opportunities and customer needs, followed by an assessment of their technical feasibility. Technical assessment generally focuses on the technical attributes of the product. After the concepts are refined based on these evaluations, production start-up instigated (Griffin and Hauser 1996; Griffin 1997). Product development is believed to be less costly and the firms are more likely to exploit market opportunities if trivial or risky projects are eliminated in advance through tests of their technical performance and marketing potential. Calantone and Di Benedetto (1998) found that superior performance with respect to marketing and market intelligence activities allow the firm to perform technical activities better and influence the ultimate positional advantage. Consequently, proficient activities (i.e., idea generation, technical assessment and product development) should enhance an innovation's technical performance while idea generation and product development activities should improve the degree to which it is superior in meeting market demand. Thus:

H7. Proficiency in idea generation and opportunity analysis is positively related to (a) the degree of customer need met and (b) product advantage.

H8. Proficiency in technical assessment is positively related to product advantage.

H9. Proficiency in product development is positively related to (a) the degree of customer need met and (b) product advantage.

3.3.2.2 The Effects of Development Speed and Development Cost (H10, H11)

NPD speed (or cycle time) and costs have consistently been considered critical competitive variables. Ali et al. (1995) and Kessler and Chakrabarti (1999) define speed to market (or cycle time) as the time elapsed between initial stages (that is, the beginning of idea generation) to the ultimate commercialization. Stating it differently, achieving speed refers to accelerating activities that occur throughout the development process. Product obsolescence necessitates timely introduction and low cost production of new products. Most buttress that speed in innovation development engender success since firms can reap pioneering advantages by being prompt and timely in exploiting opportunities and/or responding to their environments (Kessler and Chakrabarti 1999). Consequently, one would expect that the faster and the less costly a firm can develop a new product, the greater the likelihood it can reap pioneering advantages and higher returns. This brings us to:

H10. Development speed is positively related to (a) the degree of customer need met and (b) product advantage.

H11. Development cost is negatively related to (a) the degree of customer need met and (b) product advantage.

3.3.3 Positional Advantages

Positional advantages can be obtained through lowering of costs and creating value to customers (Day and Wensley 1988). According to research on the adoption and diffusion of innovations, typically analyzed according to Rogers' (1976) scheme, the relative advantage, compatibility with potential adopters, the trialibility and observability of new products all exert positive effects on successful adoption (Gatignon and Robertson 1989). Meanwhile, firms creating superior, unique and novel products should enjoy competitive advantage in the market and hence commercial success (Friar 1995; Gatignon and Xuereb 1997; Atuahene and Ko 2001). They point to the importance of products that, in the eyes of the customer, provide high performance and economic advantages (benefit to cost ratio) (Cooper and Kleinschmidt 1987; Montoya-Weiss and Calantone 1994; Song and Parry 1996; Souder et al. 1997). Hence, the market leverage gained via these products should be assessed based on dimensions addressing both technologies (i.e., product advantage) and markets (i.e., the degree of customer need met; Firth and Narayanan 1996).

3.3.3.1 The Effect of Degree of Customer Need Met (H12)

Products that better match consumer needs are more likely to be successful in the market (Cooper and Kleinschmidt 1987; Maidique and Zirger 1984). Some also emphasize a product's potential for reducing consumer costs and expanding consumer capabilities (Bhoovaraghavan et al. 1996; Sengupta 1998; Michael et al. 2003; Hultink and Robben 1999). Day and Wensley (1988) assert that such products offer greater potential for customer satisfaction and loyalty, and thus should entail higher performance. Consequently,

H12. Degree of customer need met is positively related with project performance.

3.3.3.2 The Effect of Product Advantage (H13)

Product advantage refers to the degree to which the new product provides customers with improved quality, superior technical performance and higher benefit-to-cost ratio (Calantone and Di Benedetto 1988; Song and Parry 1997). Montoya-Weiss and Calantone (1994) and Langerak et al.'s (2004) results exhibit a positive relationship between product advantage and new product performance, while Henard and Szymanski's (2001) meta-analysis identified product advantage as the most important factor to explaining the success of the new products. Moreover, Cooper and Kleinschmidt (1987) and others have found a positive relationship between new product success and measures of product advantage, such as the presence of unique features and product quality (Song and Parry 1996; Souder et al. 1997; Sethi 2000). Thus, it is posited that:

H13. Product advantage is positively related with project performance.

3.3.4 Market Environment (H14-H15)

Cooper and Kleinschmidt (1987) describe an attractive market for a new product as one with a high growth potential, large size, weak competition and lacking intense competitive activity. The success of a newly introduced product cannot be adequately explained without considering the market dynamics (Montoya-Weiss and Calantone 1994; Calantone et al. 1997). As mentioned, contingency theory takes into account the influential internal and external factors on the conduct of firms' business and competitive actions. This framework posits that firms gain competitive advantage if their internal environment (i.e., strategies, resources and internal capabilities) are matched appropriately to environmental opportunities (Porter 1981; Mahoney and Pandian 1993). The contingency approach focuses on how firms structure and construct their culture and strategies due to the environmental turbulence they face;

this determines the extent to which these intra-organizational factors translate to performance outcomes (Prescott 1986; Atuahene-Gima 1995; Calantone et al. 1997; Souder and Song 1998; Calantone et al. 2003; Han et al. 1998). Day and Wensley (1988) also argue that the conversion of a positional advantage into performance outcomes is contingent upon other factors. Consequently, in this study, it is propose that the project's environment (that is, market size, potential and competitiveness) moderates the relationship between positional advantages (i.e., either the degree of customer need met or product advantage) and project performance.

Market potential signifies the attractiveness of a target market, that is, its *size* and *growth* (Song and Parry 1997). A large market with a high growth potential should amplify the rewards incurred from the product's quality, performance, or benefits perceived by the market (Cooper 1979; Cooper and Kleinschmidt 1987; Song and Parry 1994). Song and Parry's (1997) results indicate that the relationship between product differentiation and relative product performance was moderated by increases in market potential. Thus, referring to contingency theory, the linkages from the degree of customer need met and product advantage to project performance is predicted to be strengthened in markets that are of larger size and higher growth.

Market competitiveness, on the other hand, refers to the intensity and concentration of rivalry within the firm's target market. When market competitiveness is high, a new product with perceived benefits and advantages should elicit aggressive responses from competitors, which could adversely affect project performance (Cooper 1979; Debruyne et al. 2002). Despite the significant and negative correlation obtained between market competitiveness and new product success in Cooper (1979) and Song and Parry's (1994) studies, other studies have failed to find a significant relationship between market competitiveness and new product success (e.g., Cooper and Kleinschmidt 1987). Debruyne et al. (2002), on the other hand, argued that competitors fail to respond to radical innovations and to new products that employ a niche strategy, but react if a new product can be assessed within an existing product category. Calantone, Schmidt, Di Benedetto's (1997) results also show that a hostile competitive environment increased the impact of NPD proficiency. The degree to which meeting customer needs lead to success may be diminished by the rivalry in the market, but product advantage should bring about higher returns as competition intensifies. Thus:

H14. The positive relationship between the degree of customer need met and project performance should be significantly stronger as (a) market size increases, (b) market growth increases, but weaker (c) market competitiveness increases.

H15. The positive relationship between product advantage and project performance should be significantly stronger as (a) market size increases, (b) market growth increases and (c) market competitiveness increases.

3.4 METHODOLOGY

3.4.1 Sampling Frame

The sampling frame, obtained from a commercially supplied list, comprised 600 North American firms operating in chemical, biochemical and pharmaceutical industries. Respondents to the mail survey included product line managers, NPD managers and product managers. Each firm was contacted by phone to encourage the participation by the correct key informant prior to sending the survey. Respondents provided information for their latest new product project (on the market five years or less) that involved the development of any product that has not been previously produced or sold by their company or division. The respondents were also asked to identify these projects as successes versus failures (Cooper and Kleinschmidt 1987).

The mailing of the surveys generated 306 usable questionnaires yielding a response rate of 51%. The descriptive statistics describing the sample of participating firms are provided in Table B-2. A comparison of project success (success vs. failure) and indicated firm characteristics (i.e., firm size, annual sales, export sales, percentage sales and profits generated by new products) were performed to identify any significant difference that may exist between successful and failed projects. The *t*-tests revealed no significant differences at .05 level (except for R&D expenditure) indicating lack of serious problems resulting from firm demographics. Majority of the respondents were employed in the marketing function (N=130), followed by R&D department (N=110) and general management (N=18).

3.4.2 Analysis

The proposed model was examined using partial least squares analysis (PLS). PLS was selected to test the hypotheses since it is intended for causal-predictive analysis in explaining complex relationships (i.e., when the number of indicators are beyond 40 or 50), factors that are collinear, and/or interaction effects (Fornell and Bookstein 1982; Hulland 1999). The objective of PLS, first proposed by Wold (1963), is the explanation of variance by ordinary least squares (OLS) (Barclay 1991). OLS estimates each of the latent variables as an exact linear combination of its indicators, with the goal of maximizing the explained variance for the indicators and latent variables. Following a series of OLS analyses, PLS optimally weights the indicators such that a resulting latent variable estimate can be obtained. Accordingly, it avoids the indeterminacy problem and provides an exact definition of component scores. Because the iterative algorithm generally consists of a series of OLS analyses, identification is not a problem for recursive models nor does it presume any distributional form for measured variables. PLS is considered superior to other techniques (such as factor analysis, multiple regression and path analysis) because it tests the measurement model within the context of a structural path model (Keil et al. 2000). Chin (1998) contended that PLS, compared to other path-analytic techniques, required minimal demands on measurement scales, sample size, and residual distributions.

3.5 RESULT: MEASUREMENT VALIDATION

The PLS model was analyzed in two stages: (1) the assessment of the unidimensionality, reliabilities and validity of the measurement model, followed by (2) the evaluation of the structural path model. Using Hulland's (1999) guidelines, the adequacy of the measurement model was tested by examining: (1) unidimensionality of the constructs, (2) scale reliabilities, and (3) convergent and discriminant validity. Principle component analysis with varimax rotation was first performed to assess the unidimensionality of each construct. Only the first eigenvalue was greater than one; this supported their unidimensionality (Gerbing and Anderson 1988).

The scale reliability of the measures was evaluated by examining the loadings of the items on their corresponding factors (Fornell and Larcker 1981; Hulland 1999). PLS revealed high loadings (> .63) for all scales in the measurement model, which provided support for their reliability (see Table 3-2) (Churchill 1979; Peter 1979; Bagozzi and Yi 1988; Fornell and Bookstein 1982). Convergent validities were then assessed by calculating their internal composite reliabilities (ICR)[8] and average variance extracted (AVE)[9] (see also Table B-3) (Fornell and Larcker 1981; Chin 1998). These reliability coefficients ranged from 0.74 to 0.91, providing strong support for each latent variable (Nunnally 1978; Gerbing and Anderson 1988; Bagozzi and Yi 1988). The reported AVE's in PLS were acceptable (i.e., at least .58),

[8] ***Internal Composite Reliability (ICR)*** is similar to Cronbach's alpha, however, does not assume tau equivalency among the measures and assumes all indicators are equally weighted. The ICR statistic represents a ratio consisting of the squared total of the variance explained for each manifest variable divided by the sum of the squared total of the variance explained plus the total of the unexplained variance. An ICR greater than .7 is considered adequate to achieve sufficient reliability.

[9] ***Average Variance Extracted (AVE)*** attempts to measure the amount of variance that a latent variable captures from its indicators relative to the amount due to measurement error. The ratio is the total of variance explained divided by the sum of variance explained and variance unexplained. An AVE greater than .5 is considered adequate in the sense the manifest variables measure what is intended.

showing strong support for substantial explained variance in each dependent variable (Fornell and Larcker 1981; Chin 1998). Finally, discriminant validity was evaluated by testing whether the AVE of each construct (the average variance shared between a construct and its measures) was greater than the shared variance between the construct and other constructs in the model (square of correlation between the two constructs) (Fornell and Larcker 1981; Hulland 1999; Agarwal and Karahanna 2000). The AVE's of the constructs were all higher than their shared variances, and thus, all constructs in the model exhibited discriminant validity.

All scale items are shown in Table 3-2[10]. All items were specified as reflective indicators comprising 11-point semantic differential scales loading on their respective constructs. Fit measures were gauged using multiple item scales except for R&D fit, which was measured using a single item scale (see Table 3-2 and Appendix B). Supply chain fit incorporates four items, i.e., the degree to which the project requirements match with existing distribution capacity, target market, customer needs and existing channels (ICR=.87). The marketing fit construct consists of three items encompassing fit with advertising, promotion, and market research activities (ICR=.85). Manufacturing fit was measured using four items that gauge fit regarding existing technologies, plants, manufacturing and development skills (ICR=.91). The three items for project climate assessed cross-functional integration, the extent to which a multidisciplinary team approach was employed, and team commitment (ICR=.86). Similarly, the five items for project formality include the formality of NPD process and the degree to which target market, product concept, benefits, positioning and features are defined (ICR=.91).

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[10] The PLS construct level statistics (AVE and ICR) indicate a fit for the manifest variables to the latent variables', however, they do not give an indication of overall model fit or how the latent variables co-vary with one another.

TABLE 3-2. MEASURES AND LOADINGS

SUPPLY CHAIN FIT	ICR=.87; AVE= .62; sqrt AVE=.79
Distribution capacity	0.87
Target market	0.67
Customer need similarity	0.73
Existing channels	0.86
MARKETING FIT	ICR=.85; AVE= .66; sqrt AVE=.81
Advertising	0.83
Market Research	0.82
Promotional activities	0.78
R&D FIT	Single item NA
MANUFACTURING FIT	ICR=.91; AVE= .72; sqrt AVE=.85
Manufacturing	0.82
Plant	0.85
Development	0.93
Technology	0.79
PROJECT CLIMATE	ICR=.86; AVE= .68; sqrt AVE=.82
Cross-functional integration	0.84
Team for entire project	0.89
Team commitment	0.73
PROJECT FORMALITY	ICR=.91; AVE= .64; sqrt AVE=.80
Target market defined	0.81
Product concept defined	0.80
Benefits defined	0.82
Positioning defined	0.85
Features defined	0.84
Formal NPD process	0.63
IDEA DEVELOPMENT	ICR=.85; AVE= .60; sqrt AVE=.77
Initial screening	0.80
Preliminary market assessment	0.82
Detailed market study	0.72
Business analysis	0.74
TECHNICAL ASSESSMENT	ICR=.85; AVE= .65; sqrt AVE=.81
Preliminary technical assessment	0.86
Customer tests	0.70
In-house product testing	0.86
PRODUCT DEVELOPMENT	ICR=.82; AVE= .69; sqrt AVE=.83
Pilot production	0.78
Production start-up	0.88
DEVELOPMENT SPEED	ICR=.88; AVE= .79; sqrt AVE=.89
Time efficiency	0.87
Adherence to time schedule	0.91
DEVELOPMENT COST	Single item NA
CUSTOMER NEED MET	ICR=.90; AVE= .69; sqrt AVE=.83
Benefit importance to customer	0.86
Benefits easy to communicate	0.76
Perceived as useful	0.89
Visible benefits	0.82
PRODUCT ADVANTAGE	ICR=.88; AVE= .65; sqrt AVE=.81
Superiority	0.89
Relative product quality	0.94
Unique attributes	0.72
Impact on customer	0.64
IMPACT ON PERFORMANCE	ICR=.88; AVE= .71; sqrt AVE=.84
Technical success rating	0.80
Profitability rating	0.90
Sales/profit impact on company	0.84
MARKET SIZE	Single item NA
MARKET GROWTH	Single item NA
MARKET COMPETITIVENESS	Single item NA

NPD process proficiency measures were gauged using multiple item scales except for development cost, which was measured using a single item scale. Idea development proficiency incorporated competence in initial screening, preliminary market assessment, detailed market study, and business analysis (ICR=.85). Technical assessment proficiency includes skills in preliminary technical assessment, customer tests, and in-house product testing (ICR=.85). Product development proficiency items assess pilot production and production start-up skills (ICR=.82). Development speed is evaluated by time efficiency of the project execution and the team's adherence to the time schedule (ICR=.88).

The three 'customer need met' items were developed to assess the degree to which the product provided benefits important to the customer, easy to communicate, visible and perceived as useful (ICR=.90). Product advantage was measured by the degree to which the product was superior relative to other competitor products, had unique attributes, high relative quality and great potential to bring about impact on customers (ICR=.88). To measure project performance, respondents rated the project's profitability, technical success and sales/ profit impact on their company on three items (ICR=.88).

The moderating market environment factors were each measured using single measures: market size was assessed by asking the respondents the number of potential customers in their main target market, whereas market competitiveness was measured by the number of competitors. Market growth was measured using a 11 point semantic differential item indicating the pace of growth in the market (i.e., negative growth vs. fast growth; e.g., 15% per year). Firm size (by incorporating the natural logarithms of annual revenue) and number of employees were employed as control variables (due to the large variance of the reported answers).

3.6 RESULTS: STRUCTURAL MODEL

The PLS construct level statistics (AVE and ICR, explained above) indicate a fit for the manifest variables to the latent variables; however, they do not give an indication of overall model fit or how the latent variables co-vary with one another. Since PLS is designed to maximize prediction, the emphasis is put on explanatory power to maximize variance in the dependent variables based on the independent variables in the model. Consequently, the degree to which PLS models accomplish this objective is evaluated based on prediction oriented measures (R^2) (instead of covariance fit as is attempted in SEM) (Fornell and Cha 1994; Hulland 1999). Tables 3-3, 3-4, 3-5, 3-6, 3-7 and 3-8 show the results for the hypothesized model: the path estimates along with an indication of the significance of the hypotheses. Finally, Table 3-9 presents the variance explained for each dependent construct.

Since the data comprised responses from single informants, common method variance was statistically controlled for using two techniques (Podsakoff et al. 2003): first, Harman's one-factor test, i.e., a test on whether a factor analysis yields a single factor when all constructs are analyzed, was conducted. The results of principal components analysis without rotation exhibited 12 factors with eigenvalues greater than 1.0 accounted for approximately 75% of the total variance. Thus, the results of the Harman's one factor test indicated that the variables did not form only a single higher-order factor. Second, following Podsakoff et al.'s (2003) and Netemeyer et al. (1997)'s guidelines, a 'same-source' factor (i.e., single-common-method-factor) was incorporated to the indicators of all constructs in the model. This model in which the same-source factor loadings were estimated freely was compared to a constrained model in which the loadings of all indicators to the same source were set to zero. The difference between these models represents a significance test of whether there exists an effect of a common-method factor. A confirmatory factor analysis yielded a χ^2 difference of 674.2 (df = 45, p<.01). Hence, this significant difference between the two models suggested that a same source factor was evident. Following this, a path analysis through PLS was conducted for the unconstrained model to investigate the effects of common-method variance on the indicator loadings and model paths. Despite this, the indicator loadings to their theoretical factors[11] as well as the paths among the model constructs[12] all remained significant with trivial attenuation (or inflation) (see Appendix B Table B4- Table B-10). On the whole, considering the weak points of all possible techniques to assess method biases (Podsakoff et al. 2003), it was concluded that there was *some* effect of common methods variance, but the results remained consisted when this effect was controlled for.

3.6.1 Results for H1- H4. a-e (Please refer to Table 3-3)

Supply chain fit was significantly positively related to idea generation proficiency (γ_{1a} =.087, p<.10), product development proficiency (γ_{1b} =.364, p<.01), development speed (γ_{1c} = .121, p<.10), providing support for H1a, H1c and H1d. Contrary to what was expected, it also increased development cost (γ_{1d} = .160, p<.05), thus H1e was rejected. The results also showed that marketing fit exerted a negative impact on idea development (γ_{2a} = -.164, p<.05) and development cost (γ_{2d} = -.154, p<.05). Therefore, H2a was rejected whereas H2d was supported. Marketing fit, however, did not have any significant effect on product development (γ_{2b} = .055, n.s.) or development speed (γ_{2c} = .055, n.s.; not providing support for H2b or H2c). R&D

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[11] Except for the loadings of product advantage, which were slightly inflated.

[12] Except for marketing fit-product development, marketing fir-product advantage, product development-project formality, idea development-customer need met, idea development-product advantage, development cost-customer need met and moderating effect of market size on product advantage - project performance.

TABLE 3-3. RESULTS (H1- H4. a-e)

Strategic Fit / NPD Process Proficiency		H1 Supply Chain Fit		H2 Marketing Fit		H3 R&D Fit		H4 Manufacturing Fit	
(a)	Idea Development and Opportunity Analysis	H1(a):	+	H2(a):	+	H3(a):	+	H4(a):	+
		γ_{1a} =	0.087 (t=1.4428)	γ_{2a} =	-0.164 (t= -3.3175)	γ_{3a} =	-0.014 (n.s.)	γ_{4a} =	0.101 (t=2.0392)
		Conclusion:	Support	Conclusion:	Reject	Conclusion:	Not Support	Conclusion:	Support
(b)	Technical Assessment	n.a.		n.a.		H3(b):	+	H4(b):	+
						γ_{3b} =	0.161 (t=3.1029)	γ_{4b} =	0.009 (n.s.)
						Conclusion:	Support	Conclusion:	Not Support
(c)	Product Development	H1(c):	+	H2(c):	+	H3(c):	+	H4(c):	+
		γ_{1c} =	0.364 (t=5.3407)	γ_{2c} =	0.055(n.s.)	γ_{3c} =	0.042 (n.s.)	γ_{4c} =	0.069 (n.s.)
		Conclusion:	Support	Conclusion:	Not Support	Conclusion:	Not Support	Conclusion:	Not Support
(d)	Development Speed	H1(d):	+	H1(d):	+	H3(d):	+	H4(d):	+
		γ_{1d} =	0.121 (t=1.341)	γ_{1d} =	0.055(n.s.)	γ_{3d} =	0.091 (t=1.5565)	γ_{4d} =	0.050 (n.s.)
		Conclusion:	Support	Conclusion:	Not Support	Conclusion:	Support	Conclusion:	Not Support
(e)	Development Cost	H1(e):	-	H2(e):	-	H3(e):	-	H4(e):	-
		γ_{1e} =	0.160 (t=2.2081)	γ_{2e} =	-0.154 (t= -2.1411)	γ_{3e} =	-0.030 (n.s.)	γ_{4e} =	-0.081 (n.s.)
		Conclusion:	Reject	Conclusion:	Support	Conclusion:	Not Support	Conclusion:	Not Support

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions.
* indicates 0.1 significance level;
** 0.05 significance level and
*** 0.01 significance level.

fit did not exert any significant influence on idea generation (γ_{3a} = -.014, n.s.) or product development (γ_{3c} = .042, n.s.) or cost (γ_{3e} = -.030, n.s.; not providing support for H3a, H3c or H3e), but improved technical assessment (γ_{3b} = .161, p<.01) and development speed (γ_{3d} = .091, p<.10; confirming H3b and H3d). Manufacturing fit improved idea generation (γ_{4a} = .101, p<.05; as predicted in H4a), but did not significantly influence on any of the remaining proficiency measures.

3.6.2 Results for Tests of Mediation (H1-H4.f-g) (Please refer to Table 3-4)

Contrary to predictions, supply chain fit had negative *direct* impacts on the degree of customer need met (γ_{1f}= -.298, p<.01) and product advantage (γ_{1g} = -.248, p<.01), contradicting H1f and H1g. The relationship from supply-chain fit to product advantage was mediated by product development proficiency and development cost. Additionally, supply-chain fit indirectly affected on the degree of customer need met through development proficiency and development speed. Marketing fit, on the other hand, *directly* and positively influenced the degree of customer need met (γ_{2f}= .454, p<.01) and product advantage (γ_{2g}= .361, p<.01), as opposed to what was predicted in H2f and H2g. It also indirectly affected product advantage through impairing proficiency in idea development and opportunity analysis and decreasing development cost. Its indirect impact on degree of customer need met was mediated by reducing idea development proficiency.

R&D fit influenced the degree of customer need met directly and negatively (γ_{2f} = -.113, p<.05; as opposed to H3f), as well as, indirectly through increasing development speed. It did not have a significant direct impact on product advantage (γ_{3g} = .029, n.s.; supporting H3g), however, an indirect effect through enhancing technical assessment. Manufacturing fit also did not exert any direct influence neither of the degree of customer need met (γ_{4f} = .055, n.s.) and product advantage (γ_{2g} = .016, n.s.; in accordance to H4f and H4g). However, it impacted product advantage and degree of customer need met indirectly by enhancing idea generation proficiency.

TABLE 3-4. RESULTS FOR TESTS OF MEDIATION (H1-H4.f-g)

Positional Advantages / Strategic Fit		(f) Customer Need Met		(g) Product Advantage	
H1	Supply Chain Fit	H1(f):	no direct rel.	H1(g):	no direct rel.
		γ_{1f} =	-0.298 (t=- 4.4350)	γ_{1g} =	-0.248 (t=-4.1047)
		Conclusion:	Reject	Conclusion:	Reject
H2	Marketing Fit	H2(f):	no direct rel.	H2(g):	no direct rel.
		γ_{2f} =	0.454 (t=10.8392)	γ_{2g} =	0.361 (t=5.3736)
		Conclusion:	Reject	Conclusion:	Reject
H3	R&D Fit	H3(f):	no direct rel.	H3(g):	no direct rel.
		γ_{3f} =	-0.113 (t= -2.1762)	γ_{3g} =	0.029 (n.s.)
		Conclusion:	Reject	Conclusion:	Support
H4	Manufacturing Fit	H4(f):	no direct rel.	H4(g):	no direct rel.
		γ_{4f} =	0.055 (n.s.)	γ_{4g} =	0.016 (n.s.)
		Conclusion:	Support	Conclusion:	Support

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, ** and *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

3.6.3 Results for H5-H6. a-e (Please refer to Table 3-5)

Project formality and project climate fostered proficiencies in idea development (γ_{5a} = .510, p<.01; γ_{6a} = .310, p<.01), technical assessment (γ_{5b} = .419, p<.01; γ_{6b} = .208, p<.01), and product development (γ_{5c} = .236, p<.01; γ_{6c} = .190, p<.01), supporting H5a, H5b, H5c, H6a, H6b and H6c. Project formality decreased speed (γ_{5d} = -.363, p<.01), at the same time reducing cost (γ_{5e} = -.167, p<.05; as opposed to H5d, but parallel to H5e). On the contrary, project climate increased speed (γ_{6d} = .664, p<.01) while increasing development cost (γ_{6d} = .386, p<.01; providing support for H6d, but leading to the rejection of H6e).

TABLE 3-5. RESULTS (H5-H6. a-e)

Project-specific Advantages / NPD Process Proficiency		H5		H6	
		Project Formality		Project Climate	
(a)	Idea Development and Opportunity Analysis	H5(a):	+	H6(a):	-
		γ_{5a} =	0.510 (t=7.6474)	γ_{6a} =	0.310 (t=5.7849)
		Conclusion:	Support	Conclusion:	Reject
(b)	Technical Assessment	H5(b):	+	H6(b):	+
		γ_{5b} =	0.419 (t=6.7800)	γ_{6b} =	0.208 (t=3.8019)
		Conclusion:	Support	Conclusion:	Support
(c)	Product Development	H5(c):	+	H6(c):	+
		γ_{5c} =	0.236 (t=2.8331)	γ_{6c} =	0.190 (t=2.7031)
		Conclusion:	Support	Conclusion:	Support
(d)	Development Speed	H5(d):	+	H6(d):	+
		γ_{5d} =	-0.363 (t= -4.3861)	γ_{6d} =	0.664 (t=9.6924)
		Conclusion:	Reject	Conclusion:	Support
(e)	Development Cost	H5(e):	-	H6(e):	-
		γ_{5e} =	-0.167 (t=-2.0062)	γ_{6e} =	0.386 (t=4.8302)
		Conclusion:	Support	Conclusion:	Reject

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, ** and *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

3.6.4 Results for H7-H11. a-e (Please refer to Table 3-6)

The NPD activities proficiencies significantly enhanced degree of customer need met and product advantage were idea development (β_{1a} = .203, p<.01; β_{1b} = .187, p<.01; as predicted in H7a and H7b) and product development (β_{3a} = .399, p<.01; β_{3b} = .450, p<.01; as in H9a and H9b). Contrary to H8, proficiency in technical assessment decreased product advantage (β_{2b} = -.171; p<.01). Development speed significantly reduced customer need met (β_{4a} = -.121, p<.01; contrary to H10a), did not affect product advantage (β_{4b} = .006, n.s.; not providing support for H10b). Development cost did not exert any significant impact on degree of customer need met (β_{5a} = -.024, n.s.; not providing support for H11a), but decreased product advantage (β_{5b} = -.078, n.s.; parallel to H11b).

TABLE 3-6. RESULTS (H7-H11. a-e)

NPD Process Proficiency \ Positional Advantages		(a)		(b)	
		Customer Need Met		Product Advantage	
H7	Idea Development and Opportunity Analysis	H7(a):	+	H7(b):	+
		β_{1a} =	0.203 (t=3.7033)	β_{1b} =	0.187 (t=2.6808)
		Conclusion:	Support	Conclusion:	Support
H8	Technical Assessment	n.a.		H8:	+
				β_{2b} =	-0.172 (t= -3.7707)
				Conclusion:	Reject
H9	Product Development	H9(a):	+	H9(b):	+
		β_{3a} =	0.399 (t=8.5931)	β_{3b} =	0.450 (t=7.9771)
		Conclusion:	Support	Conclusion:	Support
H10	Development Speed	H10(a):	+	H10(b):	+
		β_{4a} =	-0.121 (t= -2.3573)	β_{4b} =	0.006 (n.s.)
		Conclusion:	Reject	Conclusion:	Not Support
H11	Development Cost	H11(a):	-	H11(b):	-
		β_{5a} =	-0.022 (n.s.)	β_{5b} =	-0.078 (t= -1.5005)
		Conclusion:	Not Support	Conclusion:	Support

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, ** and *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

3.6.5 Results for H12-H13 and Tests of Moderation (H14-H15) (Please refer to Table 3-7 and 2-8)

The degree of customer need met and product advantage both enhanced the project's impact on performance (β_6 = .299, p<.01 and β_7 = .421, p<.01; providing support for H12 and H13). The linkage from degree of customer need met to project performance was affected by neither market size (β_{11a} = -.168, n.s.), market growth (β_{11b} = .097, n.s.), nor market competitiveness (β_{11c} = -.089, n.s.), providing lack of support for H14a, H14b and H14c. The relationship between product advantage and project performance was negatively moderated by market size (β_{12a} = -.405, p<.10) and market growth (β_{12b} = -.525, p<.05), but positively by market competitiveness (β_{12c} = .389, p<.05), contrary to what was expected (H15a, H15b and H15c). Market size and market growth had positive direct impacts on project performance (β_8 = .654, p<.01 and β_9 = .297, p<.10, respectively), whereas market competitive a significant negative direct influence (β_{10} = -.109, p<.01). Finally, annual sales exert a negative effect on performance (β_{13} = -.058, p<.05), but number of employees was not significantly related (β_{14} = -.029, n.s.).

TABLE 3-7. RESULTS (H12-H13)

Positional Advantages \ Outcomes		Project Performance	
H12	**Customer Need Met**	H12:	+
		β_6 =	0.299 (t=3.0141)
		Conclusion:	Support
H13	**Product Advantage**	H13:	+
		β_7 =	0.421 (t=4.1370)
		Conclusion:	Support
Market Variables	Market Size	β_8 =	0.654 (t=3.7253)
	Market Growth	β_9 =	0.297 (t=1.5216)
	Competition Concentration	β_{10} =	-0.109 (t= -3.3530)
Control Variable	Annual Sales	β_{13} =	-0.058 (t=-1.6578)
	Number of Employees	β_{14} =	-0.029(n.s.)

TABLE 3-8. RESULTS FOR TESTS OF MODERATION (H14-H7.a-b)

Moderators \ Paths		H14: Customer Need Met - Project Performance		H15: Product Advantage - Project Performance	
(a)	**Market Size**	H14(a):	+	H15(a):	+
		β_{11a} =	-0.168(n.s.)	β_{12a} =	-0.405 (t= -1.3741)
		Conclusion:	Not Support	Conclusion:	Reject
(b)	**Market Growth**	H14(b):	+	H15(b):	+
		β_{11b} =	0.097(n.s.)	β_{12b} =	-0.525 (t=-1.998)
		Conclusion:	Not Support	Conclusion:	Reject
(c)	**Market Competitiveness**	H14(c):	-	H15(c):	-
		β_{11c} =	-0.089(n.s.)	β_{12c} =	0.389 (t=2.0164)
		Conclusion:	Not Support	Conclusion:	Reject

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, ** and *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

TABLE 3-9. VARIANCE EXPLAINED RESULTS

Dependent Variables	Multiple R^2
Idea Development	0.50
Technical Assessment	0.41
Product Development	0.35
Development Speed	0.27
Development Cost	0.13
Product Advantage	0.41
Customer Need Met	0.36
Project Performance Impact	0.54

3.7 DISCUSSION

Internal innovation development is perceived as high risk and difficult venture. Despite the most prevalent product failure reasons that are primarily associated with the market side of innovation, research on NPD projects has focused on internal factors from the firm's perspective. However, in the extant literature, it is widely accepted that a match between what is needed (i.e., market pull) and what can be developed internally (i.e., technology push) is necessary. The operationalization of this match is still not provided in the literature. Thus, this study elucidates the notion of 'strategic fit' as the degree of new resources and capabilities required for the product (based on Venktraman's conceptualization of fit as matching). Measures to assess 'strategic fit' that incorporates all functions (that is, supply-chain, marketing, R&D and manufacturing) relevant in NPD process are provided.

In the innovation literature, resources, capabilities and strategic orientations have been directly linked to positional advantages and performance outcomes. Despite its importance being stressed in popular press, the implementation of these orientations and process activities has generally been neglected in new product models. Thus, drawing upon Day and Wensley's (1988) framework, whether a firm's internal environment (i.e., the strategic fit of the project, project specific sources of advantages and proficiency in NPD process implementation) influences positional advantage and performance outcomes is scrutinized in this study. The moderation effects of external environmental factors on these relationships are also tested within the context of contingency theory (which states that the relationships from internal factors to innovation success are not under the total control of the managers, but are a least partly determined by the market forces). Thus, two contributions of this research lie in providing an operationalization of 'strategic fit' of the project and incorporating the implementation aspects in technological innovation models. The comprehensive model serves to aid in both the prediction and the understanding of internal innovation development at the project level. As Day and Wensley suggest (1988), achievement of performance superiority depends on identification of skills that "exert most leverage on positional advantages" (p. 5). Accordingly, this analysis may provide managers an understanding of the project-level factors that engender positional advantages and performance returns and whether they are mitigated by market dynamics. Thus, this study may aid their decision-making and identification of skills and process activities to allocate their resources and investments to. Due to the complexity of the proposed model, hypotheses were explored through a component-based partial least squares analysis (PLS).

3.7.1 Strategic Fit: Direct Effects

The findings demonstrated that supply chain fit (which reflects the degree to which the new projects exploits existing distribution channels and past projects' target market and market demand), enhanced idea development, product development proficiency and development speed, but also elevated costs. The synergy with the firm's supply chain skills resulted in more effective new product idea generation and more proficient and timely development activities; however, supply chain fit deteriorated cost structure, which further impacted positional advantage. One of the reasons may be the shifting of bargaining power to suppliers due to prior transactions and commitments, thus increasing dependence and transaction costs.

On the other hand, the project's fit in terms of advertising, market research and promotional requirements inhibits idea generation skills, which may be because of a focus on ideas that are guaranteed to sell. Such synergy did not significantly enhance development capabilities or timeliness. Moreover, similar to supply-chain fit, marketing fit lead to higher costs, which may result from inefficiencies due to maturations and decreasing demand or neglected opportunities. On the whole, these first two aspects of fit incorporating the customer-side both increased development costs; but supply chain fit enhanced, whereas marketing fit diminished idea development proficiency. Therefore, the findings indicate that less departure from the existing value-chain, but more departure from the marketing gestalt may be beneficial for the generation of new ideas and the identification of opportunities.

The results indicated that the project possible requirement's match between firm's R&D expertise, level of R&D expenditures and R&D personnel's training does not determine how effective novel product ideas are generated, how well opportunities are identified or how proficient development activities are executed. In other words, the degree to which firms are inventive and entrepreneurial in the earlier stages of their processes or skillful in product development may not be determined by the extent to which the project entails radical changes in research and development. However, R&D fit enhances technical assessment proficiency and development speed; that is it allows the deficient-free and timely response to customer expectations. Additionally, the findings related to manufacturing fit show the importance of internal sources for idea generation and gaining competitive advantages. The project requirements need to be met with the existing development capabilities and manufacturing resources.

Overall, it can concluded that for better idea development and opportunity analysis, higher supply chain and manufacturing fit, but less marketing fit is required. For more proficient technical assessment and product development, higher R&D and supply-chain fit, respectively, may be desirable.

3.7.2 Strategic Fit: Indirect Effects

As mentioned, this study examined whether strategic fit of the project had indirect effects on positional advantages and project performance mediated by the quality of tactics and implementation. The results indicated that only manufacturing fit has strictly indirect (positive) effect on returns through idea generation proficiency, whereas supply-chain, marketing and R&D fit influence positional outcomes both directly and indirectly through NPD activities. Thus, fit of the project with regards to the *market side* of the NPD project are automatically converted into positional advantages to a certain degree.

These conversions are also mediated by proficiencies in *idea generation* (marketing fit-degree of customer need met and product advantage; supply chain fit-degree of customer need met and product advantage), *product development* (supply chain fit-product advantage and degree of customer need met), *development speed* (supply chain fit-degree of customer need met and product advantage; R&D fit-degree of customer need met) and *development cost* (marketing fit-product advantage; supply chain fit-product advantage). Interestingly, supply-chain fit decreases positional advantages both directly and through enhancing idea generation and product development. This indicates that NPD process proficiency failed to compensate for supply chain fit's negative impact on positional advantages. This may be due to repeated focus on the target market and demand forecasts of previous projects, which may preclude the firm from providing novel and superior benefits over current products and thus lose positional advantages. Thus, an incremental approach in decision making with regards to supply-chain resources and capabilities seems to eventually inhibit both the degree to which customer needs are met and the profile of products as unique, new and having high quality.

The new project's synergy with the firm's existing marketing (i.e., advertising, market research and promotional capabilities) enhances its positional advantages. Marketing fit also indirectly affects both product advantage and the degree to which customer needs are met through decreasing idea development proficiency. This suggests that superior market positions can be achieved in two ways: (1) the advantages accrued as a result of exploiting existing advertising, promotion and research capabilities in the products offered and (2) more effective idea generation, which actually requires departure from existing marketing resources and skills.

The impact of R&D fit on product advantage is strictly indirect through technical assessment proficiency. The benefit from the match of the project requirements with the available R&D expertise, i.e., enhanced technical assessment, ultimately decreases product uniqueness. Thus, the existing R&D expertise, level of R&D expenditures and R&D personnel's training enables more effective technical assessment during the NPD process, which further diminishes product advantage. This suggests that increasing R&D expertise and technical assessment capabilities limits the level of uniqueness of the developed product.

Both supply chain and R&D fit increase development speed, which further deteriorates the degree to which customer needs are met. This may be explained by the notion that firms opted to 'focus on trivial, rapidly executable development projects for the sake of increasing speed to market' (Calantone et al. 1997, p. 179) and fail to meet what is needed in the market. What is more, supply chain fit indirectly reduces product advantage through increasing costs. This may suggest that focus only on projects that require existing supply chain capabilities may entail costs related to losing new relationship opportunities (i.e., opportunity costs) and prior transaction commitments that creates a lock-in situation (i.e., sunk costs). On the other hand, marketing fit increases product advantage through reducing development cost. Thus, use of existing advertising, promotion and research capabilities enhances product advantage both directly and indirectly by decreasing associated costs.

3.7.3 Project-Specific Sources of Advantage

In this analysis, the impact of project-specific sources of advantage on the proficiency of NPD process implementation is investigated. It was advocated that the effects of project formality and project climate on the effectiveness of idea generation and opportunity analysis vary: project formality diminished, whereas project climate enhanced this proficiency. In the literature, it is generally accepted that formal systems tend to repress creativity, brainstorming and experimentation. However, contrary to what was expected, the findings indicated that formal management process and cross-functional integration actually reduce uncertainties and enhance idea generation, possibly through specifying the required tasks and their sequence and encouraging open channels of communication and information sharing. Project formality and climate also improved technical assessment and product development: efficiencies attained through formal mechanisms and cross-functional integration did lead to better execution.

Moreover, these project-specific advantages displayed contrary effects on development speed and cost: Project formality reduced, while project climate increased speed and cost. Formalized procedures can regulate the tasks people perform and assign role responsibilities, and thus facilitate input and involvement from other departments whenever necessary. This may lead to cost efficiencies, however bureaucratic requirements associated with formality may be time-consuming. Committed team members under the supervision of their project leaders, more direct communication and cooperation seem to bring about contrary consequences, that is, making the development project more timely but more costly.

3.7.4 Proficiency of NPD Process Implementation

It was predicted that the execution of NPD process activities are key to achieving positional advantage in the market. The results indicated that proficient idea generation and product development activities led to positional advantage, in the form of product advantage and responsiveness to customer needs. However, the findings showed that proficiency in technical assessment diminished product advantage. This may result from a focus on technical attributes and performance of the product that may lead to failure in considering product quality and benefits in the eyes of the customers. Development speed, contrary to the general assumption in the literature, hindered the degree to which customer needs were met. This may be due to neglect of consumer readiness for the sake of development speed. Interestingly, high development cost weakened product advantage, but did not influence firms' effectiveness in meeting customer demand. Increasing cost diminished the quality and performance level of the new product, however did not affect how the customer perceived its benefits.

3.7.5 Positional Advantage and Environmental Factors

Positional advantage should pay off, that is, lead to superior project performance. The findings indicated that both meeting customer needs and product advantage significantly enhanced the project's impact on performance. This signifies the importance of exceeding customers' needs over what is offered in the market and investing to gain relative product advantages. However, as the contingency framework suggests, the extent to which such positional advantages lead to performance returns should be moderated (i.e., strengthened or weakened) by the market environment. Market environment brings about opportunities for the firm, but also a certain level of unpredictability regarding external changes which involve threats to the survival and growth of the firm. Subsequently, market size and growth should enhance the level of returns firms incur from their positional advantage. However, the uncertainty and hostility as a result of competitor actions should inhibit the degree to which meeting customer needs and product advantage lead to higher project performance. The results provided mixed support for the hypotheses.

Product advantage (that is, products with higher quality, technical performance and benefit-to-cost ratio) engender superior performance consequences as the size and the growth of the market *decreases*. On the other hand, the relationship between product advantage and project performance is positively moderated by market competitiveness. Thus, the relationship between product advantage and project performance becomes *stronger* as the market demand shrinks and the competition becomes more intense. In contrast, meeting customer provides higher returns irrespective of the market conditions. Thus, investing in meeting customer needs always proves rewarding regardless of whether rivalry is severe or customer demand is changing.

3.7.6 Limitations and Future Research

The measurements were primarily perceptual and collected from single respondents, all of whom were employed at firms operating in chemical, biochemical and pharmaceutical industries. Gonul et al. (2001, p.79) mention that marketing strategies employed in these industries may be different from others due to difficulties in identifying the decision maker and the actual buyer of the product. The particulars of these industries may have limited the generalizability of the model, thus, further research is recommended to investigate other industries. Single respondents leave the effects linking the constructs subject to common method variance. Thus, a multiple informant design is recommended for further studies. In this study, the impact of market factors on the strengths of key model paths was scrutinized. Future research may investigate the moderating impact of technological factors, such as the rate of technological change or the presence of dominant standards.

CHAPTER 4

GLOBAL STRATEGIC OUTSOURCING FOR RESOURCE DEFICIENT, MARKET EFFICIENT TECHNOLOGICAL INNOVATION

4.1 INTRODUCTION

Technological advances and increasing globalization characterize the current business milieu and have radically transformed the competitive landscape. Consequently, the study of technology-intensive (TI) markets has attracted significant research attention in the marketing, management and engineering disciplines (Buzzell 1999; John et al. 1999; Teece 1988; Dutta and Weiss 1997; Wuyts et al. 2004). These markets are characterized by considerable uncertainty due to heterogeneous and rapidly changing technologies, and by the fact that buyers frequently lack relevant prior experience (Bourgeois and Eisenhardt 1988; Glazer 1991; von Hippel 1986). To survive in such environments, firms increasingly strive to develop capabilities and achieve strategic flexibility by building closer outsourcing relationships and adopting modular systems (Harrigan 1985; Weiss and Heide 1993; Sanchez 1995). They choose to outsource either a portion or the entire product development process to survive and be more responsive to the market dynamics (Garud and Kumaraswamy 1995; Schilling 2000).

According to the Quarterly Index (January 13, 2005 in The Wall Street Journal; January 14, 2005 in Silicon.com) from outsourcing advisory firm TPI, the value of major outsourcing contracts awarded in 2004 totaled over $76 billion worldwide. The phenomenon of downstream manufacturers cooperating with upstream suppliers to introduce new products and/or improve the quality of existing product lines is prevalent across a spectrum of industries including consumer-electronics, computer software, textiles, automobiles, steel and pharmaceuticals

(Clark and Fujimoto 1991; Bettis et al. 1992). Although these relationships constitute avenues for inter-firm learning and increase firms' adaptability, they also create a certain degree of supplier-buyer dependence and bring about additional threats such as the potential leakage of tacit know-how and the gradual loss of knowledge-based capabilities (Heide and Weiss 1995; Swan and Allred 2003). Thus, buyer firm's dependence on external suppliers for design not only puts its intellectual property in jeopardy, but also casts doubts on how much intellectual property it really owns. Referring to these vulnerabilities, a recent Businessweek article (Special Report by Engardio and Einhorn, March 21, 2005, p. 84) mentions that "companies worry about the message they send to their investors" as they outsource their design activities.

Another important feature of technology-intensive (TI) markets is the increasing utilization of modular product architectures as the basis for new product designs and development (Sanchez 1995, 1999; Katz and Shapiro, 1994; Stremersch et al. 2003; Staundenmayer et al. 2005). Modularity is created by standardizing the interfaces between functional components and specifying greater reusability and commonality among product families (Sanchez and Mahoney, 1996; Wilson et al., 1990; John et al. 1990; Garud and Kumaraswamy 1995). Moreover, these structures enable embedded coordination through buyers' and suppliers' adherence to shared objectives and common standards, linking geographically dispersed component developers (Kogut and Kulatilaka 1994) and making global technology outsourcing possible (Mikkola 2003).

Research on buyer behavior in TI markets remains focused on discrete buyers' choices in single transactions with a cost-based approach, as opposed to considering performance outcomes of portfolios of transactions (Walker and Weber 1984; Swan and Allred 2003; Stremersch et al. 2003). Similarly, the literature on modularity, standardization and network externalities in TI markets focuses on the buying of modular systems using neoclassical rationales (i.e., production-cost perspective) and institutional economics (i.e., a transaction-cost perspective) (Wilson and et al. 1990; Schilling 2000; Swan and Allred 2003; Stremersch et al. 2003; Schilling and Steensma 2001). As Weiss and Heide (1993) suggest, previous research on buyer behavior in TI markets has focused on specific strategic decisions as opposed to buyers' underlying processes.

Putting it all together, the study of buyer-supplier relationships in technology-intensive modular system markets requires consideration of interdependencies across transactions, operation costs and locations (Aulakh and Kotabe 1997; Kim and Hwang 1992). The literature may benefit from analyses of interaction effects of performance determinants and more dynamic (continuous) systemic techniques as opposed to earlier studies, which are rather static and conceptualize buyer-supplier exchanges as a sequence of independent one-time events. Thus, it is critical to gain an understanding of the characteristics of buyers' technology outsourcing relationships in global markets and their effects on the market value of their firms.

In summary, grounded in the marketing, management, and international business literatures, the primary objective of this third essay is to develop and test a model of the determinants of the market value of firms' global technology outsourcing relationships, classified according to the task characteristics, switching costs and the degree of environmental uncertainty (Heide and Weiss 1995; Eisenhardt 1985; Weiss and Heide 1993; Pisano 1990). The methodology involves an event study analysis and other secondary data sources (Fama 1991; McWilliams and Siegel 1997; Srinivasan and Bharadwaj 2004). This research also provides implications for managers on the returns and risks of global strategic outsourcing. The focus will be on the unique consequences of loosely coupled systems, i.e., modular systems employed in external innovation development (Schilling 2000; Sanchez 1999; Mikkola 2003). The organization of this essay is as follows. First, an overview of the model and definitions of constructs are provided. Descriptions of the sample and the analysis techniques will then be presented, followed by discussion of the findings.

4.2 TECHNOLOGY OUTSOURCING LITERATURE

The bulk of the buyer-supplier literature dates back to the late 1970's, much originating from Coase (1937)'s transaction 'cost' economics (TCE). TCE focuses on how to match transaction characteristics with governance mechanisms, and the conditions under which *either* market *or* firm minimizes transaction costs. Commencing with Buckley and Casson (1976), scholars utilized a cost-based approach to explain firms' strategic choices (i.e., choosing internalization versus externalization). Drawing upon both transaction cost and internalization theories (which scrutinize the most efficient governance structures with regards to the associated costs), these authors maintained that the 'discrete choice' of strategy had the lowest cost (i.e., was most efficient; Williamson 1981; Rugman 1981; Walker and Weber 1984). The dependent variable was usually discrete categories of entry mode, and thus the methodologies employed were generally discriminant analysis and/or logistic regression (Agarwal and Rawi 1992; Kim and Hwang 1992). Since the internalization school focused its attention on firm level phenomena, the scholars predominantly collected primary data (Erramilli and Rao 1993; Aulakh et al. 1998).

By focusing on cost minimization, these studies ignored other important criteria, such as value enhancement and strategic proactiveness. Thus, several scholars advocated that the reason for internalization may not be market failure but rather value maximization and firm success. Theories such as the resource-based view, resource dependency and relationship marketing were developed to explain interfirm relationships by relation-specific assets as distinctive resources and to investigate the performance outcomes of interdependencies among buyers and suppliers (Heide and John 1988, 1992; Noordewier et al. 1990; Ganesan 1994). Going beyond the focus on single transactions, efficient contracting and transaction costs, these scholars also addressed production costs, firms' unique bundles of both internal and external resources and capabilities, and the interrelatedness of several exchanges (Aulakh and Kotabe 1997; Granovetter 1973; Pisano 1990). Several studies employed this perspective at the nation and/or industry level (Wilson et al. 1990; Weiss and Heide 1993). With the emergence of these diverse theoretical underpinnings either drawn upon TCE solely or being integrated with TCE, alternative metric dependent variables such as performance and data analysis methods such as moderated regression and structural equation modeling started to proliferate (Wasti and Liker 1997; Jap and Ganesan 2000). Moreover, the use of secondary data sources has increasingly become prevalent in recent empirical studies, which may be due to low response rates in surveys and challenges inherent in cross-cultural designs (Wan and Hoskisson 2003; Shaver 1998; Makino et al. 2004; Schilling and Steensma 2001).

Previous research on buyer behavior in high technology markets has focused on discrete buyers' choices in single transactions as opposed to the performance outcomes of portfolios of transactions. Walker and Weber (1984) examined the effect of transaction costs on "make or buy" decisions, mediated by the impacts of supplier market competition and two types of uncertainty (i.e., volume and technological uncertainty). Swan and Allred (2003) analyzed the factors that influence product and process technology decisions across the continuum of options from internal development to outsourcing. Stremersch et al. (2003) identified two focal buyer decision dimensions, namely the decision of whether to outsource system integration and the decision of how much to concentrate purchases with one or more suppliers. At the project level, Clark (1989) examined the effect on product development of project scope (that is, the extent to which a new product is based on unique parts developed internally) and the content of the product (i.e., features, performance, degree of innovation).

More recently, a new literature stream on outsourcing relationships has emerged employing content-based event studies and examining the market reaction to outsourcing arrangements. Based on outsourcing announcements across a variety of industries from 1990 to 1997, Hunton, Reck and Hayes (1998) found a significant positive return one day after (day +1) the announcement ($p < 0.10$). In addition, their results indicated an inverse relationship between the market perception and the buyer firm's size. Similarly, Peak, Windsor and Conover (2002) examined how the market reacted to IT outsourcing announcements in particular. The results of both studies exhibited a significant positive return to the IT outsourcing announcement during the event period ($p < 0.05$ and $p< 0.10$, respectively). These studies also examined the influence of factors, such as primary objective, asset specificity, resource dependency and technological discontinuity, on the investor's reactions to IT outsourcing announcements. However, there is clearly a paucity of studies on the market's evaluation of firm's technology outsourcing activities, that is, whether and how technology outsourcing announcements lead to significant abnormal returns in stock prices.

On the whole, there is a need for research on the performance outcomes of partnerships that exhibit increasing levels of suppliers' involvement in the product development processes, and thus entail certain risks, such as know-how leakage and diffusion to competitors. Aberdeen's "Outsourced Manufacturing Strategies Benchmark Report" ("Produce Significantly Different Results, According to New Aberdeen Report", Business Wire, 12 October 2004) indicates that managers' concerns center around losing control in outsourcing ventures. Buyers generally strive to minimize the likelihood of opportunistic expropriation of tacit technological knowledge, eliminate the difficulties of monitoring partners due to geographical or cultural distance, and avoid switching costs (Tidd 1995; Pisano 1990). These notions necessitate the empirical validation of risks and benefits of strategic outsourcing relationships in the context of modular systems and global TI markets -- a topic that has drawn significant interest in recent years, but which has only been studied conceptually to date. Accordingly, this study extends previous studies by employing event analysis of abnormal stock returns to examine the market value of external innovation development. The market's reaction to technology outsourcing arrangements has been a proxy for the business value of such initiatives. This study investigates the extent to which the key factors associated with the risks of technology outsourcing arrangements (including task characteristics, environmental uncertainty and switching costs) influence the market's reaction as measured by the cumulative abnormal returns (CAR).

4.3 THEORETICAL FOUNDATIONS AND MODEL OVERVIEW

Past research has suggested that the problems that exist in high-technology markets are of two different kinds from a buyer's perspective. First, these markets are characterized by considerable uncertainty due to heterogeneous and rapidly changing technologies, and to the fact that buyers frequently lack relevant prior experience (Glazer 1991; Teece 1988; von Hippel 1986; Dosi 1988). Thus, the buyers choose to outsource their product development activities and engage in partnerships with their suppliers in order to combine suppliers' resources and capabilities with their knowledge base (Wuyts et al. 2004; Swan and Allred 2003; Appleyard 2003; Athaide and Stump 1999; Howells et al. 2003; Pennings and Harianto 1992). They aim to enhance their flexibility and productivity and to lower transaction and production costs (Lambe and Spekman 1997; Ragatz et al. 1997). Second, these outsourcing relationships lead the buyers to face switching costs, as a result of earlier commitments to particular product technologies or suppliers (Heide and Weiss 1995; Heide and John 1998; Stump and Heide 1996). As a result, even though these relationships constitute avenues for inter-firm learning and increase firms' adaptability, they create a certain degree of supplier-buyer interdependence (Dutta and Weiss 1997; Ireland et al. 2002; Ahuja 2000; Gulati and Garguilo 1999). Overall, the costs and consequences of outsourcing for the buyer firms include external dependence, functional mismatches, and coordination difficulties, along with the gradual loss of internal design, manufacturing, and other knowledge-based capabilities (Mikkola 2003; Schilling 2000; Wilson et al. 1990). Moreover, the most important risk associated with these linkages (one that can lead to loss in competitive power) is likely leakage through suppliers of both technical and marketing know-how to competitor firms (especially at the design stage) (Dutta and Weiss 1997).

These arguments are embedded in streams of research such as agency, resource dependence and transaction cost theories (as detailed below; see Ouchi 1979; Jaworski 1988; Pfeffer and Salancik 1978; Eisenhardt 1985). Referring to the factors that determine risks of outsourcing relationships identified in the previous literature, the determinants of value of global technology outsourcing arrangements were classified into three broad categories in this paper: i.e., *task characteristics* (including knowledge and experience of the partners regarding the task and the costs of obtaining information), *switching costs* (including sources of dependencies and the characteristics of the parties involved) and *the degree of environmental uncertainty* (Bergen et al. 1992; Heide and Weiss 1995; Eisenhardt 1985; Lawless and Price 1992; Weiss and Heide 1993; Pisano 1990).

4.3.1 Agency Theory. The focus of agency theory is determining the most efficient governance mechanisms for a particular relationship from the principal's point of view, given the determinants of risks of the arrangement (i.e., the *characteristics of the parties involved* and the *degree of environmental uncertainty*, the *task complexity* and the *costs of obtaining information for the monitoring of the agent*; see Ouchi 1979; Eisenhardt 1985, 1989; Anderson 1995; Kraft 1999). The primary assumptions of agency theory are information asymmetry (i.e., the principal lacks complete information as to what the behavior of the agent will be), the uncertainty related to the outcome of the agent's behavior, the self-interest seeking features and divergent goals of the parties. Bergen and et al. (1992) assert that the buyer-supplier link can also be viewed as an agency relationship as the buyer (i.e., the principal) attempts to gain accurate product/ component information and desired benefits from a supplier (i.e., the agent). Generally, agent and principal risks occur due to discrepancies between the objectives, knowledge and capabilities of the buyer firm versus those of the supplier firm. Due to difficulties buyers face in monitoring their behavior, agents may be tempted to exhibit opportunistic behavior in the forms of moral hazard[13], adverse selection[14] and/ or imperfect commitment (Ouchi 1979; Bergen et al. 1992). In the case of technological outsourcing relationship, such behaviors may be detrimental

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[13] The *moral hazard problem* occurs as a result of shirking or evasion of obligations in the ongoing relationship. These are considered forms of opportunism since one of the parties to the exchange is purposely withholding effort or somehow refraining from performing agreed-on actions (Wathne and Heide 2000).

[14] *Adverse selection* indicates a situation where one party/ supplier deliberately committing to a contract that they know they would not be able to fulfill. This may be viewed as opportunism in the sense that one party purposely withholds critical information (Wathne and Heide 2000).

particularly in instances where certain factors, such as nonmodular (i.e., tightly integrated) systems and high supplier involvement, increase know-how leakage.

4.3.2 Resource Dependence Theory. Resource dependence theory views interfirm governance as a strategic response to conditions of *uncertainty* and *dependence* (Pfeffer and Salancik 1978; Heide 1994; Anderson and Narus 1990). The basic assumptions are that the lack of sufficient resources and/or capabilities to complete a task creates dependence on the parties from whom the resources are obtained and introduces uncertainty into a firm's decision making (Heide 1994; Ganesan 1994; Heide and John 1992).This uncertainty occurs to the extent that the resource flows are not subject to the firm's control, and may not be predicted accurately. This notion is applicable to technology outsourcing relationships that are usually initiated due to the buyer's need to control key technologies in the value chain and manage the technological turbulence they face in their operating environment. Links with suppliers can help reduce the cost of components through specialization and the sharing of information on costs, but can also be a source of technology when a firm does not have the competence to develop a critical component in-house (Tidd 1995). However, according to the theory, principal (buyer) risk occurs due to the principal's lack of experience and expertise and the agent's (supplier) capabilities with the activity to be outsourced. Buyer firms that lack the knowledge and experience necessary to evaluate the quality of the outsourcing service may encounter problems since they make themselves vulnerable to the agent's opportunistic behavior.

4.3.3 Transaction Cost Theory. Transaction cost theory focuses on how to match transactions of different characteristics with governance mechanisms, and the conditions under which either market or firm (vertical integration) serves to minimize transaction costs. Emphasis is given to transaction costs, i.e, actual and opportunity costs of transacting under various governance structures. The theory argues that transaction specific investments and the uncertainty of transactions give rise to transaction costs and possibly create market failure; that is, they become inefficient means to mediate exchange (Rindfleisch and Heide 1997; Bergen et al. 1992). TSIs increase the investors' asset specificity and dependence on the transaction or relationship and give rise to safeguarding problems, while external and internal uncertainty leads respectively to adaptation and evaluation problems (Stump and Heide 1996). On the whole, according to the transaction cost theory, transaction risks result from transaction-specific factors, including *asset-specificity*, *frequency*, *interdependency,* and *technological uncertainty*.

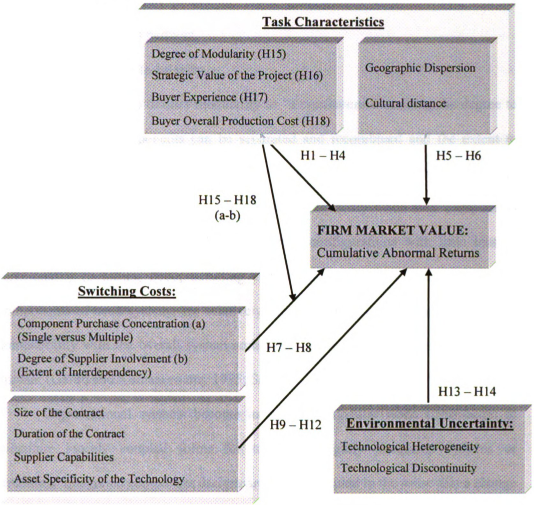
Transaction cost theory is consistent with resource dependence theory in that they both view non-market governance as a response to *environmental uncertainty* and *dependence* (Heide 1994; Reuer 2001). Regarding the latter, transaction-specific assets can be argued to constitute dependence, because their presence makes exchange partners irreplaceable or replaceable only at a cost (Barney and Ouchi 1986). Agency and transaction cost theory are also complementary: both theories, based on the assumption that parties are motivated by economic self-interest and may engage in opportunistic behavior, examine efficiency aspects of how firms organize functional relationships (Bergen et al. 1992). While transaction cost theory deals with the reduction of *ex-post* transaction costs through aligning transactions with appropriate governance mechanisms, agency theory adopts an ex-ante view of relations between principal and agent (i.e., minimization of ex-post costs through ex ante alignment of incentives).

Thus, these three theories serve to explain how buyer firms would react and behave in their technology outsourcing relationships in accordance to the extent of *their transaction-specific investments (or the factors that contribute to the risk of their suppliers' engaging in opportunistic behavior), their interdependencies* and *environmental uncertainty.* Therefore, factors that would contribute to the effectiveness and efficiency of a particular technology outsourcing relationship should comprise: the degree of modularity of development systems, the strategic importance of the contract to the buyer firm's performance, buyer experience and supplier capabilities, the number of other supplier relationships of the buyer, the degree of supplier involvement in the relationship, the size and duration of the contract, geographic and cultural distance between the partners, and the technological environment.

4.3.4 Overview of The Model

The model, of which the unit of analysis is the technology outsourcing announcements, is depicted in Figure 4-1. Buyers are hypothesized to receive abnormal returns in their outsourcing agreements, based on: (1) task characteristics [i.e., degree of modularity (H1), strategic importance of the development project (H2), buyer experience (H3), overall production cost of the buyer (H4), geographic dispersion (H5) and cultural distance (H6)]; (2) switching costs [i.e., component purchase concentration (H7), degree of supplier involvement (H8), the size (H9) and duration of the contract (H10), supplier capabilities (H11), and the asset specificity of the technology (H12)]; and finally, environmental uncertainty [i.e., technological heterogeneity (H13) and discontinuity (H14)]. Lastly, this research explores four moderation relationships: the impact of component purchase concentration and of the degree of supplier involvement on firm market value from will be moderated by the degree of modularity (H15), the strategic importance of the development project (H16), buyer experience (H17) and buyer production costs (H18).

FIGURE 4-1. HYPOTHESIZED MODEL ON DETERMINANTS OF GLOBAL TECHNOLOGY OUTSOURCING RETURNS



4.3.4.1 The Effects of Task Characteristics

Task characteristics studied in the agency theory literature can be broadly included in two categories: behavior observability (i.e., ability to gather information about agent behavior) and outcome measurability (i.e., ability to specify and track desired outcomes) (Eisenhardt 1985; Jaworski 1988; Oliver and Anderson 1994; Lawless and Price 1992). The extent to which the principal is knowledgeable about the task has been cited to have an impact on the ability to monitor agents' behavior (Choudhury and Sabherwal 2003). Correspondingly, this study incorporates variables that may have an impact on monitoring ability in global technology outsourcing relationships, such as degree of modularity, strategic value of the contract, buyer experience, buyer overall production costs, geographical dispersion and cultural distance of relationship partners.

4.3.4.1.1 Degree of Modularity

Schilling (2000) defines modularity as "a continuum describing the degree to which a system's components can be separated and recombined and the extent to which the system architecture enable the mixing and matching of components" (p. 312). Systems are said to have a high degree of modularity when their components can be disaggregated and recombined into new configurations with little loss of functionality (Schilling 2000; Schilling and Steensma 2001; Mikkola 2003). The components of such systems are relatively independent of one another, but require compatibility with the overall system architecture to be easily recombined with one another (Garud and Kumaraswamy 1995; Sanchez 1995; John et al. 1999).

Organizational systems become increasingly modular when firms begin to substitute loosely coupled forms for traditional tightly integrated systems or structures. Integrated component designs are tightly coupled in the sense that a change in the design of one component within an integrated assembly of components will require compensating changes in the designs of other components in the assembly, making these product architectures difficult, costly, and time-consuming to modify (Orton and Weick 1990; Sanchez and Mahoney 1996). Schilling (2000) refers to this as 'synergistic specificity' and asserts that it is through the development of standardized interfaces that synergistic specificity between components may be reduced (p. 316). Through specifying and standardizing the nature of an activity and the terms of exchange, a standard interface makes assets nonspecific (Garud and Kumaraswamy 1995; Sanchez 1995; Sanchez and Mahoney 1996; Schilling 2000).

As a result, the loose coupling of components facilitates greater specialization in particular activities, and thus autonomous development of components and control of the outputs of suppliers (Orton and Weick 1990; Staundenmayer et al. 2005). These notions all indicate that the degree of modularity reduces the likelihood of functional mismatches, the buyer firm's switching costs, and its external dependence. Modular systems also involve less disclosure of information about data and design plans. Modularity, in other words, provides a structure that coordinates the loosely coupled activities of component developers, reducing the risk of technology know-how leakage and the need for close monitoring of agents' behavior (Sanchez and Mahoney 1996). Thus:

H1: The market's reaction to strategic outsourcing arrangements will be positively related to the degree of modularity of development systems.

4.3.4.1.2 Strategic Value of the Project

This construct represents the impact of the development or acquisition of the component on organizational profitability and productivity, which would differ based on the goal of the buyer in engaging in technology outsourcing relationships (that is, cost reduction or operational efficiency versus revenue enhancement) (Weiss and Heide 1995; Robertson and Gatignon 1986). The closer a particular activity of a firm comes to its technological core and competitive advantage, the higher its asset specificity, bringing about reluctance to relinguish control over the activity and/or the necessity for safeguarding mechanisms (Wasti and Liker 1997; Sanchez and Mahoney 1996). In other words, the strategic value of the component to the buyer firm is expected to play a significant role in determining the level of dependency on suppliers and the difficulty faced in monitoring suppliers' performance (which are both acknowledged to contribute to transaction risk). As Pfeffer and Salancik (1978) suggest “asymmetry is the true source of power, a result of unequal concentration of resources or unequal perception of the importance of the exchange” (p. 52). Accordingly, transaction risks should be lower for technology outsourcing contracts in which the objective of the buyer firm is cost reduction or efficiency as opposed to increasing revenues or enhancing the firm’s competitive position. Moreover, the higher the importance of the component or the value of development project, the more likely the buyers will be inclined to protect their tacit technological knowledge against threats of opportunism (Dutta and Weiss 1997). However, despite the transaction risks, a project involving the development of a proprietary technology should engender competitive advantage in the market (Friar 1995; Gatignon and Xuereb 1997). Accordingly, the announcement of such projects would be an indicator of the buyer firms’ future commercial success and generate more favorable market reactions. Therefore:

H2: The market’s reaction to strategic outsourcing arrangements will be higher when the goal is revenue enhancement (i.e., high strategic value of the contract to the buyer firm) as opposed to cost reduction (i.e., low strategic value).

4.3.4.1.3 Buyer Experience

A buyer experienced in developing the technology may be more likely to be confident and more inclined to specify the exact process the supplier should follow (Eisenhardt 1985; Jaworski and MacInnis 1989). On the other hand, less experienced would lead the buyer to rely on the supplier's abilities and knowledge and may lead to vulnerability on the part of the buyer, which is referred to as information asymmetry in the literature. Information asymmetry presents conditions typical of principal-agent relationships, in which the distribution of information is likely to be skewed. In the case when buyers have less information and experience than the supplier with which to evaluate the supplier's performance, buyers incur monitoring costs and face performance ambiguity. This will reduce the buyer's ability to assess the supplier's performance and value of the technology (Ouchi 1979). Additionally, if the skills and other characteristics of the supplier cannot be obtained through substitutes, they may appear irreplaceable in the eyes of the buyers. Buyer's reputation, patents, R&D and development skills all signal its future success (Reuer 2001; McNamara 1999). Overall:

H3: The market's reaction to strategic outsourcing arrangements will be positively related to the experience of the buyer.

4.3.4.1.4 Overall Production Cost of the Buyer

Production costs of the buyer are those related to the production function (Stremersch et al. 2003). Swan and Allred (2003) assert that with a low cost goal, internal development of a product technology should be less favorable for attaining positional advantage and may even draw away from resources necessary for other activities. In the case when the overall production cost is high, the buyer firm will resort to outsourcing rather than internal development to gain product-based cost advantages. Therefore, in the case where the overall production cost of the buyer is high, the investors' evaluation of technology outsourcing arrangements will be positive:

H4: The market's reaction to strategic outsourcing announcements will be positively related to the overall production cost of the buyer.

4.3.4.1.5 Geographical Dispersion

This construct refers to the location of a firm's operations and linkages throughout the world. Communication is hindered as spatial and cultural separation increase between partners. A dispersed configuration of a buyer's supplier relationships across the world may increase the difficulty and the cost of coordinating and integrating the development, manufacturing, and promotion of a product (Swan and Allred 2003). Moreover, socialization, shared experiences, beliefs, and common goals are more difficult to achieve between the members of a buyer firm and a supplier firm, particularly if the supplier is remotely located. Hence, geographic distance between the buyer and supplier not only escalate operational costs, but may be a barrier to achieving project goals. Consequently:

H5: The market's reaction to strategic outsourcing arrangements will be inversely related to the geographical dispersion of the relationship.

4.3.4.1.6 Cultural Distance

Cultural distance identifies the distance that exists between the national cultures of the partners of the alliance (Shenkar 2001; Kogut and Singh 1988). A crucial assumption of agency theory is that rational managers are expected to act in their own self-interest. The basic assumption of agency theory (i.e., self-interest in the presence of diverging goals between the individual and the collective) may be emphasized in individualistic countries (Hofstede 1980; Sharp and Salter 1997). Moreover, cultural distance may impede goal congruence between partners, strengthening the 'divergence of preferences' assumption of agency theory (i.e., people are assumed to have preferences for their own actions which do not necessarily coalign with those of other organization members or partners). In these ways, cultural distance increases the transaction risk and thus, the need for close monitoring (Reuer 2001; Merchant 2003). Thus:

H6: The market's reaction to strategic outsourcing arrangements will be inversely related to the cultural distance of the partners.

4.3.4.2 The Effects of Switching Costs

Buyer switching costs may arise as a result of prior commitments (1) to a technology (transaction specific assets) and (2) to a particular supplier (relationship specific assets). Asset specificity means the buyer firm has specialized knowledge or tools with little or no use outside the transaction. Moreover, as a result of the prior transactions and investments, buyers may have invested in assets that are incompatible with new products. In addition to compatibility problems, buyers may face switching costs because of established relationships with particular suppliers.

The general effect of both types of switching costs for a buyer is a disincentive to explore new suppliers (Heide and Weiss 1995; Swan and Allred 2003). Consequently, buyers will be motivated to stay in existing relationships to economize on switching costs. Essentially, switching costs constitute a form of dependence, which is described by the extent of replaceability of the exchange partner (Heide and John 1988; Heide 1994). Agency theory predicts that the purchase of products or services that cannot be closely monitored will lead to shirking by suppliers (Wasti and Liker 1997). As a general rule, the buyer firm would try to detect opportunistic behavior by the suppliers through heavy monitoring. Knowing that it is being monitored would make the supplier less likely to shirk. In the outsourcing and modular systems context, six variables (i.e., size and duration of the contract, component purchase concentration, degree of supplier involvement, supplier capabilities and asset specificity of the technology) are proposed to represent the switching costs perceived by the buyer firm and the extent of irreplaceability of the supplier firm.

4.3.4.2.1 Component Purchase Concentration

The presence of open standards for the interfaces between the various components allows the system components to be sold by multiple suppliers. The buyer need not buy all system components from the same supplier, regardless of whether the buyer outsources the integration function; instead buyers mix and match components from different manufacturers, reducing their dependence on a single supplier. As a result, the buyer needs to decide whether to purchase all system components from a single supplier (high concentration) or from multiple suppliers (low concentration) (Stremersch, and et al. 2003; Tidd 1995; Wilson et al. 1990). The buyer's position is strengthened the greater the number of alternate sources of supply and the less the transaction costs involved in switching to another supplier. This would reduce the threat of opportunism and the necessity of monitoring. Such relationship competencies would enhance the buyer's ability to achieve the goals set in their outsourcing project, and thus increase its market value:

H7: The market's reaction to strategic outsourcing arrangements will be inversely related to higher component purchase concentration.

4.3.4.2.2 Degree of Supplier Involvement

Supplier involvement in NPD may be determined by the extent to which the supplier influences decision-making during the early stages of product development, the amount of control the buyer retains over the design, and the frequency of design-related communication between the buyer and the supplier (Wasti and Liker 1997). As supplier involvement increases in earlier NPD stages (i.e., activities concerned with product conceptualization and evaluation such as idea generation, concept development, design and planning) as opposed to later stage activities (i.e., production, product testing and commercialization), the intangible nature of the tasks and the diffusion risk of tacit know-how and core technologies increase. Consequently, buyers may be concerned about multi-client suppliers transmitting such information to potential competitors. Critical information that leaks out to competitors at the idea generation, design and planning stages through suppliers utilizing the same or similar designs for different customers can constitute a serious detriment to the buyer's competitive power. Hence:

H8: The market's reaction to strategic outsourcing arrangements will be greater when the supplier involvement is high (i.e., when the supplier contributes to earlier NPD process stages) compared to when it is low (i.e., when the supplier contributes to later stages).

4.3.4.2.3 Size of the Contract

The buyers' goals in engaging in supplier relationships (that is, having access to resources and capabilities that they lack internally) may be a major source for the resource dependency between them and their suppliers (Kallunki, et al., 2001). In addition to increasing the buyers' dependency on their suppliers, the size of the contract may raise the level of switching costs required to substitute another supplier. Larger contracts may attract more attention in the market and may increase investors' credibility to the buyer firms. However, the monetary size of the contract should also play a significant role in determining the level of dependency -- as the monetary size of the contract relative to the size of the buyer increases, the buyers tend to relinquish control over their internal resources and lose some bargaining power. This would further add to the costs associated with switching between suppliers as well as difficulties in the monitoring their behaviors. Hence, the risks may outweigh the risks of large outsourcing contracts:

H9: The market's reaction to strategic outsourcing arrangements will be inversely related to the size of the contract.

4.3.4.2.4 Duration of the Contract

The duration of the contract plays a significant role, particularly in technology outsourcing arrangements. Contracts of longer duration may become more problematic in technology-intensive environments in which technologies rapidly change and become outdated. A long-term commitment to a particular supplier is likely to be less cost-effective and may reduce the buyer's ability to leverage cost-saving technologies. Consequently, long-term contracts may limit the buyer firm's strategic flexibility. The relationship may lead to a 'lock-in' situation where the buyer cannot seek better options. This is a particular constraint to flexibility and competitive power when the supplier is a poorly-performing firm. On the other hand, the market's evaluation of contracts of longer duration may signal success in inter-firm learning, and thus enhanced development capabilities of the buyer. Hence, outsourcing contracts of longer duration should increase firm market value:

H10: The market's reaction to strategic outsourcing arrangements will be positively related to the duration of the contract.

4.3.4.2.5 Supplier Capabilities

Factors such as supplier's development cost advantages, ability and funding to conduct R&D, skill and competitiveness in product development, number of patents and other facilities may lead to certain asymmetries in the exchange relationship, thus escalating dependence at the buyer's expense (Clark and Fujimoto 1991; Wasti and Liker 1997). On the other hand, a supplier's successful performance history (i.e., reputation) gives the buyer an indication of the behavioral tendencies of the supplier, reduces the need for behavior monitoring, and allows the buyer to utilize outcome-based contracts to a greater extent (Wasti and Liker 1997). Thus, investors may favor collaborations with reputable suppliers. Therefore:

H11: The market's reaction to strategic outsourcing arrangement will be positively related to higher supplier capabilities.

4.3.4.2.6 Asset Specificity of the Technology

A resource can be described as asset specific if it cannot readily be redeployed (Williamson 1981). Asset specificity is considered a critical dimension in technology outsourcing relationships because many aspects of product development are proprietary. From the perspective of transaction cost economics, buyer firms that outsource highly asset-specific resources (e.g., proprietary technologies) are likely to encounter high transaction risks. Correspondingly, the level of asset specificity should be different among outsourcing arrangement that involve licensed and patented technologies, proprietary innovations that were developed by particular suppliers, or technological products to be codeveloped by the buyer and supplier. First, suppliers are less worried about the client's potential termination of the contract and may behave more opportunistically, maximizing their own self-interests at the expense of their buyers (Wathne and Heide 2000; Weiss and Heide 1993). Second, when proprietary technologies are developed by the supplier, substituting another supplier would be prohibitively costly and could likely result in a significantly delays. Buyers are likely to encounter a technological lock-in scenario, in which they can be "held hostage" to a particular technology provider. However, in the eyes of the investors, development of proprietary technologies will create more opportunities for differentiation and relative advantage over competitors, hence entailing future income for the buyer firms (Gatignon and Xuereb 1997; Kleinschmidt and Cooper 1991; Song and Parry 1996; Ali et al. 1995). Thus:

H12: The market's reaction to strategic outsourcing announcements will be higher in outsourcing arrangement that involve high asset-specific technologies (proprietary innovations developed by the supplier or technological products to be codeveloped) as opposed to low asset-specific technologies (licensed and patented technologies).

4.3.4.3 The Effects of Environmental Uncertainty

An important determinant of buyer decision making is environmental uncertainty because particular market conditions impose demands on a buyers' information processing capacity, are difficult to predict, and are beyond the control of either principal or agent (Achrol and Stern 1988; Weiss and Heide 1993). In a general sense, perceived uncertainty in the environment leads to uncertainty related to a task; i.e., the difference between the amount of know-how required to complete a task and the amount already possessed. In the context of TI markets, technological heterogeneity and discontinuity create uncertainty regarding developing the component (due to changes in component specifications), as individuals struggle to understand new and incompletely specified processes or products (Burkhardt and Brass 1990; Tushman and Anderson 1986).

4.3.4.3.1 Technological Heterogeneity

Technological heterogeneity refers to a lack of a common technological standard (Garud and Kumaraswamy 1995; Sanchez and Mahoney 1996). One defining feature of high-technology markets is the presence of multiple, frequently discrepant product standards and lack of a single dominant design (Tushman and Anderson 1986; Teece 1988; Bourgeois and Eisenhardt 1988). Organizations may have a higher preference for close monitoring and relationships with their suppliers under conditions of high technological heterogeneity, because they want to minimize the information they need to process to cope with uncertainties associated with such complexity.

4.3.4.3.2 Technological Discontinuity

High-technology markets also represent considerable uncertainty for buyers due to technological discontinuity, which represent increasing speed and magnitude of technological change. As stated by Von Hippel (1986), a buyer's prior technologies, experiences and capabilities are often 'rendered obsolete' in such markets (p. 796). According to Tushman and Anderson (1986), high-technology markets tend to be 'competence destroying', constituting a shift in the locus of technical expertise from industry incumbents to new entrants (Weiss and Heide 1993; Pisano 1990). The introduction of fundamentally different technologies or competence-destroying discontinuities can lead to major changes in the distribution of power and control. Because of resource limitations, firms turn to and eventually become reliant on external sources in developing new product and/or process technology (Kotabe and Murray 1990; Swan and Allred 2003). Environmental uncertainty, on the whole, involves not only lack of knowledge of the precise cost and outcomes of different alternatives, but often also lack of knowledge of what alternatives are. Thus, this would increase the irreplaceability of the supplier and the buyer's dependence (Wasti and Liker 1997; Wilson et al. 1990). Therefore:

H13: Technological heterogeneity will inversely affect the market's reaction to strategic outsourcing arrangements.

H14: Technological discontinuity will inversely affect the market's reaction to strategic outsourcing arrangements.

4.3.4.4 Moderating Effects of Modularity, Strategic Value, Buyer Experience and Costs

4.3.4.4.1 Degree of Modularity

Buyer firms, in their outsourcing relationships, determine the number of suppliers from whom to purchase their system components (that is, the concentration of their component purchases and the extent to which these suppliers will engage in their development activities; Tidd 1995; Wilson et al. 1990; Wasti and Liker 1990). Modularity also allows independent development of technologies and embedded coordination through adherence to common standards (Sanchez 1995, 1999). Modular systems provide platforms that facilitate greater specialization in development processes and outsourcing activities (Staundenmayer et al. 2005). Therefore, it is plausible to state that modularity may increase the effectiveness of collaboration with and acquisition of components from multiple suppliers (i.e., low concentration) as opposed to single supplier (high concentration) (Stremersch, and et al. 2003). Moreover, higher supplier involvement (that is, when the suppliers play active roles in more strategic phases of development such as design, R&D and planning) may actually be inefficient and furthermore detrimental in the context of modularity, since modular systems reduce the level of interdependency between the buyer and supplier firms. Thus, the negative effects of component purchase concentration and supplier involvement during the development of the product on the stock market's evaluation of outsourcing initiatives may diminish as modularity increases. Therefore:

H15a: The higher the degree of modularity, the higher the negative impact of component purchase concentration (i.e., multiple suppliers) on the market's reaction to strategic outsourcing arrangements.

H15b: The higher the degree of modularity, the higher the negative impact of component purchase concentration (i.e., multiple suppliers) on the market's reaction to strategic outsourcing arrangements.

4.3.4.4.2 Strategic Value of the Project

The consequences of decisions related to purchase concentration and supplier involvement should be crucial for the buyer firms in a given project/ purchase with greater strategic value (i.e., a project which provides advantages over competitors or in building competitive advantages; Robertson and Gatignon 1986; Heide and Weiss 1995). For initiatives with greater strategic value, the costs and risks to the buyer of collaborating with a few suppliers (i.e., high concentration) or enabling supplier involvement in the earlier stages of product development would outweigh the benefits. High component purchase concentration and supplier involvement may entail threats such as know-how leakage, gradual loss of capabilities and external dependence, which may ultimately diminish buyer's competitive advantage. Therefore:

H16a: If the goal is revenue enhancement (i.e., high strategic value) as opposed to cost reduction (i.e., low strategic value), the negative effect of component purchase concentration on the market's reaction to strategic outsourcing arrangement will be higher.

H16b: If the goal is revenue enhancement (i.e., high strategic value) as opposed to cost reduction (i.e., low strategic value), the negative effect of supplier involvement on the market's reaction to strategic outsourcing arrangement will be higher.

4.3.4.4.3 Buyer Experience

Stremersch et al. (2003) advocate that buyers with low project related know-how 'lack the prime motivation to mix and match components from multiple vendors' (page 337). Moreover, the less experience they have, the less they are capable of differentiating between different offerings (Weiss and Heide 1993; Heide and Weiss 1995). However, this study argues that buyers who lack relevant project experience would benefit more from working with multiple suppliers (i.e., low concentration) since maintaining an open consideration set and acquiring diverse and rich information will outweigh the relevant information acquisition costs. In contrast, more experienced and skilled buyers face less uncertainty and have less of an incentive to search for multiple supplier partners. Staying with the existing few suppliers would be more efficient in terms of time and costs, and thus they would be better off collaborating with a few suppliers (i.e., high concentration).

On the other hand, buyers with less experience may be able to have access to suppliers' know-how and capabilities while working closely with their suppliers. In this case, due to their need of relevant knowledge to develop a product, buyers would attain better outcomes by enabling higher supplier involvement in their process. On the contrary, for buyers with existing experience and capabilities, suppliers' involvement would entail more risks (such as leakage of strategic secrets and technical know-how and eventual loss of capabilities in developing the particular technology) than benefits. Thus:

H17a: The more (less) the buyer has project-related experience, the lower (higher) the negative impact of component purchase concentration on the market's reaction to strategic outsourcing arrangements.

H17b: The more (less) the buyer has project-related knowledge, the higher (lower) the negative impact of supplier involvement on the market's reaction to strategic outsourcing arrangements.

4.3.4.4.4 Overall Production Cost of the Buyer

External development of a product technology may both reduce production costs and engender positional advantage and may even draw away from resources necessary for other activities (Stremersch et al. 2003; Swan and Allred 2003). When the overall production cost is high, the buyer firm will gain product-based cost and differentiation advantages by collaborating with multiple suppliers. However, outsourcing of activities in the earlier stages of the product development (i.e., idea generation and strategic planning) should be detrimental to the buyer firm's competitive prospect. Therefore, such supplier involvement should entail negative consequences irrespective of the level of the overall production cost of the buyer. Hence:

H18a: The more (less) the level of overall production cost of the buyer, the lower (higher) the negative impact of component purchase concentration on the market's reaction to strategic outsourcing arrangements.

H18b: The level of overall production cost of the buyer will be negatively influence the market's reaction to strategic outsourcing announcements irrespective of (i.e., not moderated by) the level of overall production cost of the buyer.

4.4 DATA AND METHODS

The impact of an outsourcing agreement was measured using an event study methodology, which investigates the statistically significant impact on financial markets of a given type of event. Assuming market efficiency, perfect information, and the rationality of investors, the predicted effects of an event on the NPV of cash flows should be immediately reflected on stock prices (Chaney et al. 1991; Srinivasan and Bharadwaj 2004). Event studies demand defining the event of interest and the 'event window' (i.e., the period over which the impact of the event on firms' stock prices will be examined). In this study, the event study encompasses the impact of an outsourcing agreement on the buyer company's stock price. It is also vital to identify and isolate the effect of any confounding events pertaining to the firm that have occurred within the event window, in order to evaluate the precise response of market to the firm's particular decision.

The data on outsourcing agreements involving supply, manufacturing and development activities among both US and non-US companies were extracted from the SDC Platinum Database between January 1982 and December 2004. Daily returns for the US parent of the companies were obtained from the Center for Research in Security Prices database. The initial search yielded 1568 agreements. Non-high tech industries (17), reseller and distribution contracts (151), equity relationships and joint venture agreements (423) were eliminated from the sample. Announcements of buyer firms without a public U.S. parent company (481) were not included in the analysis. Finally, following McWilliams and Siegel (1997)'s guidelines for controling confounding effects, agreements (22) of which any partner company disclosed any other significant announcements surrounding the event window that might threat the validity of the results were eliminated (Chaney et al. 1991; Srinivasan and Bharadwaraj 2004).

This procedure resulted in total sample size of 449 agreements announced from April 1986 to July 2004. The agreements pertain to 17 different countries and 22 different industries at the 3-digit SIC level. Of the agreements, 176 (39.2%) involved cross border participants. A majority of the buyers (i.e., 347; 77.28%) operated in manufacturing industries, followed by information technology (83; 18.49%) and telecommunications (19; 4.23%). 340 (75.7%) of the announcements entailed agreements with a supplier operating outside the buyer firm's industry and 402

(89.5%) had undisclosed termination dates for the agreement. The *t*-tests revealed no significant differences at the 0.05 level in abnormal returns based on the country and industry of both the buyers and the announcements (i.e., contracts), indicating lack of potential biases resulting due to these demographics. Moreover, there was no significant difference in stock market reactions based on whether the announcement entailed a prespecified agreement duration (or termination date).

4.4.1 Analysis and Operationalization of Dependent Variable

The event study technique is based on the premise that reactions of the stock market can be employed as benchmarks for evaluating the appropriateness of a decision and as proxies for future market performance. Stock prices reflect the true value of the firms because they are assumed to indicate the discounted value of all future cash flows and incorporate all relevant information (Chaney et al. 1991; Merchant 2003; Srinivasan and Bharadwaj 2004). Thus, cumulative abnormal returns (CAR) signify investors' beliefs about the firm's value as a result of an event announcement. Positive CARs indicate that most investors perceive that the event will result in significant future cash flows, while negative CARs are expected when they hold pessimistic views regarding the announced event.

This event study analysis was conducted following the procedure proposed by McWilliams and Siegel (1997) (p. 652). To calibrate the dependent variable (cumulative abnormal returns), the market model of Brown and Warner (1985) was first estimated per firm:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \tag{1}$$

where, R_{it} is the return on security i in period t, R_{mt} denotes the corresponding daily returns on the value-weighted market portfolio (i.e., S&P 500), α_i is the intercept, β_i

represents systematic risk, and ε_{it} is the error term (i.e., $N(0, \sigma^2)$). Recent studies use estimation periods intervals ranging from 45 days to 260 days (Madhavan and Prescott 1995; Lane and Jacobson 1995). As the estimation period interval increases, the statistical accuracy of parameters (i.e., α_i , β_i and ε_{it}) also increases (Koh and Venkatraman 1991). Thus the trading days used were t = -250 and t= 10, where t=0 denotes the event. Then abnormal returns AR:

$$AR_{it} = R_{it} - (a_i + b_i R_{mt}) \tag{2}$$

where a_i and b_i are the company specific OLS parameters and $(a_i + b_i R_{mt})$ is the predicted stock return based on the 241-day estimate period. R_{it} indicates the actual return on stock i on day t. The abnormal returns (i.e., AR_{it}) are then standardized by the estimated standard deviation (i.e., S_{it}) following Hanvanich and Cavusgil (2001)'s approach:

$$SAR_{it} = \frac{AR_{it}}{S_{it}} \quad \text{for stock i and day t} \tag{3}$$

where

$$S_{it} = \sqrt{S_i^2 \left(1 + \frac{1}{T} + \frac{(R_{mt} - \bar{R}_m)^2}{\sum_{t=1}^{T} (R_{mt} - \bar{R}_m)^2} \right)} \tag{4}$$

SAR_{it} denotes the standardized abnormal return for stock i in day t in Equation 3. In Equation 4, S_i^2 is the residual variance from the market model (i.e., Equation 1) for stock i, whereas $\bar{R}_m$ represents the average market return computed over the same 241-day estimation period used to estimate the parameters in Equation 1 for stock i, and T is the number of days used to estimate the market model. The event windows, i.e., the time period intervals around the announcement day, are denoted as d (McWilliams and Siegel 1997). The cumulative standardized abnormal return for stock i (i.e., $CSAR_{i,\tau K}$) for d-day event window, where $t \in [\tau, K]$ is calculated as:

$$CSAR_{i,\tau,K} = \frac{1}{\sqrt{d}} \sum_{t=\tau}^{K} SAR_{it} \tag{5}$$

In the literature, abnormal returns are accumulated for up to a 60 day period (Lee and Wyatt 1990). However, in this study, [-4,0], [0,4], [-3,0], [0,3], [-4,3] and [0,2] event windows are employed in order to reduce noise in the dependent variable and to assess the market's reaction pattern over time (Chaney et al. 1991; McWilliams and Siegel 1997; Reuer 2001; Srinivasan and Bharadwaj 2004). Finally, consistent with prior studies (Chaney et al. 1991; McWilliams and Siegel 1997; Im et al. 2001), to examine the significance of the average CARs of N firms, the Z-statistics were calculated, using the standard abnormal returns for each firm on day t and across all firms. The significance of the abnormal returns based on the Z-statistic test indicates whether technology outsourcing announcements have a significant impact on the market value of the firms:

$$Z = \sqrt{N} \times ASCAR_{\tau} \tag{6}$$

where

$$ACSAR_{\tau} = \sum_{i=0}^{K} CSAR_{i} / N \tag{7}$$

4.4.2 Operationalization of Independent Variables

Degree of Modularity. To operationalize modularity, industry level proxies were employed (Schilling and Steensma 2001). Correspondingly, the overall use of modular systems was estimated by employing three measures: the use of externalization (i.e., the ratio of $ amount of total shipments to $ amount spent on production workers); the degree of alliance formation (i.e., counts of alliances by industry divided by the number of firms in the industry) and the use of computer networks in the outsourcing of R&D by employment. These figures were obtained from the *US Census Bureau,* the *SDC Platinum Database* and *the RDS TableBase*, respectively.

Strategic Value of the Project. As described earlier, the objective in engaging in technology outsourcing relationships (i.e., to increase revenues or enhance the firm's competitive position versus to cut costs/ improve operational efficiency) determines its strategic importance for the buyer firm. To gauge the strategic importance of the contract, a categorical measure was employed: a binary variable was coded as 0 if the announcement mentioned (in the *Factiva Press Releases* and *SDC Platinum Database*) a goal of cost reduction and 1 if it described goals such as revenue-enhancement or it involved a technology transfer, R&D and exploration activities (Koh and Venkatraman 1991).

Buyer Experience. A proxy was employed to gauge whether the buyer firm had the know-how to execute the development project by coding whether the buyer firm's business description and industry code and those of the outsourcing arrangement were identical (0 if same vs. 1 if different), obtained from the *SDC Platinum Database* (Merchant and Schendel 2000).

Overall Product Cost of the Buyer. The overall production cost of the buyer firm should influence the degree to which the buyer firm favors outsourcing (compared to internal development) for the purpose of improving cost structures and gaining product-based cost advantages. Accordingly, to estimate the level of overall production costs of the buyer firms, the company costs of goods were gathered from *Compustat Company Balance Sheets*.

Geographic Dispersion. The geographic distance between the partners in an outsourcing relationship impede the buyer firm's abilities to monitor their suppliers' performance. Accordingly, a distance score between the countries-of-origin of the firms is gauged to measure the geographic dispersion.

Cultural distance. To estimate the cultural distance between the buyer and the supplier firms, Kogut and Singh (1988)'s index of cultural distance was employed (this is the dominant method to measure culture distance between countries in the literature of international business; Merchant and Schendel 2000; Merchant 2003; Reuer 2001). The composite index is formed based on the deviation of each country from the U.S. along each of the four Hofstede (1980) cultural dimensions (that is, power distance, individualism/collectivism, masculinity/femininity, uncertainty avoidance). The differences between countries are corrected in this index for the variance of each dimension. Mathematically, the index has the following form:

$$Cd_j = \sum_{i=1}^{4} \{(I_{ij} - I_{iu})^2 / V_i\} / 4$$

where

Cd_j = the cultural distance between the home country (U.S.) and the host countries
Iij = the index value for cultural dimension i of country j
Vi = the variance of the index of dimension i
U = home country (i.e., U.S.)

Component Purchase Concentration. The number of suppliers the buyer firm collaborates with represents the degree to which the buyer diversifies risks and reduces the vulnerabilities associated with relying on a single supplier. To measure the concentration of the buyer's component purchases, the number of other suppliers from whom the buyer firm acquired components or developed technological products was recorded (Stremersch et al. 2003; Kim and Park 2002). The higher the number of suppliers the buyer collaborated with, the lower is the component purchase concentration. This information was obtained from a search for other outsourcing announcements of the buyer in the *Factiva Press Releases* and the *Compustat Database* (if not reported in the corresponding announcement texts).

Supplier Involvement. The intangible nature of the tasks and the diffusion risk of tacit know-how and core technologies (and thus the supplier's involvement) increases as the supplier contributes to earlier NPD process stages. Parallel to this, based on the announcement text obtained from *SDC Platinum Database*, a binary variable indicated 0 if the supplier contributed to later stages versus 1 if to the earlier stages of product development.

Size of the Contract. The monetary size of the contract signified the degree of resource dependency between the buyer and supplier. Contract details along with the size (annual revenue) of the buyer firms reported (in the *SDC Platinum* and *Compustat Databases,* respectively) were collected to estimate the value of the contracts to the buyer (Kallunki et al. 2001). Unfortunately, more than half of the announcements did not provide contract details, perhaps due to confidentiality reasons. However, 127 announcements did provide such information (32.5% of the sample) and this information was thus included in the analysis. An analysis for potential selection bias was conducted to determine if the sample of announcements that contained this contract size information differed significantly from those excluding it. The Levene's test for homogeneity of variances indicated that the variance for the CARs were not statistically different. Moreover, a t-test was performed for equality of means between the announcements that reported vs. not reported this information. The results showed that the CARs for the two groups did not differ significantly ($p > 0.05$), thus the reporting of the contract size (versus not reporting) did not result in any bias.

Duration of the Contract. Contract duration is an important factor that influences the ability and the flexibility of the buyer firm in leveraging any potential technological discontinuity. The duration of the contracts included in this study ranged from 1 to 25 (expected) years, as collected from *Factiva Press Releases* and *SDC Platinum Database.*

Supplier Capabilities. As mentioned, supplier capabilities add to the asymmetries in dependency at the expense of the buyer firm in developing technological products. To measure their capabilities, the number of patents the firm had registered at the *American National Standards Institute* was employed.

Asset Specificity of the Technology. All events in the data were classified into two groups, based on asset specificity. Combined resources were defined as asset specific if they included (1) licensed and patented technologies; (2) proprietary innovations that were developed by particular suppliers and thus cannot be readily re-sold or redeployed by competitors; and (3) technological products to be codeveloped by the buyer and supplier (as indicated in *Factiva Press Releases* and *SDC Platinum Database*). These categories were coded with the dummy variable as 1 if the outsourced functions were asset specific, otherwise as 0.

Technological Heterogeneity. To calibrate the technological heterogeneity in the industry that pertains to the outsourcing arrangement, the number of standards registered in each industry at the *American National Standards Institute* was recorded for each of the corresponding announcement year.

Technological Discontinuity. Relying on Schilling and Steensma (2001)'s measurement of technological change, total factor productivity (TFP) growth for each industry (starting from 1982) was acquired from *Bartelsman-Gray Database,* which is based on a five-factor production function (production work hours, capital, non-production workers, non-energy materials, and energy). This index represents the difference between the growth rate of output (real shipments) and the revenue-share weighted average of the growth rate of each function (Schilling and Steensma 2001).

4.5 RESULTS

4.5.1 Event Window Determination: Market Efficiency and Unanticipated Events Assumptions

Table 4-1 presents the overall market reaction to technology outsourcing announcements in the sample; i.e., the Table lists the average abnormal returns during a 11-day period from five days before the announcement to five days after the announcement. Interestingly, the market appears to react positively to the announcements on the event date, whereas negatively after 3 days ($p<0.05$). Thus, on the day of the announcements, such strategic initiatives are immediately perceived to have the potential to increase future income of firms; but their market value is reduced after three days, perhaps because some investors reconsider while other investors engage in profit-taking.

Table 4-2 displays the cumulative abnormal returns for six different windows: (1) a five-day pre-event period from day –4 to the event date; (2) a five-day post event period from the announcement date to day 3 afterward; (3) a four-day pre-event period from day –3 to the event date; (4) a four-day post event period from the announcement date to day 3 afterward; (5) an eight day event period from day –4 to day 3 afterward; and (6) a three-day post event period from the announcement date to day 2 afterward. Significant results were observed before, after and during the event period for the overall set of announcements.

TABLE 4-1. AVERAGE ABNORMAL RETURNS (N=449)

Day	Mean Abnormal Return	Positive: Negative Returns	Generalized Z
-10	0.28%	212:237	0.577
-9	0.22%	218:231	1.146
-8	-0.05%	198:251	-0.749
-7	-0.22%	205:244	-0.086
-6	-0.11%	191:258	-1.412*
-5	-0.06%	201:248	-0.464
-4	0.28%	219:230	1.240
-3	0.05%	198:251	-0.749
-2	0.04%	207:242	0.104
-1	0.02%	196:253	-0.938
0	0.39%	227:222	1.998**
1	0.02%	200:249	-0.559
2	-0.01%	197:252	-0.843
3	-0.35%	187:262	-1.790**
4	-0.31%	194:255	-1.127
5	0.00%	217:232	1.051
6	-0.20%	209:240	0.293
7	-0.30%	199:250	-0.654
8	0.11%	221:228	1.430*
9	0.28%	222:227	1.525*
10	0.28%	201:248	-0.464

TABLE 4-2. CAR'S AROUND TECHNOLOGY OUTSOURCING ANNOUNCEMENTS (N=449)

Event Window	Mean Cumulative Abnormal Return	Positive: Negative Returns	Generalized Z
(-4,0)	0.78%	220:229	1.335*
(0,+4)	-0.27%	203:246	-0.275
(-3,0)	0.51%	210:239	0.388
(0,+3)	0.04%	229:220	2.188**
(-4,+3)	0.44%	223:226	1.619*
(0,+2)	0.40%	233:216	2.566***

NOTE: The symbols *, ** and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively, using a one-tailed test.

As mentioned, the market efficiency assumption implies that stock process incorporate all information available to tmhe market (Fama 1991; McWilliams and Siegel 1997). If the announcement or information disclosed to the investors is reflected in the stock prices, then this assumption is satisfied. In this sample, the three-day post event period from the announcement date to day -2 generated cumulative abnormal returns with the highest significance level, and thus was chosen as the input for the dependent variable. Thus, it can be concluded that the effects of the technology outsourcing announcement events are quickly incorporated into the stock prices of the buyer firms. Moreover, since this event window was after the announcement and was the shortest duration, it allows control for any confounding effects as a result of information leakage about the agreements prior to the formal announcement. Thus, this present sample satisfied the 'unanticipated events' assumption, which states that information related to the technology outsourcing initiatives is only available through the press announcements and not before.

Interestingly, the market's reaction was approximately symmetrically distributed: among the 449 announcements, during the (0, +2) event window 233 (51.89%) produced positive market reactions, while 216 (48.11%) generated negative reactions. The conflicting reactions suggest that some investors perceived that for some firms the returns from technology outsourcing outweighed the risks associated with it; others held the opposite view.

4.5.2 Explanation of Abnormal Returns

To explain the cross-sectional variation in the abnormal returns and the proposed model was examined using moderated regression using ordinary least squares (OLS) estimation method (Neter et al. 1996; Kim and Park 2002; Kale et al. 2002; Merchant and Schendel 2002; Reuer 2001). Table 4-3 and Table 4-4 present the descriptive statistics and the correlation coefficients, respectively, for all variables included in the model (Figure 3-1). Note that abnormal returns has mean of zero in Table 4-3 because the symmetrical bimodal distribution (i.e., bipolar investor perceptions) resulted in a small absolute mean value[15].

TABLE 4-3. DESCRIPTIVE STATISTICS (N=449)

	Mean	Std. Deviation
Abnormal Returns	0.00	0.06
Modularity	0.16	0.08
Buyer Experience	0.76	0.43
Strategic Value	0.82	0.22
Size of Contract	337.72	294.50
Duration of the Contract	3794.49	1465.67
Geographic Dispersion	4085.81	3442.36
Cultural Distance	1.51	5.40
Technological Heterogeneity	33346.99	20696.71
Technological Discontinuity	0.40	4.20
Asset specificity	0.46	0.50
Supplier involvement	0.55	0.50
Supply Concentration	-5.24	9.68
Supplier Capabilities	993.96	1264.29
Buyer Costs	11587.54	23372.38

Three regression models were specified; they are shown in Table 4-5, which summarizes the regression results for each model. In the first model, only the effects of the two environmental uncertainty variables (i.e., technological heterogeneity and discontinuity) were assessed. Neither of the two variables exhibited a significant impact on abnormal returns ($p<0.05$). The overall model was not significant at 0.05 significance level based on a F-test ($F=1.74$, $p<0.18$) with R^2 and adjusted R^2 of 0.01.

Model 2 specified only the main of the hypothesized determinants of abnormal returns. This model was significant ($F = 1.72$, $p = 0.05$) with slightly higher explanatory power ($R^2 = 0.05$ and adjusted $R^2 = 0.02$). Only two independent variables had significant effects on the stock market evaluations of technology outsourcing (t-

[15] Cross-tabs analysis and t-tests were conducted to identify any significant patterns between the announcements that received positive versus negative market evaluations. The results showed that the directionality of the abnormal returns significantly differed based only on the country-of-origin of the agreement ($\chi^2 = 33.731$, df = 21, $p<.05$).

TABLE 4-4. CORRELATION COEFFICIENTS AMONG CONSTRUCTS (N=449)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Abnormal Returns	1.00														
Modularity	-0.06	1.00													
Strategic Value	-0.05	0.05	1.00												
Buyer Experience	-0.03	-0.07	-0.11*	1.00											
Buyer Costs	-0.07	-0.03	-0.07	0.10**	1.00										
Geographic Dispersion	0.10*	-0.04	0.02	-0.02	0.05	1.00									
Cultural Distance	0.07	-0.18**	-0.10*	-0.06	-0.02	0.16**	1.00								
Supplier involvement	-0.02	0.01	0.40**	-0.19**	-0.10*	0.06	0.07	1.00							
Supply Concentration	0.04	-0.23**	-0.05	-0.08	-0.21**	0.03	0.04	0.00	1.00						
Size of Contract	0.09	-0.15**	-0.10*	0.01	-0.04	0.00	0.11*	-0.04	0.04	1.00					
Duration of the Contract	-0.08	0.24**	0.18**	-0.06	-0.23**	-0.10*	-0.22**	0.05	0.07	-0.21**	1.00				
Supplier Capabilities	-0.04	0.03	-0.05	0.00	-0.03	0.01	-0.04	-0.05	0.04	-0.02	0.12**	1.00			
Asset specificity of Technology	0.09	0.05	0.07	0.01	-0.10*	-0.20**	-0.05	-0.17**	-0.06	-0.05	0.09	0.04	1.00		
Technological Heterogeneity	0.07	0.02	-0.03	-0.04	-0.01	0.02	0.08**	0.00	0.00	0.08	-0.30**	-0.05	-0.06	1.00	
Technological Discontinuity	-0.05	-0.02	0.03	0.03	0.00	-0.01	0.00	-0.05	0.03	0.02	0.03	-0.01	0.05	0.02	1.00

NOTE: The symbols * and ** denote statistical significance at the 0.05 and 0.01 levels, respectively.

values are starred in the table; $p<0.01$). Contrary to H5, geographic dispersion was positively related to abnormal returns ($\beta_5 = 0.119$). As predicted by H12, the results indicated that whether the agreement involved an asset specific technology is positively associated with the market's reactions as measured by cumulative abnormal returns ($\beta_{12} = 0.127$).

The third model included the main effects of all independent variables as well as the moderating impacts of modularity, strategic value, buyer experience and costs (modeled as the multiplicative interaction in the last eight terms in Table 4-5). This model exhibited the highest level of significance ($F=1.82$, $p<0.05$) and highest explanatory power ($R^2 = 0.09$ and adjusted $R^2 = 0.04$). Among the task characteristics, cumulative abnormal returns as a result of technological outsourcing agreements was positively associated with modularity ($\beta_1 = 0.315$; $p<0.05$) and negatively with strategic value of the project ($\beta_2 = -0.384$; $p<0.05$). Hence, H1 was supported and H2 was rejected. Geographic distance positively affected abnormal returns ($\beta_5 = 0.126$; $p<0.01$). Since this effect was hypothesized to be negative when in fact it is positive, H5 was rejected. Buyer experience, costs or cultural distance between the buyers and suppliers did not exert significant impacts on the market's reaction to technology outsourcing arrangements. Therefore, H3, H4 and H6 were not supported.

Among switching costs constructs, only asset specificity was significantly and positively related to cumulative abnormal returns ($\beta_{12}= 0.131$; $p<0.01$); thus H12 was accepted. Accordingly, the effect of component purchase concentration, supplier involvement, contract size, duration, or supplier capabilities was not significant. The results did not support H7, H8, H9, H10 or H11. Moreover, neither technological

TABLE 4-5. MODEL RESULTS (ESTIMATES AND SIGNIFICANCE LEVELS) (N=449)

		Unstandardized Coefficients		Standardized Coefficients		Collinearity Statistics	
MODEL 1	**Hypothesis**	**Estimate**	**Std. Error**	**Estimate**	**t-value**	**Tolerance**	**VIF**
(Constant)		-0.002	0.005		-0.368		
Technological Heterogeneity	-	0.000	0.000	0.073	1.550	1.000	1.000
Technological Discontinuity	-	-0.001	0.001	-0.050	-1.063	1.000	1.000
MODEL 2	**Hypothesis**	**Estimate**	**Std. Error**	**Estimate**	**t-value**	**Tolerance**	**VIF**
(Constant)		-0.037	0.037		-0.998		
Modularity	+	-0.024	0.035	-0.035	-0.694	0.837	1.194
Strategic Value	+	0.013	0.014	0.050	0.949	0.781	1.280
Buyer Experience	+	-0.003	0.006	-0.022	-0.459	0.937	1.068
Buyer Costs	+	0.000	0.000	-0.071	-1.411	0.870	1.149
Geographic Dispersion	-	0.000	0.000	0.119	2.441**	0.925	1.081
Cultural Distance	+	0.000	0.001	0.018	0.363	0.885	1.130
Supply Concentration	-	0.000	0.000	-0.025	-0.500	0.871	1.148
Supplier involvement	-	0.001	0.006	0.007	0.124	0.764	1.309
Size of Contract	-	0.000	0.000	0.063	1.290	0.930	1.076
Duration of the Contract	+	0.000	0.000	-0.045	-0.819	0.714	1.401
Supplier Capabilities	+	0.000	0.000	-0.040	-0.854	0.977	1.024
Asset specificity	+	0.014	0.005	0.127	2.553**	0.887	1.127
Technological Heterogeneity	-	0.000	0.000	0.054	1.085	0.886	1.129
Technological Discontinuity	-	-0.001	0.001	-0.053	-1.125	0.989	1.011

NOTE: The symbols * and ** denote statistical significance at the 0.05 and 0.01 levels, respectively.

TABLE 4-5. MODEL RESULTS (ESTIMATES AND SIGNIFICANCE LEVELS) (N=449) (cont'd)

MODEL 3	Hypothesis	Estimate	Std. Error	Estimate	t-value	Tolerance	VIF
(Constant)		0.141	0.100		1.410		
Modularity	+	0.216	0.110	0.315	1.968*	0.084	11.965
Strategic Value	+	0.098	0.048	0.384	2.035*	0.060	16.570
Buyer Experience	+	-0.018	0.023	-0.137	-0.768	0.068	14.760
Buyer Costs	+	0.000	0.000	0.036	0.249	0.101	9.920
Geographic Dispersion	-	0.000	0.000	0.126	2.573**	0.895	1.117
Cultural Distance	-	0.000	0.001	-0.006	-0.124	0.860	1.163
Supplier involvement	-	0.001	0.002	0.259	0.882	0.025	40.078
Supply Concentration	-	-0.013	0.024	-0.121	-0.557	0.046	21.908
Size of Contract	-	0.000	0.000	0.078	1.597	0.902	1.108
Duration of the Contract	+	0.000	0.000	-0.028	-0.510	0.704	1.421
Supplier Capabilities	+	0.000	0.000	-0.047	-1.001	0.972	1.029
Asset specificity	+	0.015	0.005	0.131	2.648**	0.877	1.140
Technological Heterogeneity	-	0.000	0.000	0.045	0.905	0.876	1.142
Technological Discontinuity	-	-0.001	0.001	-0.064	-1.369	0.979	1.021
Modularity *Concentration	-	-0.011	0.006	-0.138	-1.902*	0.407	2.455
Modularity *Involvement	-	-0.136	0.067	-0.321	-2.032*	0.086	11.629
Value*Concentration	-	-0.001	0.001	-0.025	-0.516	0.944	1.060
Value*Involvement	-	0.068	0.028	-0.445	-2.422**	0.064	15.748
Experience*Concentration	+	0.001	0.001	0.437	1.468	0.024	41.346
Experience*Involvement	-	0.008	0.013	0.152	0.605	0.034	29.351
Cost*Concentration	+	0.000	0.000	-0.058	-1.025	0.662	1.511
Cost*Involvement	-	0.000	0.000	-0.097	-0.669	0.103	9.732

NOTE: The symbols * and ** denote statistical significance at the 0.05 and 0.01 levels, respectively.

heterogeneity nor discontinuity has a direct effect on abnormal returns, thus not providing support for H13 and H14. Environmental turbulence, regardless of measurement, does not significantly impact the market's evaluations of technology outsourcing agreements.

On the other hand, component purchase concentration and supplier involvement interacting with the degree of modularity exerted significant negative effects on abnormal returns (β_{15a} = -0.138, β_{15b}= -0.321; $p<0.05$). The interaction effect of strategic value with supplier involvement (but not with component purchase concentration) was significant and negative (β_{16b} = -0.445, $p<0.01$). Thus, H15a, H15b and H16b were supported, but H16a was not supported. Finally, buyer experience or buyer overall production costs did not moderate the relationships between component purchase concentration and supplier involvement. These results did not support H17a, H17b and H18a, but confirmed H18b.

These findings are discussed in greater detail in the Discussion section below.

4.6 DISCUSSION

Businesses in TI markets increasingly engage in strategic outsourcing relationships due to rapid technological developments and amplified global competition. In particular, many firms engage in relationships with their suppliers in order to gain flexibility, responsiveness, and competitive advantages against their rivals. Despite benefits, such relationships entail certain costs and threats for the buyer. These relationships may lead to asymmetries in dependence due to task specific qualities, switching costs, and the perceived dynamics of the technological environment. Thus monitoring and coordination mechanisms become necessary to prevent opportunistic supplier behavior and the expropriation of buyers' technological know-how and commercial secrets. Furthermore, relying on suppliers' know-how and capabilities for the development of technologies may lead to loss of buyers' capabilities and cast doubts on the amount of their tacit contributions. Both in the scholarly literature and the business press, strategic outsourcing arrangements involving product technologies have attracted significant attention. However, to the best of the author's knowledge, this is the first study that analyzed the market value of firms' global technology outsourcing initiatives as well as the factors that influence their stock market evaluation.

The overall picture that emerges can be described as follows. First, modularity exerted a positive influence on stock market evaluations as measured by cumulative abnormal returns. As mentioned earlier, the loose coupling of component designs within a modular architecture allows the mixing and matching of modular components without having to redesign other components. This provides firms the capability of developing a potentially large number of product variations with distinctive functionalities, and thus the flexibility and speed in responding to their market's requirements. Since development work can proceed independently across firms, modular systems enable the reduction of asymmetric dependencies and monitoring costs in interorganizational relationships. More importantly, these architectures involve less disclosure of strategic and technical information, such as design plans and development techniques. Above all, this study demonstrates another advantage of these loosely coupled systems, that is, reducing the investors' risk perceptions of global technology outsourcing relationships.

Strategic value of the project (i.e., cost reduction or revenue enhancement) was also positively associated with the market's reaction, suggesting that investors perceive contracts with strategic goals (rather than efficiency goals) to lead to higher returns. Such contracts with strategic aspirations are viewed by investors to have higher potential to increase the firm's future success. Moreover, as predicted, technology outsourcing agreements entailing asset specificity on the part of the buyer (that is, involved proprietary technologies jointly developed, or developed by the supplier) resulted in positive stock market reactions. In other words, the market reacts favorably to buyers that employ suppliers' patented and proprietary technologies. Thus, it would be plausible to state that outsourcing projects increased firm's value in the stock market if they: (1) involved proprietary innovations developed jointly or by the suppliers; and/or (2) entailed more strategic goals such as meeting demand, developing new products or entering new markets.

Furthermore, geographic distance increased abnormal returns acquired from outsourcing announcements. Thus, global technology outsourcing in distant locations enhanced firm market value. The findings also call into question the general conception in the popular press and concerns of executives regarding the difficulties and risks of technology outsourcing and offshoring. However, cultural distance (as opposed to geographic distance) did not have an impact on the market evaluation of technology initiatives. Correspondingly, it may be concluded that relationship-related, but not strategic and operational aspects of the arrangement influenced investors' perceptions regarding the returns and risks of technology outsourcing. Furthermore, buyer project-related experience or production costs did not have an immediate effect on the stock market reactions. Experience and cost may be less visible to investors or their impact may be blurred with the buyer firms' other characteristics, such as brand image. Further research may also test for the impact of other constructs such as reputation.

Contract size and duration were not significantly associated with market reaction. It appears that investors were not concerned about the size or duration of the contract when they assessed the potential for rewards or the degree of the risk inherent in outsourcing initiatives. Furthermore, component purchase concentration or supplier involvement did not influence stock market reactions. Since this information is internal, it may take a longer duration than the event date tested in this analysis for these factors to impact firm market value. Supplier capabilities did not exert a significant influence on abnormal returns. This may be because supplier capabilities may be reflected into stock prices in the longer run. Another underlying reason may be that investors may not be aware of the expertise and reputation of suppliers outside the US. Finally, neither technological heterogeneity nor technological discontinuity impact abnormal returns directly. Future research may test their moderating effects.

While the main effects of component purchase concentration and supplier involvement on stock market reactions were nonsignificant, they exerted a negative impact in combination with the degree of modularity. In other words, as expected, modularity negatively moderated the effects of component purchase concentration and supplier involvement on market value. As modularity increased, working with a few suppliers and allowing for supplier involvement in the earlier stages of product development diminished in importance in determining firm market value. High supply concentration and high supplier involvement indicate that the buyer firms do not employ the advantages accrued by using loosely coupled systems (i.e., their ability to develop components independently and reconfigure modules without the loss of functionality): the consequences are more costly than beneficial to the buyer firms. Strategic value of the project did not significantly moderate the impact of component purchase concentration, but exerted a negative impact on abnormal returns combined with supplier involvement. This finding was consistent with literature that posits that firms chose to internalize activities that were associated with their core competencies.

Thus, if the agreement entailed high value for organizational profitability and productivity, supplier involvement to the earlier stages of development had a detrimental effect on firm market value. The market did not favor high supplier input to buyers' projects of high strategic value and product technologies related to their core competencies. Project related experience or production costs of the buyer did not moderate the impacts of supply concentration and supplier involvement on stock market evaluation. In other words, buyers' experience and costs do not play a significant role interacting with the number of suppliers that they work with and the extent to which they outsource their product development. Similar to their main effects, buyers' expertise to execute a development project and overall production costs are either not available or not of concern to investors in their evaluations of the returns and risks of technology outsourcing.

This study has a number of implications for both research and practice. From the research perspective, this study provides valuable insights into the consequences of technology outsourcing, since there is a paucity of studies on the outcomes of global outsourcing in technology-intensive markets. Furthermore, the symmetric stock market results (i.e. half positive and half negative abnormal returns) indicate that the argument on outsourcing's negative impact (or positive impact) on market value or performance should be revisited. About half of the announcements triggered positive reactions; the other half produced negative responses. The findings of this study may benefit practitioners by offering insights that may guide them to maximize the market impact of their outsourcing initiatives. As an illustration, in the context of technology-intensive markets and technology outsourcing initiatives, the market favors modular systems since such architectures provide firms with both strategic and operational flexibility. The empirical analysis indicated that strategic outsourcing for the development of new products and proprietary technologies enhances firm market value. This also suggests that technology outsourcing for efficiency purposes may result in unfavorable market reactions. Outsourcing for cost reduction may lead to potential leakage of tacit know-how and the gradual loss of knowledge-based capabilities and thus increase investors' uncertainty as to how much intellectual property the buyer firms really own in the products. Consequently, executives should expect a negative reaction from investors when they announce technology outsourcing initiatives for attaining efficiency or for developing products for which they are already prominent in commercializing. Managers should also take into consideration the fact that the market favors global technology outsourcing with partners. Therefore, it actually may be beneficial to disclose contract details.

This study assessed the risks and returns associated with technology outsourcing and presented empirical evidence that tests prevailing claims in the scholarly literature and popular press. Future research may expand upon the model to include other factors that may influence firm market value as a result of technology outsourcing initiatives. Market characteristics such as growth potential and market concentration might explain the portion of the variance that was not explained in this study. Since proxies were employed to measure all indicators, future studies may examine the model using (or combined with) survey data. For instance, the degree of modularity was operationalized at the industry level. Further research using secondary data sources may develop a firm level measurement which may result in better estimates of free parameters (thus may be possible through primary data collection). In addition, although there was no significant difference observed with respect to the abnormal returns between the announcements with contract size details vs. those without, a further analysis may be required to shed light on why only some firms do not disclose this information.

CHAPTER 5

CONTRIBUTIONS AND FUTURE RESEARCH

5.1 INTRODUCTION

This dissertation scrutinized technological innovation from three lenses: (1) the scholarly literature was synthesized and scrutinized for effect size moderators using a theory-driven meta-analysis; (2) the determinants of internal innovation development (moderated by environment) were examined employing partial least squares analysis; and (3) the effect on company value of external innovation development within loosely coupled systems was analyzed using an event study methodology. Overall, two research questions were addressed: (1) which factors associated with both internal and external innovation development contributed to firm performance and market value; and (2) under what conditions do internal and external development engendered superior outcomes. Together, the three studies involved different theoretical models of innovation, the analysis of various types of data (i.e., published literature, primary and secondary data) and use a variety of methodologies (i.e., meta-analysis, PLS, and event study). Thus, this research derived knowledge and new research directions concerning innovation from the extant body of literature and from the analyses of the 'values' of both internal and external innovation development.

The first essay benefits academics because the cumulative results of published studies are examined theoretically and empirically to reveal general patterns as well as to investigate substantive and methodological sources of inconsistencies. Simplification could also benefit practitioners. Based on cross-sectional data of North American firms, the second essay involves an empirical investigation of a comprehensive model of the determinants of internal innovation success. This model is of theoretical interest to academics, but also tells practitioners *what works if the goal is internal development.* Finally, the last essay involves an event study analysis of the impact of outsourcing agreements on the market value of companies. This model extends existing research and also tells practitioners *whether* and *under what conditions* to develop externally. These contributions are detailed in the subsequent sections below.

5.2 STUDY RESEARCH QUESTIONS AND CONTRIBUTIONS

STUDY #1. Inconclusive New Product Innovation "Returns": A Meta-Analysis Of Research On Innovation In New Product Development

The primary goals of this meta-analysis were twofold. First, the innovation literature is ripe for an objective and rigorous synthesis due to the amount of new research and the fact that some of studies have contradictory results. This study examined of the underlying grounds for inconsistencies and their impact on the relationships of new product innovation with its determinants and outcomes. In the NPD, marketing and management literatures, the differences in the level of analysis and perspectives, as well as the diverse labels and categorizations of innovation have resulted in inconsistencies in actual empirical results. Particularly, the effects of environmental turbulence, strategic orientations, organizational structure, and most importantly, new product performance are highly debated. For instance, some argued that a focus on customers' existing preferences (i.e., customer orientation) facilitated new product innovation, while others argued that reliance on customer input led to reactive strategies and incrementally innovative products rather than bold and radical ones. The common tenet in the literature regarding the impact of the organizational structure was that flexible organic structures enhanced receptivity to new technology. However, some research found that centralization *facilitated* (rather than hindered) new product innovations by reducing conflict and ambiguity, leading to a more uniform response to the incoming technology. Lastly, while some argued that more innovative products provided value to customers and differentiation advantages relative to competitor offerings, other studies have concluded that less innovative products were less uncertain, more familiar and synergistic and brought about greater success. Hence, this meta-analysis scrutinized whether the substantive and methodological differences (i.e., level of analysis, perspective and measurement) among the studies published in the literature limited generalizability of their results and led to contradictory conclusions.

The second set of key question addressed in this study was whether turbulence, strategic orientation and organizational structure enhanced (or hindered) new product innovation and whether new product innovation improved new product performance. Hence, this present study presented a theory-driven meta-analysis providing an objective and rigorous evaluation of the overall tendency in a body of literature by standardizing the results of large number of studies. Using structural equation modeling, an overall model that included technological turbulence, market turbulence customer orientation, competitor orientation, organizational structure, new product innovation, and new product performance, as well as the moderating variables described previously, was explored. The overall goal was to analyze a synthesized model that permitted evaluation of key mediators and moderators on the relationships of innovation with its antecedents and outcomes.

RQ(1) ***Did the level of analysis, the perspective and/or the measurement of new product innovation impact the findings of the studies?***

The evaluation of the findings of the two substantive moderators (i.e., level of analysis and perspective) provided interesting insights that may benefit innovation researchers. First, market turbulence did not overall directly affect new product innovation. But when the impact of the substantive artifacts was analyzed, this relationship may be positive for program or firm level analysis. Second, technological turbulence overall facilitated new product innovation. But researchers examining particular projects or taking a firm perspective may find this relationship nonsignificant. Therefore, environmental turbulence directly impacted program level new product innovation, supporting the literature that states that rising environmental uncertainty increases the rate and level of innovation required to survive (e.g., Kotabe and Swan 1995). Future research may analyze whether environmental turbulence also influenced the degree to which other firm resources (organizational structure, marketing and technical resources and know-how) and activities (strategic planning and idea generation) engender new product innovations.

Third, customer orientation was not overall a direct antecedent of new product innovation, but program research may find this path positive while project research may find it negative. Similarly, competitor orientation did not exert an overall direct effect on new product innovation, however it may exert a direct positive influence in project or firm oriented research. Fifth, mechanical structures encouraged new product innovation overall, but not in program level research (n.s.), nor in firm-level analysis. At the project level and when the customer perspective was taken, the impacts of customer and competitor orientations on innovation were partially mediated by organizational structure (i.e., there were direct effects on innovation, as well as indirect effects on innovation through structure). The findings regarding strategic orientations corroborated the principles of RBV theory and the three-tier contingency model of the strategy-structure-performance relationship. This study focused on customer and competitor orientations but an entrepreneurial or technological orientation may play a similar role as complete mediator.

Moreover, examining the moderating impact of perspective, the results of hypothesis testing exhibited three unexpected results regarding the effects of turbulence, orientations and structure. First, market turbulence engendered new product innovation within the firm perspective, whereas hindered when the customer perspective was adopted. This suggested that market turbulence facilitated development of new product innovations in the presence of high competitive intensity and frequent shifts in competitor actions and strategies. To the contrary, it decreased innovation due to rapid product obsolescence and changes in customers' perceptions of innovativeness of product and companies. Similarly, competitor orientation was negatively linked with new product innovation in the 'customer perspective' subgroup, suggesting that monitoring of competitor actions led to reactive strategies and incrementally innovative products rather than bold and radical ones. Interestingly, from a firm perspective, mechanical structures were negatively linked with new product innovation; however, it facilitated innovation within a customer perspective. Thus, more formalization and centralization, which entail efficiency in decision making and in responding to their environment, enabled new product innovations viewed as 'new' in the market. Furthermore, new product innovation directly and positively influenced new product performance, regardless of the level of analysis (i.e., program or project level research) or perspective (i.e., firm or customer oriented research).

Finally, the methodological moderator investigated in this analysis -- namely, operationalization of the innovation construct – moderated four of the hypothesized paths (the relationships being significant only in the 'categorical single item' subgroup). This showed that measurement may have a major impact on the results of a structural model (including one of new product innovation) and that categorical single item measures inflated the strength of these relationships. Thus, future researchers should design their studies with caution.

Overall, a synthesis of the innovation research corroborated the premises of the two major theoretical foundations (i.e., the RBV and contingency frameworks) regarding the determinants and outcomes of new product innovation. This meta-analysis may be further extended by testing the moderating effects of other study artifacts (see Table A-1). The studies included in this analysis predominantly focused on manufacturing industries, collected their survey data in North America and conducted cross-sectional analyses of innovation. Future studies may control for the effect of these characteristics.

RQ(2) ***What are the antecedents that significantly facilitate (or impede) new product innovation? Does new product innovation improve (or deteriorate) performance?***

As mentioned, a structural model on the determinants and outcomes of new product innovation was analyzed to derive empirical generalizations and to investigate mediating relationships. The findings indicated that market turbulence, but not technological advancements in its industry, increased the monitoring of competitor actions and strategies. Technological turbulence, however, encouraged mechanical structures and new product innovation. Hence, rapid technological advancements may lead firms to become less organic to innovate more. On the other hand, neither market nor technological uncertainty affected customer orientation. This may signal the significance of being responsive to customer demands irrespective of the level of environmental turbulence. Furthermore, both market and technological turbulence had indirect effects on new product innovation through either strategic orientation constructs and/or organizational structure. Customer orientation and competitor orientation also preceded new product innovation indirectly through mechanical structures.

Thus, firms in turbulent environments organize in such a way that would enable them to efficiently manage any necessary adjustments in accordance to the changes in their industries. For uncertain environments that demand fast reactions, building consensus may take too much time; thus a continual crisis orientation, a centralized approach and formalized processes may be more rewarding. Centralization and formalization may facilitate implementation by reducing conflict and ambiguity, leading to a more uniform response to the changes in the environment (Meyers et al., 1999). Overall, these findings are contrary to the contingency framework of the industrial organization (IO) paradigm, which views strategy as a firm's response to the competitive industry environment and proposes that firms should adopt less centralized, more organic structures in dynamic, uncertain environments.

On the other hand, customer and competitor orientation indirectly affected new product innovation and performance through mechanistic structures. This may indicate that innovation requires more mechanistic approaches, through which (1) possible conflicts in NPD processes can be prevented, and (2) integrated and harmonious operations can be implemented across functions. Through senior level involvement and centralized strategic planning and agenda setting, firms may achieve both generating novel products and meeting market demand. Finally, new product innovation engendered new product performance. Thus, as RBV and contingency theories suggest, firms may achieve superior performance if they can utilize their internal resources and capabilities in distinctive ways (Day, 1994; Mahoney and Pandian, 1993; Peteraf, 1993).

On the whole, the inherent risks associated with new product development, the rising R&D costs as result of rapid technological development, increased competition, and continuous changes in the demands of consumers intensifies the need for new product innovations. Managers operating in highly turbulent environments are confronted with the necessity of being innovative and highly responsive to the dynamics of their industry. The findings of this study highlighted the importance of new product innovations, as well as strategic orientations along with mechanistic organizational structures, in coping with industry turbulence and attaining competitive advantages.

STUDY #2. Market Efficient Technological Innovation: A Detailed Model with Marketing Implications

Research on NPD projects has predominantly focused on internal factors and adopted a firm perspective. Particularly, earlier literature ignores the market side of NPD. The literature posits that highly innovative products (which entail less fit to the firm) hinder adoption and have high costs and risks to the firm; however, at the same time, these products provide firms with a differentiated position in the market. Thus, a combination of both firm and market perspectives (that is, considering both the internal and the external side of new product innovation development) may ensure higher explanatory power in the study of new product success. In the extant literature, the match between what is needed (i.e., market pull) and what can be developed internally (i.e., technology push) is viewed to drive success. However, the operationalization of this match is still a frontier research issue.

Meanwhile, with their limited available resources, managers are faced with the challenge to achieve a balance between speed to market and quality of execution in search for success in the contemporary business environment. The competing goals of minimizing risk by acquiring sufficient technological and market information, while also minimizing costs and time to market, escalated the importance of NPD process implementation. The quality in NPD execution allows firms to avoid sacrifices of necessary information, mere focus on 'doable' incremental projects, as well as prevent loss of opportunities for more profitable radical innovations. In the literature, resources, capabilities and strategic orientations have been directly linked to positional advantages and performance outcomes. The quality of the implementation of these orientations and process activities has not generally been included in NPD models.

Consequently, this second study constituted an empirical analysis of the determinants and outcomes of market efficient innovation development, referring to Day and Wensley's (1988) work and incorporating the notion of fit. The specific research questions addressed were: (1) does the project's internal environment (i.e., the strategic fit of the project and project structure and climate) have a direct impact on positional advantages and project performance, or exert an indirect effect mediated by the NPD process implementation; and (2) under what conditions does internal technological innovation development serve to attain superior performance?

Thus, this study delineated the notion of 'strategic fit' both from the firm and customer perspectives. As opposed to measures such as "having more than adequate resources" in prior literature, an operationalization to assess 'fit' was provided: the degree of new resources and capabilities required for the product and the extent of synergy the project enjoyed with the existing structure. The 'internal innovation development' model proposed in this study is anchored in Day and Wensley's (1988) source-position-performance (SPP) framework, which linked firms' sources of advantage (skills and resources) to positional advantages based on cost and/or product differentiation. The project's internal environment (i.e., strategic fit of the project,

project related sources of advantages and proficiency in NPD process) was purported to influence positional advantage and performance of the project, moderated by external environmental factors. This moderation effect of environmental turbulence, supported by NPD contingency theory, indicates that the extent to which internal factors engender new product success is determined by external factors, and thus partially outside the control of the managers. This analysis further provided practitioners with a comprehensive list of internal, environmental and supply-chain related factors important for successful development.

This study focused on the chemical, biochemical and pharmaceutical industries, which may have limited the generalizability of the model. Further research is recommended to investigate other industries. Despite that statistical controls were implemented to control for common method variance, perceptual measurement and single respondents leaves the model effects subject to this bias to a certain extent. Thus, a multiple informant design is recommended for further studies

RQ(1) Does the project's internal environment (i.e., the strategic fit of the project and project structure and climate) have a direct impact on positional advantages and project performance, or exert an indirect effect mediated by the NPD process implementation?

As mentioned, Day and Wensley (1988) contended that:

"*Superior skills and resources are not automatically converted into positional advantages, nor is there a certain performance payoff from superior cost or differentiation positions. Both conversions are mediated jointly by strategic choices, including objectives and entry timing and the quality of tactics and implementation*" (p. 6).

Accordingly, this study examined whether strategic fit of the project and project-specific advantages (i.e., project formality and project climate) directly influenced positional advantages versus whether NPD process implementation mediated these effects. The results indicated that only manufacturing fit has strictly indirect (positive) effect on returns through idea generation proficiency, whereas supply-chain, marketing and R&D fit influence positional outcomes both directly and indirectly through NPD activities. Thus, fit of the project with regards to the *market side* of the NPD project was automatically converted into positional advantages to a certain degree. At the same time, in line with the SPP framework, these conversions were also mediated by proficiencies in idea generation, product development, development speed and development cost.

Interestingly, supply-chain fit decreased positional advantages both directly and through enhancing idea generation and product development. This indicates that a repeated focus on the target market and demand forecasts of previous projects enhanced internal implementation proficiencies, but impeded external market effectiveness and the supply of novel and superior benefits over current products. On the other hand, the new project's synergy with the firm's existing marketing enhanced its positional advantages directly as well as indirectly through decreasing idea development proficiency. This suggested that firms may attain superior market positions in two distinct ways: by exploiting existing marketing capabilities in the products previously offered, at the same time through more effective idea generation, which actually requires departure from existing marketing skills. Further research may examine the determinants and outcomes of idea generation in greater detail.

The findings regarding development speed were also interesting and deserve further investigation. Both supply chain and R&D fit increased development speed, which interestingly hindered the degree to which customer needs were met. This has been frequently addressed and debated both in the academic literature and popular press. For the sake of timeliness, firms opted to 'focus on trivial, rapidly executable development projects' (Calantone, et al., 1997, p. 179), which occasionally resulted in failure in meeting market demand. This may be due to the neglect of consumer readiness for the sake of development speed. Researchers may examine the dynamics among strategic planning, NPD process execution, speed to market and performance returns.

The findings on the effects of project formality and project climate on the effectiveness of idea generation and opportunity analysis was contrary to both the expectations of this study and the literature (Veryzer 1988; McDermott and O'Connor 2002). The results indicated that formal management processes and cross-functional integration enhanced idea generation, technical assessment and product development possibly through reducing uncertainties and specifying the required tasks and their sequence. Moreover, project formality reduced, while project climate increased speed and cost. Thus, project formality not only provided time and cost efficiencies, but formal mechanisms and cross-functional integration led to better execution. Future studies may also investigate how different levels of and approaches to cross-functional integration impact performance outcomes. For instance, project formality and project climate may exert a combinatorial effect on implementation effectiveness and efficiency.

Finally, the execution of NPD process activities was purported to be the key to achieving positional advantage in the market. The results provided partial support: proficient idea generation and product development activities did bring positional advantage, but proficiency in technical assessment diminished product advantage. Therefore, a focus on technical attributes and performance of the product may lead to a neglect of product quality and benefits in the eyes of the customers.

RQ(2) Under what conditions does internal technological innovation development serve to attain superior performance?

The findings indicated that both meeting customer needs and product advantage significantly enhanced the project's impact on performance. This corroborated the significance of exceeding customers' needs over what is offered in the market and investing to gain relative product advantages. In addition to this, the degree to which product advantage (but not meeting customer needs) provided performance returns was moderated by market conditions. The relationship between product advantage and project performance was found to be *stronger* as the market demand shrinks and the competition becomes more intense. On the other hand, investing in meeting customer needs always proves rewarding regardless of whether rivalry is severe or customer demand is changing. Future research may investigate the moderating impact of technological factors (such as the rate of technological change or the presence of dominant standards), which were not included in this analysis.

STUDY #3. Global Strategic Outsourcing for Resource Deficient, Market Efficient Technological Innovation

TI industries are increasingly characterized by firms outsourcing either a portion of or the entire product development process. The goal is either survival or being more responsive to the market dynamics. Even though outsourcing relationships may enhance the buyer firms' technical intelligence and increase their flexibility, they create coordination difficulties, overreliance on suppliers' resources and capabilities, and thus potential leakage or gradual loss of tacit know-how. Consequently, the risks of technology outsourcing as well as their wealth effects have been major concerns to managers. Despite such attention in the business press, there is a paucity of studies on technology outsourcing, most of which adopted a cost-based approach while ignoring value enhancement and performance outcomes that result from such strategies. In this thesis, the focus is on discrete buyers' choices in single transactions. Consequently, this study constituted an empirical validation of the performance outcomes of strategic outsourcing relationships in the context of global technology intensive markets and modular systems.

In summary, grounded in agency, resource dependency and transaction cost theory, the primary objective of this third study was to develop and test a model on the determinants of the market value of external innovation development. This research aimed to provide implications for managers on the returns and risks of global strategic outsourcing. The market evaluation of technology outsourcing announcements was used as a proxy for the business value of such initiatives. Furthermore, the extent to which key factors associated with such agreements influence the buyers' market (shareholder) value as a result of their technology outsourcing announcement was investigated. On the whole, buyers were hypothesized to receive abnormal returns in their outsourcing agreements, based on the task characteristics, switching costs and the degree of environmental uncertainty. Specifically, this study examined: (1) do technology outsourcing agreements increase firm market value; and (2) how do the key factors related to these arrangements (including certain risks and their interrelatedness to other projects) impact their market evaluation?

Future research may expand upon the model to include other factors that may influence firm market value as a result of technology outsourcing initiatives. Since proxies were employed to measure all indicators, future studies may examine the model using (or combined with) survey data. Further research using secondary data sources may develop a firm level measurement which may result in better estimates of free parameters (which may be possible through primary data collection).

RQ(1) Do technology outsourcing agreements increase firm market value?

Interestingly, as represented in Table 4-1, the market reacted positively to the announcements on the event date, whereas negatively after 3 days ($p<0.05$). On the day of the announcements, technology outsourcing initiatives were immediately perceived likely to increase firms' future cash flows. However, their market value reduced after three days, perhaps because some investors reconsider while other investors engage in profit-taking. Moreover, as Table 4-2 indicates, significant abnormal returns were generated in four event windows: (1) the five-day pre-event period from day –4 to the event date; (2) the four-day post event period from the announcement date to day 3 afterward; (3) the eight day event period from day –4 to day 3 afterward; and (4) the three-day post event period from the announcement date to day -2. Thus, the effect of technology outsourcing announcement events on firm market value was significant and was quickly incorporated into the stock prices of the buyer firms.

Interestingly, technology outsourcing generated positive and negative investor reactions in approximately equal measure: half of the announcements received favorable (positive) market reactions, while half generated negative reactions. The conflicting reactions suggest that some investors perceived that for some firms the returns from technology outsourcing outweighed the risks associated with it; others held the opposite view. Further tests were conducted to identify any significant patterns between the announcements that received positive versus negative market evaluations. The results showed that the directionality of the abnormal returns significantly differed based only on the country-of-origin of the agreement (χ^2 = 33.731, df = 21, p<.05). This notion was addressed in earlier trade theories in the international business literature (Vernon 1966; Horst 1976). These theories generally posit that at the early stages of product development, US firms exploit their technological advantage and develop their products for their home market. At a later stage of the product cycle, they exported their products to other countries based on their similarity to the US in demand patterns and supply capabilities. Gradually, as the product becomes standardized or mature, the attractions of locating value-added activities in a foreign country increase. Thus, a US firm wishing to maintain its initial share of the foreign market is eventually forced to establish marketing, service and production facilities in that foreign country. Similarly, the sample of firms in this study received favorable versus unfavorable market reactions based on the countries of the supplier firms with which they engaged in technology outsourcing relationships. Further research may conduct a longitudinal study to understand how the market reacts to technology outsourcing across a longer span of time.

RQ(2) How do task characteristics, switching costs and environmental uncertainty impact the market's reaction to global technology outsourcing?

Task characteristics, modularity, the strategic value of the project and geographic dispersion significantly affected stock market evaluations as measured by cumulative abnormal returns. This study demonstrated an additional advantage of the modular systems, i.e., reducing the investors' risk perceptions and increasing the market value of global technology outsourcing relationships. Furthermore, contracts with strategic goals of revenue enhancement (rather than efficiency goals with cost reduction concerns) increased firm market value. Geographic distance also engendered abnormal returns. Thus, global technology outsourcing in distant locations enhanced firm market value. The findings, therefore, addressed the general conception in the popular press and concerns of executives regarding the difficulties and risks of global technology outsourcing.

Another interesting finding in this study was that technology outsourcing agreements entailing asset specificity on the part of the buyer (that is, involving proprietary technologies jointly developed, or developed by the supplier) resulted in positive stock market reactions. Overall, this study showed that global outsourcing projects increased firm's value in the stock market if they: (1) involved proprietary innovations developed jointly or by the suppliers; and/or (2) entailed more strategic goals such as meeting demand, developing new products or entering new markets.

Future research may investigate using other methods the impact of the factors associated with technology outsourcing that did not exert a significant impact on firm market value (see Table 4-5). This model included factors that may be less visible to investors or their impact may be blurred with the buyer firms' other characteristics, such as brand image. Since information related to these factors (e.g., buyer experience, buyer costs, supply concentration, supplier involvement and supplier capabilities) is internal, it may take a longer duration than the event date tested in this analysis for these factors to impact firm market value. Another underlying reason may be that investors may not have sufficient information on agreements involving non-US partners. Finally, neither technological heterogeneity nor technological discontinuity impact abnormal returns directly. Future research may test their moderating effects.

The analysis of interaction effects of four task characteristics (i.e., modularity, strategic value, buyer experience and costs) and two buyer decisions (i.e., supply concentration and supplier involvement) provided valuable insights. The findings suggest that for higher market value, buyer should employ the advantages accrued by using loosely coupled systems (i.e., their ability to develop components independently and reconfigure modules without the loss of functionality) and establish relationships with multiple suppliers but allow for less supplier involvement. Furthermore, for the agreements entailing high value for organizational profitability and productivity, supplier involvement in the earlier stages of development had a detrimental effect on firm market value. This finding corroborated the common tenet in the literature that firms should internalize activities that are associated with their core competencies.

The market did not favor high supplier input to buyers' projects of high strategic value and product technologies related to their core competencies. Finally, the nonsignificant moderating effects of buyers' expertise to execute a development project and overall production costs on the linkages from supply concentration and supplier involvement to firm market value may be attributed to their unavailability or unimportance to investors in their evaluations of the returns and risks of technology outsourcing.

The findings of this study offered valuable insights for practitioners that may guide them to maximize the market impact of their outsourcing initiatives. Particularly, the market favored modular systems due to their strategic and operational flexibility advantages. Global technology outsourcing arrangements for the development of new products and proprietary technologies also enhanced firm market value. Therefore, executives should expect a decrease in their future cash flows when they announce technology outsourcing initiatives for attaining efficiency or for developing products for which they are already prominent in commercializing. Such a decrease may result due to potential leakage of tacit know-how and/ or the gradual loss of knowledge-based capabilities.

5.3 FURTHER RESEARCH RECOMMENDATIONS

This dissertation examined internal and external product development separately. The underlying motive was an interest in understanding the dynamics and the advantages in each context, before a decision be made as to which context is better for the new product innovation generation, and most importantly, firm market performance. Thus, further research may simultaneously analyze internal and external aspects to investigate how firms most effectively and effectively combine the two approaches of development of new product innovation. Future studies may examine whether other factors (and/ or linkages) may be influential in a portfolio approach or whether the relationships among the factors studied in this dissertation change. As an illustration, the relationship between NPD process implementation proficiency and perceived outsourcing risk may be analyzed.

APPENDICES

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX A

META ANALYSIS (CHAPTER 2)
SUPPORTING DOCUMENTS

TABLE A-1: STATISTICS RELATED TO SELECTED ARTICLES

	Level of Analysis		Perspective		Measurement of		Primary research		Time frame of the		Country of origin		Industry context	
FULL SAMPLE (USED FOR THE REVIEW OF THE LITERATURE)	Project/ Product Level	50	Customer Perspective	9	Categorical-unidimensional	25	Field Interview (personal and telephone)	22	Longitudinal	17	North America	73	Variety of industries/ Manufacturing/ High tech	69
	Program/ Firm Level	60	Firm Perspective	79	Categorical multidimensional	7	Sample Survey (mail and web)	62	Cross-Sectional	85	Europe	11	Variety of Services	11
	Dyad	1	Both	25	Continuous-unidimensional	17	Case study	8	Not applicable	11	Australia	4	Single	16
	Research studies	3			Continuous-multidimensional	64	Experimental Design	5			Asia	6	Non-industry respondents	6
							Secondary data analysis	6			Cross-country	6	Not applicable	11
							Literature review (+ Meta Analysis)	10			Not applicable	13		
SUBSET (USED FOR THE META-ANALYSIS)	Project/ Product Level	16	Customer Perspective	3	Categorical-unidimensional	9	Field Interview	9	Longitudinal	4	North America	36	Variety of industries/ Manufacturing/ High tech	33
	Program/ Firm Level	30	Firm Perspective	36	Categorical multidimensional	1	Sample Survey	34	Cross-Sectional	42	Europe	4	Variety of Services	4
			Both	7	Continuous-unidimensional	8	Case study	0			Australia	1	Single	6
					Continuous-multidimensional	28	Experimental Design	2			Asia	3	Non-industry respondents	3
							Secondary data Analysis	1			Cross-country	1		

NOTE: NA denotes 'not applicable'.

APPENDIX B

INTERNAL INNOVATION DEVELOPMENT (CHAPTER 3)
SUPPORTING DOCUMENTS

B.1 SELECTED QUESTIONNAIRE ITEMS

Supply-Chain Fit:
"Was the new product aimed at your existing customers- customers you sold before?"

Marketing Fit:
"Was the advertising, promotion and marketing communications for this project the kind you had used before?"

R&D Fit:
"Did the R&D skills and resources needed for this project fit closely with the existing R&D skills of the company?"

Manufacturing Fit:
"Could this product be manufactured using existing company plant and equipment, with no changes are required?"

TABLE B-1. THE LITERATURE AND THE HYPOTHESES DEVELOPED

STUDIES IN LITERATURE	GENERAL ACKNOWLEDGEMENT IN LITERATURE	HYPOTHESES DEVELOPMENT
Atuahane-Gima, 1996	A close fit enhances the project team's ability to gather and interpret market and competitive information. Increases in a project's fit led to improvements in the quality of implementation during the NPD process.	*H1. Supply chain fit is positively related with proficiency in (a) idea development and opportunity analysis (b) product development, and (c) development speed, but (d) is negatively related with development cost.*
Calantone and Di Benedetto, 1988		
Calantone, Schmidt and Di Benedetto, 1997		*H2. Marketing fit is positively related with proficiency in (a) idea development and opportunity analysis, (b) product development, and (c) development speed, but (d) is negatively related with development cost.*
Cooper and Kleinschmidt, 1987		
Cooper, 1979		*H3. R&D fit is positively related with proficiency in (a) idea development and opportunity analysis, (b) technical assessment, (c) product development and (d) development speed, but (e) is negatively related with development cost.*
Song and Montoya-Weiss, 1998		
Song and Parry, 1996, 1997		*H4. Manufacturing fit is positively related with proficiency in (a) idea development and opportunity analysis, (b) technical assessment, (c) product development and (d) development speed, but (e) is negatively related with development cost.*
Zirger and Maidique, 1990		
Barzcak, 1995	The adoption and development of products that build on the firm's existing firm capabilities engender higher success and proficiency in marketing and technical activities mediate relationships between marketing, R&D, engineering and technical resources and skills and new product success.	*H1. NPD process implementation proficiency completely mediates the relationship between supply chain fit and (f) the degree of customer need met and (g) product advantage.*
Calantone and DiBenedetto, 1998		*H2. NPD process implementation proficiency completely mediates the relationship between marketing fit and (f) the degree of customer need met and (g) product advantage.*
Calantone, Schmidt, and Song, 1996		*H3. NPD process implementation proficiency completely mediates the relationship between R&D fit and (f) the degree of customer need met and (g) product advantage.*
Song and Parry, 1996		*H4. NPD process implementation proficiency completely mediates the relationship between manufacturing fit and (f) the degree of customer need met and (g) product advantage.*

TABLE B-1. THE LITERATURE AND THE HYPOTHESES DEVELOPED (cont'd)

STUDIES IN LITERATURE	GENERAL ACKNOWLEDGEMENT IN LITERATURE	HYPOTHESES DEVELOPMENT
Adams, Day and Daugherty,1998 *Ayers, Dahlstrom and Skinner, 1997* *Clark and Fujimoto, 1990* *Cooper and Kleinschmidt, 1987* *Griffin and Hauser, 1996* *Johne and Snelson, 1988* *Kahn, 1996* *Lee and O'Connor, 2003* *Lee and Na, 1994* *Maltz and Kohli, 1996* *Norton, Parry, and Song, 1994* *Olson, Walker and Ruekert, 1995* *Olson, Walker, Ruekert and Bonner, 2001* *Ottum and Moore 1997* *Sethi, 2000* *Song, Thieme and Xie, 1998* *Souder, Sherman and Davies-Cooper, 1998* *Veryzer, 1998*	Top management support and commitment and cross-functional integration are determinants of NPD success. Top management and project leaders ensure the flow and adequacy of resources, motivate team members, reduce delays and costs by providing timely decisions, and facilitate the assimilation and application of technical and market-oriented knowledge.	*H5. Project formality is related with proficiency in (a) idea development and opportunity analysis negatively; (b) technical assessment positively; (c) product development positively; (d) development speed positively and (e) development cost negatively.* *H6a. Project climate is positively related with proficiency in (a) idea development and opportunity analysis; (b) technical assessment; (c) product development; and (d) development speed; but (e) negatively related with development cost.*
Atuahene-Gima, 1996 *Barczak, 1995* *Calantone and Di Benedetto, 1998* *Calantone et al., 1997* *Cooper, 1979* *Di Benedetto, 1999* *Dwyer and Mellor, 1991* *Griffin, 1997* *Griffin and Hauser 1996* *Kleinschmidt and Cooper, 1991* *Song, Thieme and Xie, 1998* *Souder and Jenssen, 1999*	New product success is positively related to development proficiency measures, which include idea generation, market research, predevelopment planning, concept definition and evaluation, technical assessments, product development and test-marketing.	*H7. Proficiency in idea generation and opportunity analysis is positively related to (a) the degree of customer need met and (b) product advantage.* *H8. Proficiency in technical assessment is positively related to product advantage.* *H9. Proficiency in product development is positively related to (a) the degree of customer need met and (b) product advantage.*

TABLE B-1. THE LITERATURE AND THE HYPOTHESES DEVELOPED (cont'd)

STUDIES IN LITERATURE	GENERAL ACKNOWLEDGEMENT IN LITERATURE	HYPOTHESES DEVELOPMENT
Ali, Krapfel and LaBahn, 1995	Speed in innovation development engender success since firms can reap pioneering advantages by being prompt and timely in exploiting opportunities and/or responding to their environments.	*H10. Development speed is positively related to (a) the degree of customer need met and (b) product advantage.*
Kessler and Chakrabarti, 1999		*H11. Development cost is negatively related to (a) the degree of customer need met and (b) product advantage.*
Cooper and Kleinschmidt, 1987	Products that better match consumer needs are more likely to be successful in the market.	*H12. Degree of customer need met is positively related with project performance.*
Gatignon and Robertson, 1989		
Maidique and Zirger, 1984		
Atuahene and Ko, 2001	Firms creating superior, unique and novel products should enjoy competitive advantage in the market and hence commercial success.	*H13. Product advantage is positively related with project performance.*
Firth and Narayanan, 1996		
Friar, 1995		
Gatignon and Xuereb, 1997		
Montoya-Weiss and Calantone, 1994		
Song and Parry, 1996		
Souder, Buisson and Garrett, 1997		
Atuahene-Gima, 1995	A large market with a high growth potential should amplify the rewards incurred from the product's quality, performance, or benefits perceived by the market.	*H14. The positive relationship between the degree of customer need met and project performance should be significantly stronger as (a) market size increases, (b) market growth increases, but weaker (c) market competitiveness increases.*
Calantone, Schmidt, Di Benedetto, 1997		
Calantone, Vickery and Droge, 2003		
Han, Kim and Srivastava, 1998		
Souder and Song, 1998		
Calantone, Schmidt, Di Benedetto, 1997	When market competitiveness is high, a new product with perceived benefits and advantages should elicit aggressive responses from competitors, which could adversely affect project performance.	*H15. The positive relationship between product advantage and project performance should be significantly stronger as (a) market size increases, (b) market growth increases and (c) market competitiveness increases.*
Cooper, 1979		
Cooper and Kleinschmidt, 1987		
Debruyne, Moenaert, Griffin, Hart, Hultink and Robben, 2002		

TABLE B-2. DESCRIPTIVE STATISTICS OF FIRMS IN THE SAMPLE

	Annual Company Sales (millions)	Number of Employees	R&D Percent	% Sales by New Products	% Profits by New Products
Mean	380006	1468	3.92	18.93	22.18
Median	200000	400	3.10	15.00	18.28
Mode	100000	400	2.00	50.00	5.00
Standard Deviation	627089	4216	2.83	16.63	20.27
Minimum	40	11	0.10	0.00	0.00
Maximum	3100000	30000	15.00	80.00	90.00

TABLE B-3. CORRELATION MATRIX

		ICR	AVE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Supply Chain Fit	*0.86*	*0.62*	<u>**0.79**</u>																		
2	Marketing Fit	*0.85*	*0.66*	0.49	<u>**0.81**</u>																	
3	R&D Fit	*1.00*	*1.00*	0.26	0.24	<u>**1.00**</u>																
4	Manufacturing Fit	*0.91*	*0.72*	0.46	0.22	0.12	<u>**0.85**</u>															
5	Project Climate	*0.86*	*0.68*	-0.21	0.02	0.17	-0.21	<u>**0.82**</u>														
6	Project Formality	*0.91*	*0.64*	0.16	0.31	0.46	0.15	0.54	<u>**0.80**</u>													
7	Product Advantage	*0.88*	*0.65*	0.07	0.36	0.16	0.10	0.25	0.39	<u>**0.81**</u>												
8	Customer Need Met	*0.90*	*0.69*	0.16	0.46	0.10	0.16	0.18	0.43	0.58	<u>**0.83**</u>											
9	Idea Development	*0.85*	*0.60*	0.07	0.06	0.27	0.12	0.54	0.65	0.29	0.30	<u>**0.77**</u>										
10	Technical Assessment	*0.85*	*0.65*	0.21	0.23	0.39	0.05	0.46	0.61	0.13	0.11	0.37	<u>**0.81**</u>									
11	Product Development	*0.82*	*0.69*	0.43	0.34	0.30	0.25	0.23	0.44	0.45	0.47	0.34	0.43	<u>**0.83**</u>								
12	Development Speed	*0.88*	*0.79*	-0.01	0.05	0.09	-0.07	0.45	0.08	0.14	0.02	0.24	0.14	0.19	<u>**0.89**</u>							
13	Development Cost	*1.00*	*1.00*	-0.07	-0.15	-0.05	-0.15	0.27	-0.01	-0.15	-0.09	-0.01	-0.01	-0.07	-0.15	<u>**1.00**</u>						
14	Project Performance Impact	*0.88*	*0.72*	0.25	0.30	0.28	0.21	0.32	0.38	0.62	0.56	0.45	0.17	0.54	0.28	-0.02	<u>**0.85**</u>					
15	Market size	*1.00*	*1.00*	0.04	-0.09	-0.07	-0.07	0.18	0.05	0.01	-0.15	0.01	0.09	0.06	0.39	0.04	0.05	<u>**1.00**</u>				
16	Market growth	*1.00*	*1.00*	-0.02	0.23	-0.03	0.03	0.13	0.14	0.28	0.34	0.10	0.17	0.14	0.11	0.00	0.15	-0.06	<u>**1.00**</u>			
17	Competition Concentration	*1.00*	*1.00*	-0.26	-0.10	-0.14	-0.19	0.11	-0.13	-0.03	-0.03	-0.11	0.06	-0.21	0.00	0.18	-0.18	-0.05	0.29	<u>**1.00**</u>		
18	Annual Sales	*1.00*	*1.00*	-0.19	-0.30	-0.01	-0.15	0.14	0.16	-0.12	-0.13	0.10	0.16	-0.06	-0.01	0.25	-0.17	-0.03	0.05	0.18	<u>**1.00**</u>	
19	No of employees	*1.00*	*1.00*	-0.18	-0.32	-0.33	-0.16	-0.07	-0.33	-0.26	-0.21	-0.21	-0.24	-0.31	0.00	0.28	-0.25	0.11	0.07	0.26	0.17	<u>**1.00**</u>

NOTE: Diagonal is the square root of the Average Variance Extracted (AVE)

TABLE B-4. MEASURES AND LOADINGS:
COMMON METHOD VARIANCE (CMV) CONTROLLED

SUPPLY CHAIN FIT	ICR=.86; AVE= .62; sqrt AVE=.79
Distribution capacity	0.86
Target market	0.67
Customer need similarity	0.74
Existing channels	0.85
MARKETING FIT	ICR=.85; AVE= .66; sqrt AVE=.81
Advertising	0.83
Market Research	0.82
Promotional activities	0.79
R&D FIT	Single item NA
MANUFACTURING FIT	ICR=.91; AVE= .72; sqrt AVE=.85
Manufacturing	0.82
Plant	0.85
Development	0.93
Technology	0.79
PROJECT CLIMATE	ICR=.86; AVE= .68; sqrt AVE=.82
Cross-functional integration	0.84
Team for entire project	0.89
Team commitment	0.73
PROJECT FORMALITY	ICR=.91; AVE= .64; sqrt AVE=.80
Target market defined	0.82
Product concept defined	0.80
Benefits defined	0.83
Positioning defined	0.86
Features defined	0.84
Formal NPD process	0.62
IDEA DEVELOPMENT	ICR=.86; AVE= .60; sqrt AVE=.77
Initial screening	0.81
Preliminary market assessment	0.81
Detailed market study	0.72
Business analysis	0.75
TECHNICAL ASSESSMENT	ICR=.85; AVE= .65; sqrt AVE=.81
Preliminary technical assessment	0.85
Customer tests	0.70
In-house product testing	0.86
PRODUCT DEVELOPMENT	ICR=.82; AVE= .69; sqrt AVE=.83
Pilot production	0.79
Production start-up	0.88
DEVELOPMENT SPEED	ICR=.88; AVE= .79; sqrt AVE=.89
Time efficiency	0.89
Adherence to time schedule	0.89
DEVELOPMENT COST	Single item NA
CUSTOMER NEED MET	ICR=.90; AVE= .69; sqrt AVE=.83
Benefit importance to customer	0.85
Benefits easy to communicate	0.77
Perceived as useful	0.88
Visible benefits	0.82
PRODUCT ADVANTAGE	ICR=.90; AVE= .70; sqrt AVE=.81
Superiority	0.89
Relative product quality	0.91
Unique attributes	0.81
Impact on customer	0.73
IMPACT ON PERFORMANCE	ICR=.88; AVE= .71; sqrt AVE=.84
Technical success rating	0.80
Profitability rating	0.90
Sales/profit impact on company	0.83

TABLE B-5. RESULTS (H1- H4. a-e): CMV CONTROLLED

Strategic Fit / NPD Process Proficiency		H1		H2		H3		H4	
		Supply Chain Fit		Marketing Fit		R&D Fit		Manufacturing Fit	
(a)	Idea Development and Opportunity Analysis	H1(a):	+	H2(a):	+	H3(a):	+	H4(a):	+
		γ_{1a} =	0.081**	γ_{2a} =	-0.283***	γ_{3a} =	0.001(ns)	γ_{4a} =	0.074*
		Conclusion:	Support	Conclusion:	Reject	Conclusion:	Not Support	Conclusion:	Support
(b)	Technical Assessment	n.a.		n.a.		H3(b):	+	H4(b):	+
						γ_{3b} =	0.162***	γ_{4b} =	0.011(ns)
						Conclusion:	Support	Conclusion:	Not Support
(c)	Product Development	H1(c):	+	H2(c):	+	H3(c):	+	H4(c):	+
		γ_{1c} =	0.333***	γ_{2c} =	-0.130**	γ_{3c} =	0.084*	γ_{4c} =	0.02(ns)
		Conclusion:	Support	Conclusion:	Reject	Conclusion:	Not Support	Conclusion:	Not Support
(d)	Development Speed	H1(d):	+	H1(d):	+	H3(d):	+	H4(d):	+
		γ_{1d} =	0.097*	γ_{1d} =	-0.019(ns)	γ_{3d} =	0.107**	γ_{4d} =	0.024(ns)
		Conclusion:	Support	Conclusion:	Not Support	Conclusion:	Support	Conclusion:	Not Support
(e)	Development Cost	H1(e):	-	H2(e):	-	H3(e):	-	H4(e):	-
		γ_{1e} =	0.170***	γ_{2e} =	-0.074(ns)	γ_{3e} =	-0.048(ns)	γ_{4e} =	-0.058(ns)
		Conclusion:	Reject	Conclusion:	Support	Conclusion:	Not Support	Conclusion:	Not Support

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, **, *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

TABLE B-6. RESULTS FOR TESTS OF MEDIATION (H1-H4.f-g): CMV CONTROLLED

Positional Advantages / Strategic Fit		(f) Customer Need Met		(g) Product Advantage	
H1	Supply Chain Fit	H1(f):	no direct rel.	H1(g):	no direct rel.
		γ_{1f} =	-0.142***	γ_{1g} =	-0.100**
		Conclusion:	Reject	Conclusion:	Reject
H2	Marketing Fit	H2(f):	no direct rel.	H2(g):	no direct rel.
		γ_{2f} =	0.071**	γ_{2g} =	-0.047(ns)
		Conclusion:	Reject	Conclusion:	Support
H3	R&D Fit	H3(f):	no direct rel.	H3(g):	no direct rel.
		γ_{3f} =	-0.156***	γ_{3g} =	-0.002(ns)
		Conclusion:	Reject	Conclusion:	Support
H4	Manufacturing Fit	H4(f):	no direct rel.	H4(g):	no direct rel.
		γ_{4f} =	0.019(ns)	γ_{4g} =	-0.039(ns)
		Conclusion:	Support	Conclusion:	Support

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, **, *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

TABLE B-7. RESULTS (H5-H6. a-e): CMV CONTROLLED

Project-specific Advantages NPD / Process Proficiency		H5 Project Formality		H6 Project Climate	
(a)	Idea Development and Opportunity Analysis	H5(a):	+	H6(a):	-
		γ_{5a} =	0.302***	γ_{6a} =	0.229***
		Conclusion:	Support	Conclusion:	Reject
(b)	Technical Assessment	H5(b):	+	H6(b):	+
		γ_{5b} =	0.404***	γ_{6b} =	0.210***
		Conclusion:	Support	Conclusion:	Support
(c)	Product Development	H5(c):	+	H6(c):	+
		γ_{5c} =	-0.138(ns)	γ_{6c} =	0.050(ns)
		Conclusion:	Not Support	Conclusion:	Support
(d)	Development Speed	H5(d):	+	H6(d):	+
		γ_{5d} =	-0.574***	γ_{6d} =	0.589***
		Conclusion:	Reject	Conclusion:	Support
(e)	Development Cost	H5(e):	-	H6(e):	-
		γ_{5e} =	-0.009(ns)	γ_{6e} =	0.446***
		Conclusion:	Support	Conclusion:	Reject

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, **, *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

TABLE B-8. RESULTS (H7-H11. a-e): CMV CONTROLLED

Positional Advantages / NPD Process Proficiency		(a) Customer Need Met		(b) Product Advantage	
H7	Idea Development and Opportunity Analysis	H7(a):	+	H7(b):	+
		β_{1a} =	-0.207***	β_{1b} =	-0.226***
		Conclusion:	Reject	Conclusion:	Reject
H8	Technical Assessment	n.a.		H8:	+
				β_{2b} =	-0.300***
				Conclusion:	Reject
H9	Product Development	H9(a):	+	H9(b):	+
		β_{3a} =	0.071*	β_{3b} =	0.122***
		Conclusion:	Support	Conclusion:	Support
H10	Development Speed	H10(a):	+	H10(b):	+
		β_{4a} =	-0.161***	β_{4b} =	-0.043(ns)
		Conclusion:	Reject	Conclusion:	Not Support
H11	Development Cost	H11(a):	-	H11(b):	-
		β_{5a} =	-0.044*	β_{5b} =	-0.103***
		Conclusion:	Support	Conclusion:	Support

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, **, *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

TABLE B-9. RESULTS (H12-H13): CMV CONTROLLED

Outcome Positional Advantages		Project Performance	
H12	**Customer Need Met**	H12:	+
		β_6 =	0.266**
		Conclusion:	Reject
H13	**Product Advantage**	H13:	+
		β_7 =	0.054(ns)
		Conclusion:	Support
Market Variables	Market Size	β_8 =	-0.129(ns)
	Market Growth	β_9 =	0.046(ns)
	Competition Concentration	β_{10} =	-0.042(ns)
Control Variable	Annual Sales	β_{13} =	-0.111***
	Number of Employees	β_{14} =	0.142***

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, **, *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

TABLE B-10. RESULTS FOR TESTS OF MODERATION (H14-H7.a-b): CMV CONTROLLED

Paths / Moderators		H14		H15	
		Customer Need Met - Project Performance		Product Advantage - Project Performance	
(a)	**Market Size**	H14(a):	+	H15(a):	+
		β_{11a} =	-0.152(ns)	β_{12a} =	0.235(ns)
		Conclusion:	Not Support	Conclusion:	Not Support
(b)	**Market Growth**	H14(b):	+	H15(b):	+
		β_{11b} =	0.200(ns)	β_{12b} =	-0.703***
		Conclusion:	Not Support	Conclusion:	Reject
(c)	**Market Competitiveness**	H14(c):	-	H15(c):	-
		β_{11c} =	-1.008***	β_{12c} =	0.441***
		Conclusion:	Support	Conclusion:	Reject

NOTE: Presented are statements of the hypotheses, followed by the path estimates and conclusions. *, **, *** indicate 0.1, 0.05 and 0.01 significance levels, respectively.

APPENDIX C

EXTERNAL INNOVATION DEVELOPMENT (CHAPTER 4)
SUPPORTING DOCUMENTS

TABLE C-1. SUMMARY OF THEORIES AND PROPOSED MODEL

<table>
<tr><th></th><th>Agency Theory</th><th colspan="2">Transaction Theory</th><th>Resource Dependency</th><th>Technology Outsourcing Model</th></tr>
<tr><td>Definition</td><td>The focus is on determining the most efficient contract to govern a particular relationship given the characteristics of the parties involved and the fact that environmental uncertainty and the costs of obtaining information make it impossible for the principle to monitor the agent completely.</td><td colspan="2">The focus is on transaction costs (actual and opportunity costs of transacting under various governance structures) and risks that result from transaction-specific factors, including asset-specificity, frequency, interdependency, and technological uncertainty.</td><td>The focus is on identification of dependence and uncertainty as key antecedent variables motivating interfirm relationships. The theory views interfirm governance as a strategic response to conditions of uncertainty and dependence.</td><td>The focus is on the returns and risks of global technology outsourcing: The main objective is to gain an understanding of the characteristics of buyers' technology outsourcing relationships in global markets and their effects on the market value of their firms.</td></tr>
<tr><td>Unit of Analysis</td><td>Agency relationship</td><td colspan="2">Transaction</td><td>Relationship</td><td>Technology Outsourcing Arrangement</td></tr>
<tr><td rowspan="2">Commonalities</td><td colspan="2">Both theories are based on the assumption that parties are motivated by economic self-interest and may engage in opportunistic behavior. They have related conceptual approaches (for ex., environmental uncertainty and asset specificity in transaction cost theory and risk preferences in agency theory).</td><td colspan="2">Both theories view nonmarket governance as a response to environmental uncertainty and dependence. Regarding the latter, transaction-specific assets can be argued to constitute dependence, because their presence increases switching costs and makes exchange partners irreplaceable.</td><td rowspan="2">Factors that contribute to the effectiveness and efficiency of a particular technology outsourcing relationship are examined: task characteristics (i.e., knowledge and experience of the partners regarding the task and the costs of obtaining information), switching costs (i.e., sources of dependencies and the characteristics of the parties involved) and the degree of environmental uncertainty.</td></tr>
<tr><td colspan="4">Transaction specific investments create dependence, which is described by the extent of the replaceability of the exchange partner. Subsequently, the agent will make efforts to reduce its dependence on the principal by engaging in bonding behavior.</td></tr>
</table>

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