MARKETING STRATEGY FORMULATION IN THE COMMERCIALIZATION OF NEW TECHNOLOGIES

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Leslie Harris Vincent

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MARKETING STRATEGY FORMULATION IN THE COMMERCIALIZATION OF NEW TECHNOLOGIES

Approved by:

Dr. Goutam Challagalla, Co-Advisor
College of Management
Georgia Institute of Technology

Dr. Marie C. Thursby
College of Management
Georgia Institute of Technology

Dr. Sundar G. Bharadwaj, Co-Advisor
Goizueta School of Business
Emory University

Dr. Nancy Y.C. Wong
College of Management
Georgia Institute of Technology

Dr. Christina E. Shalley
College of Management
Georgia Institute of Technology

Approved May 5, 2005

For Gran -

my very own guardian angel

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SUMMARY

The key objective of Part 1 is to synthesize 23 years of innovation research findings from economic, organization theory, strategy, and marketing literatures and extend the current theoretical knowledge base in these domains through meta-analysis. In general, empirical evidence of the nature of the relationship between innovation and its antecedents and consequences is provided, while at the same time providing answers to conflicting conclusions within this field. The conclusions reached provide a more comprehensive understanding of the drivers of innovation as well as the implications associated with the phenomena. In addition, this study seeks to aid in building a strong theoretical foundation relating to the nature of the relationship of innovation with key antecedents and outcomes. It is demonstrated that innovation serves as a partial mediator of the relationships between organizational and environmental antecedents and firm performance.

Part 2 builds upon the innovation foundations set forth in Part 1 and extends the focus to consider how innovations are commercialized outside traditional organizational boundaries. Drawing upon the Resource-based view of the firm, the impact of two dynamic capabilities (network ties and absorptive capacity) on marketing strategy formulation effectiveness is explored. Utilizing a unique sample of university pre-startup teams, this research is able to track these teams over time (longitudinal research design) and provide an empirical examination of the role of dynamic capabilities in the effective formulation of marketing strategies.

CHAPTER 1

INTRODUCTION TO THESIS

This dissertation is comprised of two parts. The first part utilizes meta-analysis to summarize empirical studies that examine the correlates (antecedents and/or outcomes) of innovation. Overall, this research draws upon a meta-analytic database of 134 independent samples from 83 studies from Economics, Management and Marketing journals encompassing the period from 1980 through 2003. Meta-analysis is a useful approach for creating an overall summary of a research domain, and serves as a systematic way to understand how research design impacts the results obtained in the literature, and to empirically address conflicting findings within the literature. An emerging use of meta-analysis is for theory building and hypothesis testing (Viswesvaran and Ones 1995). In this role, meta-analysis allows the researcher to empirically test alternative theoretical models using a much larger dataset and a nomological net of constructs than a typical study can. Against this backdrop, the objectives of this research are: (1) to provide an up-to-date synthesis of the empirical literature on innovation including environmental, organizational, and individual level variables and (2) to aid in the development of a much needed theory of innovation by testing alternate models of innovation's antecedents and consequences.

Chapter 3 focuses on a quantitative integration of the innovation literature. This study examines the impact of 27 antecedents and 3 performance outcomes of innovation with an overall sample size of 122,943. Overall results indicate that organizational capabilities and structure account for the majority of the unique variance explained.

Additionally, the overall findings indicate that innovation is significantly and positively related to superior performance, in terms of both financial and efficiency performance outcomes. In addition to the overall synthesis, a multivariate generalized least squares based moderator analysis indicates that measurement factors and research design considerations in model specification can significantly bias the observed effects within a given study. Particular emphasis is placed on the impact of innovation measurement on observed effect sizes.

The objective of Chapter 4 in Part I is to test a comprehensive model of product innovation with the meta-analytic data set using structural equations modeling. Past research has demonstrated that there is a direct, robust relationship between organizational innovation and performance. However, there is a lack of understanding surrounding the relationship between the antecedents of innovation, innovation itself, and organizational performance outcomes. Additionally, these relationships have yet to be empirically investigated with one comprehensive sample (Wolfe 1994). Innovation is hypothesized as one possible mechanism by which organizations can gain a competitive advantage in the marketplace through unique organizational resources (Barney 1991). Product innovation can be the source of competitive advantage to the innovator (Wind and Mahajan 1997) and at the same time can lead to a sustainable increase in firm profits (Geroski, Machin and VanReenen 1993; Chandy and Tellis 1998). Past research supports the argument that innovation serves as a key mediator between antecedents of innovation and performance (Conner 1991; Damanpour and Evan 1984; Han et al 1998). Despite the theoretical rationale underlying innovation's role as a mediator in the relationship between environmental and organizational antecedents and performance, it can also be

the case that innovation does not act in this capacity. These environmental and organizational drivers of innovation are unique resources capable of creating a competitive advantage within their own right, and therefore would have a direct link to financial performance.

Results from Study 2 indicate that innovation does in fact serve as a key linkage between organizational antecedents and performance. Study 2 goes on to further address several conflicting findings present within the literature. Competition and environmental turbulence foster innovation and provide organizations with a means of safeguarding against uncertainty. Despite some recent studies regarding innovation in older firms, age is found to be negatively related to product innovation. Overall, organizational capabilities foster organizational innovation.

From Part I we are presented with a much more cogent picture of the role of innovation within the organizational setting. Part II extends the findings in Part I to consider the commercialization of innovations, and in particular, innovations that are technologically complex. This research contributes significantly to the current marketing strategy by examining the effective formation of marketing strategies for new technologies outside traditional organizational boundaries. This important question must be addressed considering that at any given time roughly 10.1 million adults in the U.S. are attempting to create new ventures, yet the rate of new venture failures is approximately 70 percent. Therefore it is important to step away from examining innovation and marketing strategy formation within traditional domains (i.e. large organizations) and instead focus on innovations outside organizational boundaries that generate 60 to 80 percent of new jobs annually. In particular, considering the high rate of

new venture failure, what characteristics increase the likelihood of success in the commercialization of new technologies? This research seeks to answer these compelling questions, and provide a more process-based approach to studying the effective development of marketing strategies for new technologies.

Using a dynamic capabilities framework, the role of internal and external capabilities in driving marketing strategy effectiveness for inventions developed in university labs is explored. The key to building a conceptual framework based upon the dynamic capabilities perspective is to identify the building blocks upon which competitive advantages can be formed, sustained, and improved. One such foundation is knowledge transfer, or learning. The focus of this research is on two distinct components of knowledge transfer: network ties and absorptive capacity. Past research has shown that network ties provide access to information that can be beneficial to performance outcomes (Tsai and Ghoshal 1998; Tsai 2001). In addition to this external source of information, an internal learning capacity must also be present in order to absorb and utilize the information coming in. Both network ties and absorptive capacity have been found to play a key role in both innovation and superior performance outcomes (Cohen and Levinthal 1990; Tsai 2001). Therefore it is expected that both network ties and absorptive capacity will have a complementary impact marketing strategy effectiveness (performance, strategy creativity, and strategy improvisation).

The sample for this research comes from a unique multidisciplinary program within the university setting. Technological Innovation: Generating Economic Results (TI:GER) is a two-year team based program that focuses on integrating science and engineering research with the other components (business and law) necessary for

commercialization. The teams' primary objective is that of developing a commercialization strategy for research developed within university laboratories. This study will collect data from pre-startup teams throughout their participation in the program. In addition, objective outcome measures for marketing strategy effectiveness will be collected from outside industry experts and team supervisors. The longitudinal panel data thus collected will be analyzed using random and fixed effects modeling to account for the dependencies inherent to panel data.

There has been very little empirical research on the formation of strategies at the team level and furthermore, even less research examining marketing strategy making for technologies that were developed outside traditional organizational boundaries and without a predefined market application. Overall, this research will not only contribute significantly to the current innovation and marketing strategy literature, but will also open up new avenues of research in marketing entrepreneurship.

PART I

ANTECEDENTS, CONSEQUENCES, AND THE MEDIATING ROLE OF ORGANIZATIONAL INNOVATION: EMPIRICAL GENERALIZATIONS

CHAPTER 2

INTRODUCTION TO PART I

Numerous studies in economics, organizational theory, strategic management, and marketing have focused on studying innovation. Innovation is thought to provide organizations with a means of creating a sustainable competitive advantage and is considered to be an essential component of economic growth (Brown and Eisenhardt 1995; Mandel 2004). In fact, innovation is a key strategic activity undertaken by organizations that provides them with a mechanism for better alignment with market conditions (Schoonhoven, Eisenhardt and Lyman 1990). In other words, innovation is action often undertaken by organizations as a means of handling market dynamism. Additionally, scholars have stated that innovation is a mechanism by which organizations can draw upon core competencies and transition these into performance outcomes critical for success (Reed and DeFillippi 1991; Barney 1991). While the importance of this domain has not gone unnoticed, there seems to be a lack of clarity on the drivers and performance implications associated with innovation in both academic research and the popular press (Hoff 2004; Mandel 2004). To further illustrate this point, scholars have pointed out that past research in this arena has largely been inconclusive, inconsistent, and lacking explanatory power (Wolfe 1994). The lack of consistency within the innovation literature has not gone unnoticed by other scholars. Damanpour (1991) provided an early quantitative synthesis of innovation adoption to address these concerns. Recent reviews of the innovation literature have been limited in their focus, to research on integrated product development (Gerwin and Barrowman 2002), new product

development (Brown and Eisenhardt 1995; Krishnan and Ulrich 2001; Sheremata 2000), and mathematical modeling concurrent engineering (Krishnan et al 1997; Loch and Terwiesch 1998). However, over this time period a substantial body of empirical innovation research has been conducted.

2.1 Overview of Innovation Research

While scholars and practitioners alike agree on the importance of innovation, the empirical literature examining this important phenomenon is plagued with inconsistent results. Past research highlights several discrepancies present in the literature with regards to the impact of organizational variables on innovation. In fact, the most consistent finding within the innovation literature is that the results are inconsistent with regards to innovation (Camison-Zornoza 2004; Wolfe 1994). For the most frequently investigated organizational antecedents of innovation, the results are conflicting. Variables such as organization size, resource level, diversification, and centralization have received a great deal of attention within the literature, yet no consistent generalization for the relationship between these variables and innovation has emerged. For example, in this study, age has been examined in 22 studies and roughly 9 studies find a positive relationship between age and innovation, while 6 support a negative relationship and 7 find no relationship at all. Perhaps of even greater interest is the lack of clarity surrounding the innovation-performance link. For example, the relationship between innovation and performance has been found to be positive for financial performance (Ahuja 2000; Robinson 1990; Tsai 2001) while at the same time several other studies have found the opposite to be true (Boeker 1997; Greve 2003; Kotabe 1990; Mishina, Pollock and Porac 2004). Additionally, the link between innovation and

efficiency outcomes is also unclear. Past research has found innovation to have both a positive (Moorman 1995; Rosner 1968; Souder and Jenssen 1990), negative, and no effect (Majumdar and Venkataraman 1998; Markham and Griffin 1998) on organizational efficiency. The aim of this research is to gain a systematic understanding of the potential sources leading to these inconsistent findings present within the innovation literature. This study is able to answer which antecedent factors organizations should focus on in terms of promoting the generation of innovation, and furthermore, does innovation really pay off for the organization.

Against this backdrop, the objectives of this article are: (1) to provide an up-to-date synthesis of the empirical literature on innovation including antecedents and consequences and uncover the sources of inconsistency present in the innovation literature and (2) to aid in the development of a much needed theory of innovation by testing a more comprehensive model of innovation. Study 1 provides an overall synthesis of the innovation literature and attempts to shed some much needed light on the impact of differing innovation and typologies on observed effects. Study 2 seeks to address the issues of inconsistent results and piecemeal theory development present within the innovation literature by examining antecedents, innovation, and outcomes together in one model.

2.2 Sources of Inconsistency in the Innovation Literature

2.2.1 Innovation Adoption versus Innovation Generation

Organizational innovation studies can be broadly classified into two categories: (1) those where the organization is the adopter of an innovation, and (2) those where the organization generates the innovation (Camison-Zornoza et al 2004). For the most part,

past research has failed to distinguish between these two very different activities. This distinction becomes important because the activities behind each type and the performance implications associated with these two activities are markedly different. By combining innovation generation and innovation adoption together it becomes difficult to isolate the true effect of each. For example, organizational structure has often been touted as being important in the adoption of innovation, while capability and resource variables significantly enhance the organization's ability to generate innovation. It is absolutely imperative to understand the generation of innovation inside organizations. Innovations generated by the organization, rather than simply adopted by the organization, have the potential to become rare, valuable, imperfectly imitable, and nonsubstitutable resources and have a higher probability of leading to superior performance outcomes for the organization (Barney 1991). Innovation is postulated as a key strategic activity that is necessary for survival and it is the generation of these innovations that provides firms with the means of using innovation to achieve a competitive advantage within the marketplace.

The activities leading to innovation generation are also different from those that impact innovation adoption. Past syntheses of the innovation literature have primarily focused on innovation adoption by the organization and the organizational variables that impact the propensity of an organization to adopt an innovation (see Damanpour 1991 for a review of this literature). Damanpour (1991) defines innovation as, "the *adoption* of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization" (p. 556). This definition has a broad scope so as to include different types of innovation impacting all parts of the organization

and operation activities. However, there has been a tremendous effort within the literature to shift the focus from the adoption of innovation to one of understanding the drivers and performance implications associated with innovation generated by the organization. Given the importance of the generation of innovations, the focus of this synthesis is on innovations developed within the organization. Here the focus is on the supply side of innovation (innovation generation) rather than the demand side issue of diffusion of innovations among organizations (or innovation adoption). Therefore, for the purpose of our study, innovation is defined as the internal generation of a device, system, policy, program, process, product, or service that is new to the organization and focus only on integrating those studies that address innovation within this definition[1]. To the best of my knowledge, this is the first study to empirically synthesize the literature addressing innovation generation. While past reviews have tended to be narrative and focused on only one small piece of the innovation literature (e.g. new product development, concurrent engineering, integrated product development), the goal of this study is to provide empirical generalizations from a much broader perspective, innovation generation as a whole.

2.2.2 No Standard Definition/Typology of Innovation

Past scholars have often found it necessary to categorize and distinguish innovations in order to understand the true nature of the construct (Downs and Mohr 1976). Studies focused on innovation generation have primarily used the following typologies: (1) product versus process, and (2) radical versus incremental[2]. These

[1] From this point forward, the term innovation refers to innovation generation.
[2] While we do acknowledge that there is a third typology present within the innovation literature, administrative versus technical, we do not focus on the administrative/technical

different typologies were developed in order to bring some clarity to the study of innovation. While the objective was to help gain a broader understanding of innovation, it is difficult to integrate the research on innovation together with so many different typologies examined. One potential reason for the inconsistent results within the literature is that some studies focus on either product or process innovations, while others do not make the distinction and instead lump the two types together. For example, when examining the combination of both product and process innovations the overall result indicates that innovation actually hinders financial performance. However, when one focuses on product innovation in isolation the opposite finding is true. To add to the confusion present within this domain, past research has also demonstrated that the drivers and mechanisms behind the generation of innovation differ for these types of innovation. The question remains as to whether the type of innovation studied moderates the relationship between: (1) antecedents and innovation, and (2) innovation and performance.

2.2.3 No Standard Innovation Measure

Another reason for conflicting innovation results is that there is no standard measure of innovation (Downs and Mohr 1976). For example, some studies utilize a frequency count measure of innovation that taps into the number of innovations developed by the organization (an output measure). In contrast, several studies use R&D intensity, which is clearly a resource required for innovation generation, and thus taps into the input side of innovation generation. Give that these measures are both

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typology in this study because the majority of the empirical research addressing administrative and technical innovations has been through an innovation adoption lens and there were too few studies that examine innovation generation. Therefore, we are unable to examine it as a source of heterogeneity in innovation generation studies.

considered to accurately reflect organization innovation generation, in reality they may be measuring different components of the innovation process. Therefore one would expect the measure of innovation used to moderate observed effect sizes. We identify 5 different measures of innovation and empirically test whether or not these different measures lead to similar or different conclusions. This is the first study to address the issue of measurement bias within this vast literature.

2.2.4 Piecemeal Theory Development

Another potential reason for conflicting results, in addition to the moderators already discussed, is that the theory development within this domain has been largely piecemeal. All innovation begins with creative ideas. In other words, it is creativity that provides the starting point for innovation generation within an organization. While there have been several different theoretical approaches to examining innovation inside the organization, no one comprehensive model of innovation has emerged within the literature. In addition, because innovation can be influenced by so many different variables, it is not possible to empirically examine all of them in one study. Therefore each study has focused on only one narrow set of variables and their impact on innovation in isolation. For example, a great deal of research has focused only on the organization structure antecedents of innovation (Collins et al. 1998, Hage and Dewar 1973; Moorman and Miner 1997; Sivadas and Dwyer 2000). Other scholars have looked at innovation through a dynamic capability and contingency lens and examined the impact of the environment on innovation (Teece, Pisano and Shuen 1997; Eisenhardt and Martin 2000). Additionally, other scholars have approached innovation through a RBV framework and focused on the impact of organizational capabilities on innovation (Greve

2003; Mishina et al. 2004; Nohria and Gulati 1996; Tsai 2001). Finally, other studies examine the role of individuals within an organization in the innovation process (Goes and Park 1997; Sivadas and Dwyer 2000; Keister 2002; Rao and Drazin 2002). Because of these multiple perspectives and narrow focus on innovation-antecedent relationships, no one set of antecedent variables has emerged capable of differentiating organizations that are successful innovators from those that struggle with innovation. Moreover, no single study provides a comprehensive overview of the phenomena because the focus of most empirical studies has been either on the antecedent-innovation or innovation-performance link. Therefore it is difficult to build a strong theoretical understanding and a nomological net of the nature of this phenomenon.

2.2.5 Summary

To address this need within the innovation literature, an integrative model of innovation is built and tested, drawing on these sets of antecedent factors, namely, environmental (e.g.,Woodman et. al 1993; Eisenhardt and Martin 2000), organizational capabilities (e.g., Nohria and Gulati 1996; Tsai 2001; and Greve 2003), organizational structure (e.g., Collins et. al 1988; Sivadas and Dwyer 2000) and organizational motivation (e.g., Amabile 1988[3]). Additionally, the type of innovation is examined as a mediator on the relationship of antecedents on innovation. Finally, within a single study, the impact of innovation on performance is explored and as well as the assessment of whether innovation mediates the impact of these antecedents with innovation. A clear

[3] Amabile (1988) discussed the Componential Model of Creativity and Innovation which views the generation of creative ideas, and thus innovation, as a product of resources, motivation, and organizational processes. This original theory was designed to assess individual level creativity within organizations. For the purpose of this paper, I extend this theory to the level of the organization.

understanding of the relative impact of these different sets of variables is imperative in order to advance the current knowledge base of the literature.

CHAPTER 3

META-ANALYSIS OF INNOVATION

The primary objective of a meta-analysis examining correlations is to describe the relationship between independent and dependent variables, or in this case, between antecedents of and the construct of innovation itself. However, often there is a substantial amount of variation present in the actual correlations, suggesting the presence of moderator variables (Hunter and Schmidt 2004). Then the goal of the meta-analysis is no longer simply to summarize the correlations, but rather becomes a hypothesis-testing tool to examine these moderators (Mathieu and Zajac 1990).

In this study, the procedures for conducting a meta-analysis by Hunter and Schmidt (2004) are followed. Study correlations are open to statistical artifacts, such as sampling error and measurement unreliability. Once these artifacts are controlled for, then a chi-square test should be conducted in order to determine if sufficient variance remains in the results to justify a search for moderator variables. Without sufficient variance, one can conclude that inconsistent findings are in fact completely explained by statistical artifacts.

3.1 Sampling Frame

Only studies that actually measured innovation are included in the meta-analysis. In order to identify these studies, the following procedure based upon Capon, Farley and Hoenig (1990) and Gerwin and Barrowman (2002) was used: (1) search of online bibliographic databases (ABI Inform Complete, UMI Dissertation Database, and Business Source Premier) using key words that referred to innovation, (2) manual search

of sixteen economic, management and marketing journals covering the period from January 1970 to October 2004 for studies on organizational innovation[4], (3) references used in the Damanpour (1991) meta-analysis of innovation examining innovation generation as well as references in studies found in steps 1 and 2, and (4) authors that had studied innovation in the past were contacted for working papers on innovation.

3.2 Sample Characteristics

Overall, 108 empirical studies that measure innovation are analyzed in this meta-analysis and 155 independent samples were coded for the analysis.[5] The sample size for the meta-analysis across all studies was 229,395 observations. 85 studies examined innovation in a manufacturing context and 34 in service industries. 36 studies aggregated innovation scores across multiple industries for analysis. 99 of the studies were cross sectional in nature while 56 utilized a longitudinal research design.

Several other study characteristics are also taken into account. 78 studies use a frequency count of innovation as the measure for innovation. 23 studies use a binary (1/0) measure of innovation. 17 studies use R&D intensity to represent organizational innovation, while 13 studies operationalize innovation as a series of steps taken by organizations to promote innovation. Finally, there are 24 studies that use a scale of radicalness, or newness of the innovation, as the measure of organizational innovation.

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[4] Economics (*American Economic Review, Journal of Technology Transfer, R&D Management, RAND Journal of Economics, Research Policy, Quarterly Journal of Economics*); Management (*Administrative Science Quarterly, Academy of Management Journal, Journal of Management, Management Science, Organization Science, Strategic Management Journal*); Marketing (*Journal of the Academy of Marketing Science, Journal of Marketing, Journal of Marketing Research, Journal of Product Innovation Management*)

[5] Having an independent investigator code 10% of the samples included in the database checked the quality of the coding. The intercoder reliability was 1.00.

In addition, typology of innovation used was also coded as a potential moderator variable. There are 107 product innovation studies, 25 process innovation studies; 28 address radical innovations, while only 20 focus on incremental innovations.

3.3 Meta-Analysis Procedure

This study uses the meta-analytical procedure set forth by Hunter and Schmidt (2004). In addition, the procedure set forth by Huffcutt and Arthur (1995) for detecting outliers in a meta-analytic dataset is also used[6]. First each correlation is corrected for attenuation using the reliabilities reported for each measure, where reliability information is available[7]. After the correlations are corrected for attenuation, the estimated true correlation (r_t) between each independent variable and the innovation construct is calculated. In order to calculate the mean r_t, each corrected correlation for a given study is weighted by the sample size and averaged across respondents and studies. The next step is to calculate the estimated population standard deviation (s_p^2) and finally, a chi-square statistic that allows for the assessment of the heterogeneity across the studies after correcting for statistical artifacts (Hunter and Schmidt 2004). A significant chi-square indicates the presence of moderator variables. It is also necessary to compute the 95% confidence interval around the mean corrected correlations. Both bootstrapped and bias confidence intervals are calculated to examine the significance of the mean-corrected correlations. Moreover, a fail-safe N is calculated for each variable in order to assess the

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[6] Outliers for this dataset were identified using the sample-adjusted meta-analytic deviancy (SAMD) statistic as proposed by Huffcutt and Arthur (1995). The identification of outliers eliminated 5 innovation correlations out of the sample of 531 innovation correlations coded from the samples.

[7] Corrected r_x = uncorrected r_{xy} * reliability x. reliability y. We corrected for measurement error using Hunter and Schmidt's (2004) artifactual distribution approach, since Cronbach alpha values were not available in every study.

possibility of publication bias or the "file-drawer" problem in the analysis. This information given in the last column of Table 1 indicates the number of other studies that would have to be included in the analyses in order to change the correlation to $r<0.01$, yielding confidence in the results of the meta-analysis (Hunter and Schmidt 2004). The larger the fail-safe N, the greater the confidence one has in the results obtained in the overall analysis. For example, variables such as diversification, network, resource level, size, champion, efficiency, and subjective performance would require over 1,000 additional studies to change the mean correlation with innovation to 0.01.

3.4 Results from Overall Analysis

A summary of the meta-analysis is presented in Table 1. Using the componential model of innovation as a guiding framework, the antecedents of innovation can be broadly grouped into Environmental, Resources, Motivation and Process variables (Amabile 1988; Amabile et al 1996; Woodman et al. 1993). Table 1 also provides a description of the effect size of the relationships between the antecedent variables and innovation in accordance with the guidelines set forth by Cohen and Cohen (1983), where correlations less than 0.10 are considered to be small, correlations ranging from 0.10 to 0.30 are medium, and correlations greater than 0.30 are large. The consequences, or outcomes of innovation, have been categorized into three distinct types: (1) financial performance, (2) efficiency gains, and (3) self-report subjective measures of innovation performance. Classifying variables as either antecedents or consequences provides a useful means for discussing the results (Mathieu and Zajac 1990) (Appendix A provides the definitions of the antecedent constructs; Appendix 2 for theoretical rationale underlying these antecedents and outcomes of innovation.)

Table 1: Meta-Analysis Results of Antecedents and Consequences of Innovation

	k	*N*	*r*	r_t	sd_t	*Bootstrapped 95% CI*		*Bias 95% CI*		*ES*	X^2	N_{fsR}	N_{fsO}
ENVIRONMENT													
Competition	27	7206	0.09	0.08	0.060	0.020	0.154	0.003	0.147	S	88.77***	356.30	2064.10
Turbulence	26	5608	0.10	0.11	0.067	-0.065	0.217	-0.028	0.218	M	48.07***	461.90	2755.40
RESOURCES													
Age	22	6580	0.05	0.06	0.056	0.004	0.126	0.016	0.138	S	89.97***	171.50	1357.20
Champion	17	2257	0.25	0.29	0.080	0.134	0.480	0.152	0.499	M	38.10***	1024.00	4932.70
Diversification	30	10802	0.12	0.12	0.051	0.038	0.187	0.041	0.190	M	84.72***	1353.50	3475.20
Education	16	2023	0.16	0.12	0.084	0.004	0.281	0.017	0.320	M	45.87***	219.10	1867.60
Network	23	5881	0.23	0.15	0.058	0.050	0.277	0.032	0.261	M	84.03***	1533.20	3521.30
Past Innovation	8	2138	0.33	0.35	0.054	0.115	0.558	0.111	0.558	L	27.31***	589.10	2830.20
Professionalism	12	1357	0.26	0.23	0.086	0.154	0.337	0.148	0.324	M	30.31***	298.70	2784.60
Public Ownership	5	939	0.16	0.15	0.071	0.097	0.211	0.097	0.213	M	8.11*	33.80	755.10
Resources	68	107059	0.18	0.01	0.018	-0.003	0.191	-0.004	0.172	S	1859.90***	8720.70	801.50
Size	72	116222	0.18	0.01	0.022	-0.019	0.162	-0.020	0.162	S	1155.50***	11984.60	302.00
Specialization	5	696	0.24	0.19	0.080	0.107	0.348	0.107	0.353	M	8.13*	48.90	942.90
Tenure	12	2392	0.00	-0.02	0.070	-0.077	0.069	-0.094	0.056	S	27.27***	0.00	0.00
Urbanization	8	1102	0.19	0.17	0.081	0.125	0.229	0.126	0.230	M	21.50***	68.50	1323.10
MOTIVATION													
Clan Culture	3	470	0.33	0.81	0.011	-0.016	1.256	-0.016	1.256	L	6.36**	181.60	2441.20
Competitor Orientation	13	2827	0.10	0.19	0.066	0.041	0.268	0.077	0.276	M	36.03***	222.70	2410.60
Customer Orientation	16	3259	0.20	0.28	0.066	0.178	0.418	0.185	0.418	M	42.82***	1173.00	4532.10
Openness to Change	16	1778	0.24	0.38	0.088	0.098	0.631	0.111	0.635	L	36.98***	760.70	6077.60

Table 1 (Continued)

	K	*N*	*r*	r_t	sd_t	*Bootstrapped 95% CI*		*Bias 95% CI*		*ES*	χ^2	N_{fsR}	N_{fsO}
PROCESSES													
Centralization	18	3435	0.04	0.03	0.071	-0.041	0.111	-0.042	0.110	S	46.54***	2.60	501.90
Communication Generation	7	1174	0.21	0.20	0.074	0.108	0.296	0.089	0.291	M	10.49	107.30	1364.10
Communication Responsiveness	21	4132	0.18	0.17	0.069	0.081	0.243	0.044	0.230	M	40.96***	865.20	3544.30
Complexity	12	2019	0.22	0.14	0.071	-0.043	0.262	-0.075	0.261	M	43.12***	182.30	1621.50
Formalization	16	2572	0.08	0.14	0.077	0.063	0.207	0.066	0.207	M	40.58***	127.20	2153.30
Interfunctional Coordination	6	1577	0.14	0.16	0.060	0.021	0.243	0.054	0.252	M	6.74	72.00	926.30
Team Communication	10	1966	0.21	0.15	0.068	0.016	0.292	0.006	0.285	M	22.17***	191.30	1520.90
OUTCOMES													
Financial Performance	41	118390	0.06	-0.06	0.014	-0.081	0.084	-0.081	0.078	S	1501.66***	81.70	0.00
Efficiency	18	1552	0.41	0.35	0.087	0.150	0.596	0.105	0.566	L	48.68***	1497.60	6306.80
Subjective Performance	19	4909	0.25	0.32	0.058	0.108	0.511	0.105	0.500	L	36.35***	2950.40	6145.80

k = the number of samples in each analysis; N = the total number of respondents in the k samples; r = the mean uncorrected correlation; r_t = the mean weighted corrected correlation; sd_t = the estimated population standard deviation; ES = effect size, where L is large, M is medium, and S is small (Cohen and Cohen 1983); χ^2 = a chi-square test for variance unaccounted for across the samples; N_{fsR} = fail-safe N (Rosenthal's Method) for each variable; N_{fsO} = fail-safe N (Orwin's Method) for each variable.
*p<.10. **p<.05. ** p<.01.

The overall meta-analysis results are summarized in Figure 1.

3.4.1 Environment

External factors are thought to lead to increased levels of innovation. A dynamic environment requires organizations to innovate in order to adapt to the changing environment (Meyer and Goes 1988; Nohria and Gulati 1996). Prospect Theory argues that in times of great uncertainty, organizations are more likely to be risk seeking and therefore more likely to innovate (Kahneman and Tversky 1979). However, competition and environmental turbulence have a relatively small impact on innovation.

3.4.2 Resources

The resource-based and dynamic capabilities view of the firm argues that organizational resources and capabilities provide the stimulus necessary to achieve a competitive advantage in the marketplace (Barney 1991; Teece et. al 1997). One potential mechanism through which superior performance can be obtained is through innovation. Therefore, it is expected that organizational resources capabilities will be drivers of innovation. Resources are defined as "everything that the organization has available to aid work in a domain targeted for innovation" (Amabile et al 1996, p. 1156). Overall results suggest that an organization's past innovation (a proxy for innovation stock) and the presence of an innovation champion have the strongest correlation with innovation. In addition, an organization's diversification, network ties, and specialization are all positively related to innovation. The results of the overall analysis suggest that organizational age, resource level, and size are positively related to innovation, the magnitude of this relationship is relatively small. Public ownership also has a significant

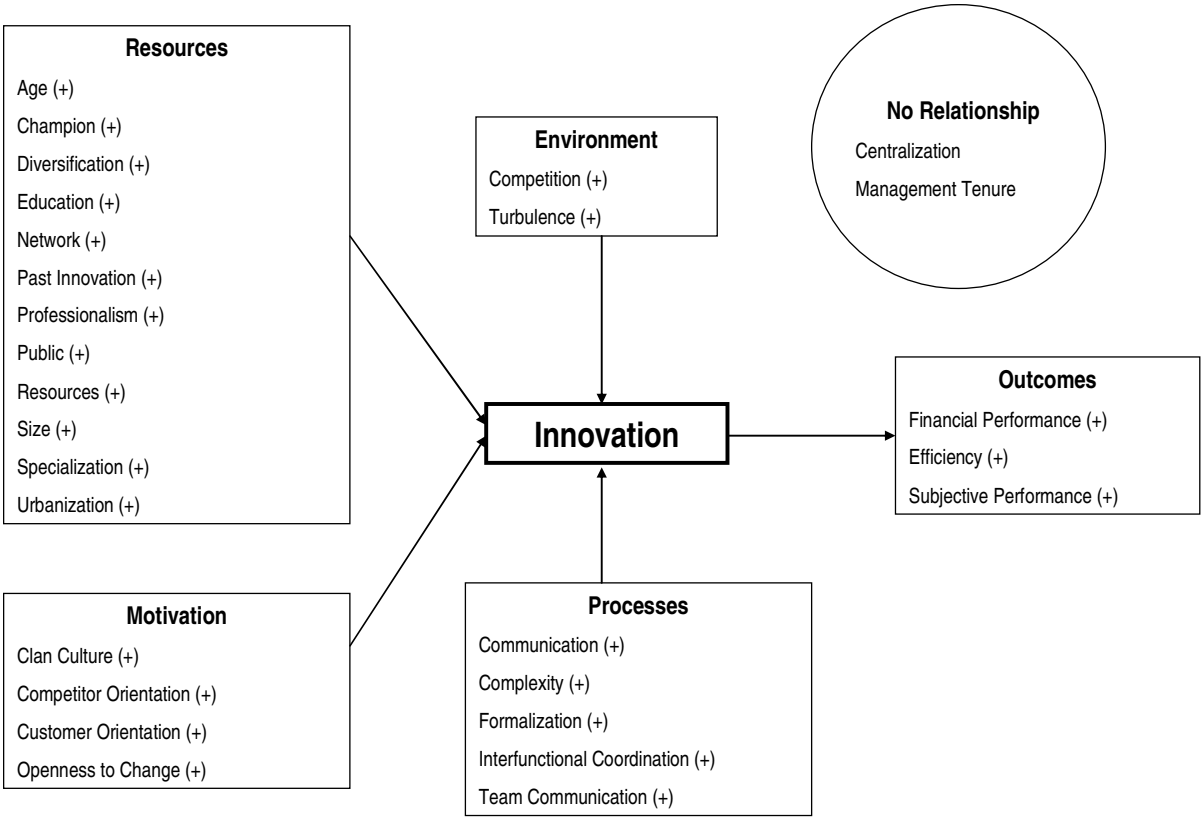

Figure 1: Summary of Meta-Analysis Results

positive relationship with innovation at the organizational level. Management education level and professionalism are positively correlated with innovation. However, managers' tenure level, which is posited to negatively impact innovation throughout the literature, shows a correlation of zero (Meyer and Goes 1988; Rao and Drazin 2002). Additionally, the level of urbanization surrounding a company seems to positively impact the generation of organization innovation.

3.4.3 Motivation

In addition to organizational resources, the organization must also possess a desire to generate innovations. Organizational motivation for innovation refers to an increased orientation towards innovation (Amabile 1988). Overall results indicate that

clan culture, which stresses an environment that is open to new ideas and promotes employee participation, cohesiveness, and teamwork to promote organizational change, has the strongest relationship with innovation[8]. Not surprisingly, an organization's openness to change has a strong significant relationship with innovation generation in the overall sample. Competitor and customer orientation are also positively related to innovation.

3.4.4 Processes

The final input necessary for innovation generation are organizational processes that provide the structure necessary for the facilitation of organizational innovation. Past research has argued that organizational structure is the primary driver of innovation because structure and processes provide the formal, internal context that is required in order for innovation to occur inside the organization (Russell 1990; Wolfe 1994). Overall results suggest that structure is in fact positively related to innovation. Organizational complexity, formalization, and interfunctional coordination provide support to the role of organizational processes in the facilitation of innovation. In addition, organizational and team communication are positively related to innovation. Surprisingly, while centralization has been the focus of a great deal of research, overall results indicates that it is not significantly related to innovation (Collins, Hage and Hull 1988; Dewar and Dutton 1986; Ettlie and Rubenstein 1987; Hage and Dewar 1978).

[8] The placement of clan culture as a motivation variable stems from the fact that it is an orientation of the firm. While a clan culture does enhance communication and teamwork which are process variables associated with innovation, the culture itself is not a process but rather an orientation, thus its placement in the motivation category.

3.4.5 Outcomes.

The link between innovation and performance is well established in the literature (Han, Kim and Srivastava 1998). The overall analysis partially supports this expectation. Results suggest that innovation is positively related to efficiency and subjective performance outcomes in this analysis. However, the corrected mean correlation between innovation and financial performance is negative and suggests that on average innovation generated within the organization detracts from firm performance. Innovation has the strongest relationship with efficiency gains in an organization and the weakest relationship with financial performance.

3.5 Decomposition of Variance

In addition to the overall analysis, it is necessary to examine which set of predictor variables explains the greatest amount of unique variance in innovation. In order to conduct this analysis, a correlation matrix for the dataset was constructed and several regression models were hierarchically run. The unique variance attributable to each variable (Environmental, Resources, Motivation and Processes) is equal to the difference in the adjusted-R^2 between the model with all 4 predictor variable sets included and the model with that particular variable set excluded. The difference between the full model (with all four predictor sets) and each of the 3 predictor set models shows the unique contribution of each (See bottom of Table 2). From the results of this analysis one can see that organizational resources account for the majority of the variance in innovation. Organizational resources uniquely account for 47.8 percent of the variance in innovation, while environmental and motivation variables uniquely account for only 2.9 and 9.9 percent of the variance respectively. Interestingly results suggest

that organizational process (i.e. centralization, formalization), which past research has demonstrated as being of vital importance for innovation adoption, does not seem to be a key driver of innovation generation and explains only 4.2 percent of the unique variance in innovation.

Table 2: Decomposition of Variance Results

Variable	***Unique Variance***	***Percent of Variance Explained***[9]
Environmental	0.0046	2.9%
Resources	0.0756	47.8%
Motivation	0.0157	9.9%
Processes	0.0067	4.2%
Total	0.1587	100%

3.6 Moderator Analysis

As a follow up to the overall meta-analysis, several tests were conducted to check for the presence of moderators in our data set. The first indicator of moderators is to examine whether or not statistical artifacts explain the variance in observed correlations (Hunter and Schmidt 2004). The chi-square test (shown in Table 1) indicates that between study variance was in fact due to statistical artifacts in 2 of the 29 variables examined. Both of the studies are based on seven or fewer samples. However, the remaining 27 analyses indicate that there are potential moderators of the innovation-variable relationship. Variables that did not have a significant chi-square or those that had too few observations could not be included in this moderator analysis. Therefore, the following variables were excluded: past innovation, public ownership, specialization, level of urbanization, clan culture, and interfunctional coordination.

[9] The remaining variation was explained by pairs of predictor set variables.

In addition to the standard procedure as set forth by Hunter and Schmidt (2004), the test for moderators can also be performed using Structural Equations Modeling (Joreskog and Sorbom 2001). All of the correlations between the independent variables and dependent variables were computed[10]. Additionally a separate correlation matrix was constructed for each independent variable that eliminated outliers and resulted in a non-significant chi-square in the previous analysis (a correlation matrix without moderators present). After construction of the two correlation matrices, the variables were analyzed using a multi-group comparison in LISREL 8.51 (Joreskog and Sorbom 2001). In this analysis, a significant χ^2 indicates that the correlation matrix with heterogeneity (or generated from the overall sample) is significantly different from the correlation matrix without moderators present. If this is found to be the case, it provides evidence of moderators present within the sample and justifies the further examination of the source of this heterogeneity. The results indicate with certainty that there are in fact differences between the two correlation matrices providing further evidence of moderators within the data set ($\chi^2_{(78)} = 48{,}204.16$, RMSEA = 0.29).

To examine the impact of moderators on the innovation-variable relationship, a generalized least squares regression (GLS) approach was taken. GLS can overcome the assumption of independence that is necessary in other multivariate analysis techniques. The correlations in this analysis cannot be treated as independent because each sample in the meta-analysis provided more than one innovation pairwise correlation. Therefore it is necessary to model within-sample dependencies and in turn safeguard against samples that yielded more information biasing the results. In order to model these dependencies,

[10] Where information was available.

it was necessary to calculate the block diagonal variance-covariance matrices for each sample and analyze them together in a single analysis (Raudenbush et al 1988). As pointed out by Raudenbush et al (1988, p.112):

> "Perhaps most important, the method [GLS] provides a systematic framework for examining whether different outcomes respond similarly or differently to treatments and whether these treatment effects depend on features of study design, sampling, and implementation."

For each sample the variances and covariances were calculated (Becker 1992; Becker and Schram 1994) as:

$$Var(r_{inn,x}) = (1-\rho_{inn,x}^2)^2 / n,$$

$$Cov(r_{inn,x}, r_{inn,y}) = [\frac{1}{2}(2\rho_{x,y} - \rho_{inn,x}\rho_{inn,y}) * (1-\rho_{inn,x}^2 - \rho_{inn,y}^2 - \rho_{x,y}^2) + \rho_{x,y}^3] / n,$$

where $r_{inn,x}$ is the sample correlation between innovation and variable x, $\rho_{inn,x}$ is the corresponding population correlation, and n is the sample size. From these calculations, a matrix consisting of variance and covariance values for each sample was constructed (Σ_i), with the full covariance matrix for the meta-analysis denoted as Σ. In order to examine the impact of moderators, the following model was estimated

$$d = X\beta + e,$$

where d is the effect size of the innovation-antecedent variable relationship, and the parameter β is estimated through GLS estimation. In order to estimate β, the following equation was used

$$\beta^* = (X'\Sigma^{-1}X)^{-1}X'\Sigma^{-1}d,$$

with the variance-covariance matrix of β^* being:

$$V_{\beta^*} = (X'\Sigma^{-1}X)^{-1},$$

Four broad categories of moderators have been identified as critical in meta-analytic studies: (1) measurement method, (2) research context, (3) estimation procedure, and (4) model specification (Assmus, Farley and Lehmann 1984; Capon, Farley and Hoenig 1990; Farley, Lehmann and Sawyer 1995). However, in this study, since the

effect size under consideration is the Pearson product moment correlation, it is not affected by either model specification or the estimation procedure. Consequently, three measurement factors are considered: (1) innovation measure, (2) innovation typology, and (3) temporal nature of the data (cross-sectional versus longitudinal). In addition, one research context moderator, namely, industry type is examined (see Figure 2). The rationale behind the impact of these moderators is provided in Table 3.

The results from the generalized least squares regression are summarized in Table 4.[11] Overall, the results provide support for the moderator hypotheses. A discussion of specific results follows.

3.6.1 Measure of Innovation

It is hypothesized that the measure of innovation employed will significantly impact the correlations observed between innovation and other constructs. The five primary methods of innovation measurement used are: (1) frequency count measure that is the summation of all innovations adopted within an organization, (2) a dichotomous measure of innovation generation, (3) R&D intensity as a surrogate for innovation, (4) a scale of organizational steps geared at the creation of innovation, and (5) a scale of innovation radicalness, or newness to the organization and/or customer base.

In particular, Hypothesis 1 predicts that a dichotomous measure of innovation will exhibit lower effect sizes than samples using other measures of innovation. The parameter estimate for Measure 2 is negative (β=–0.692, $p<0.001$) thus supporting Hypothesis 1. Therefore one can conclude that dichotomous measures of innovation negatively bias the observed effect size of innovation relationships. Additionally, the

[11] The GLS regression only examined the impact of variables with a sample size of 10 or greater.

results indicate that the other measures of innovation also bias the observed effect sizes of innovation relationships. Results suggest that measurement of innovation significantly impacts the effect sizes observed and future research can benefit from using multiple measures of innovation.

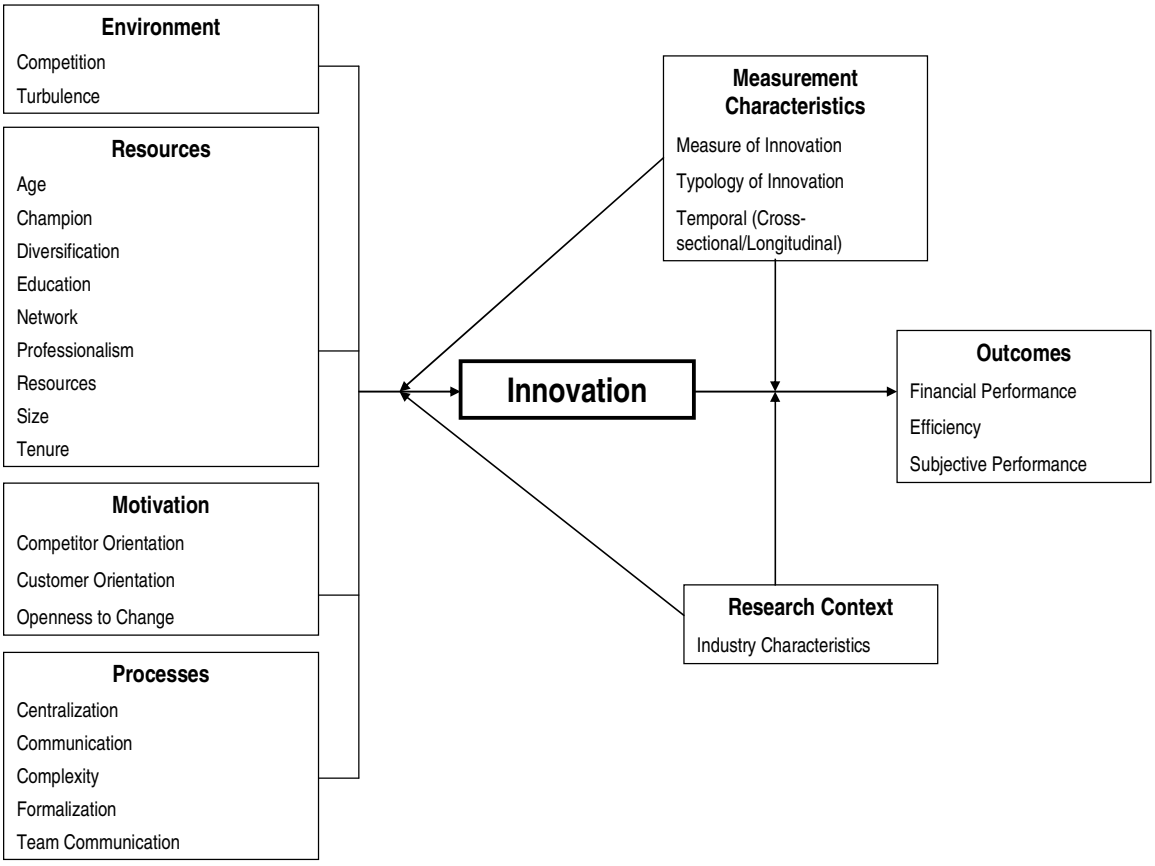

Figure 2: Conceptual Framework for Moderator Analysis

3.6.2 Typology of Innovation

Despite the prevalence of these different typologies in innovation studies, the focus of this moderator analysis is the impact of categorizing innovation as being either product or process and radical or incremental in innovation relationships. Product

innovations involve the development of a new product while process innovations are new elements that are developed for an organization's production or service operations (Knight 1967; Utterback and Abernathy 1975). In order to conduct the moderator analysis, all samples were coded as a product innovation, a process innovation, or some combination of both. Of the 155 samples, 107 examined product innovations, 25 samples were based on process innovations, and 23 samples examined both product and process innovations together. The results of the moderator analysis finds support for Hypothesis 2a and indicate that studying product, process, or a combination of the two types of innovations does bias the results obtained. Studying product innovations and process innovation in isolation tends to inflate the effect size of innovation relationships as compared to examining these same relationships with some combination of the two types of innovation (β=0.446, β=0.682, $p<0.001$, respectively). This finding provides support for Downs and Mohr's (1976) need to categorize innovation in order to gain a true understanding of the nature of innovation.

In addition, recent studies have also focused on the differential impact of radical and incremental innovations within the organization (He and Wong 2004). Radical innovations fundamentally change the activities of an organization and represent clear departures from the previous way of conducting business. Innovations that do not cause significant departure from the status quo are considered incremental in nature (Chandy and Tellis 1998). Therefore this study sought to understand the differences between focusing on radical and incremental innovations and the effect sizes obtained. Hypothesis 2b argues that studies focusing on radical and incremental innovations in isolation will bias observed effect sizes as compared with those studies that do not

discriminate between the degree of change associated with the innovation. Support is found for Hypothesis 2b. Studies that focus only on radical innovations positively bias observed effect sizes (β=0.558, $p<0.001$), while studies examining only incremental innovations negatively bias the correlations observed (β=-0.850, $p<0.001$). Therefore results suggest that studying radical and incremental innovations in isolation do in fact yield very different conclusions.

3.6.3 Temporal Design

Hypothesis 3 predicts that examining innovation either with a cross-sectional research design or longitudinally will bias the effect sizes observed. Results do not find support for Hypothesis 3 (β=-0.069, $p<0.001$) and instead suggest that studying innovation at one point in time will deflate the true effect size of these innovation relationships compared to examining the impact of innovation over time. This finding indicates a need for researchers to be cognizant of the differences in studying innovation at one point in time versus longitudinally.

3.6.4 Industry Characteristics

Innovation has been examined in several different contexts. The objective of Hypothesis 4 is to investigate the impact of studying innovation in manufacturing and service industries. Specifically, it addresses the question: whether industry characteristics result in meaningful differences between the effect sizes found between antecedents and consequences of innovation. Results find support for Hypothesis 4 and suggest that studying innovation in either a manufacturing (β=0.897, $p<0.001$) or service setting (β=0.493, $p<0.001$) inflates the effect size of innovation relationships as compared with studying innovation with a pooled sample from both settings. Therefore studying

Table 3: Theoretical Rationale for Proposed Moderators of Innovation Research

Moderators	***Rationale***
Measurement Factors	
Innovation Measure	There have been five primary means of measuring innovation in the literature: (1) frequency count measure that is the summation of all innovations adopted within an organization, (2) a dichotomous adoption or nonadoption, (3) R&D intensity, (4) implementation scales (steps that organizations take to introduce/implement an innovation), and (5) scale of innovation radicalness. Prior research indicates that scales with larger range and number are more reliable. Consequently more attenuation should result from measurement error in a dichotomous scale, and therefore lower the effect size observed (Houston, Peter and Sawyer 1983). Therefore we hypothesize that: *H1: Samples using a dichotomous measure of innovation will exhibit smaller effect sizes than samples using continuous measures of innovation.*
Innovation Typology	Past research has reported that the impact of organizational variables on innovation can be different for product and process innovations (Damanpour 1991). Additionally, the objectives associated with product and process innovations are different. Product innovations are designed to meet an organization's external needs while the emphasis for process innovations is to incorporate new elements into the operations of an organization (Knight 1967; Utterback and Abernathy 1975). Additionally, past research has highlighted the different mechanisms present within the organization to facilitate radical and incremental innovations (He and Wong 2004). Radical innovations are often exploratory in nature, while incremental innovations tend to exploit the current knowledge base within the organization. Therefore, it is expected that the typology of innovation will bias the effect sizes observed for the antecedents and outcomes of innovation, however the direction of this bias is not known a priori. *H2a: There will be a significant difference in effect sizes between samples studying product innovations, process innovations, and a combination of both product and process innovations.* *H2b: There will be a significant difference in effect sizes between samples studying radical innovations, incremental innovations, and combination of both radical and incremental innovations.*

Moderators	***Rationale***
Temporal Design	In meta-analytical investigations, scholars often code for the temporal nature of studies investigating causal relationships (e.g. Hom et al 1992). It is probable that studies investigating innovation at one point in time versus over a period of time are likely to yield different correlations between innovation and its antecedents and outcomes. Therefore we predict that the temporal design of the samples will bias the effect sizes observed with regards to innovation. However, the direction of this distortion is unknown a priori. *H3: There will be a significant difference in effect sizes between samples investigating innovation with a cross-sectional design and samples investigating innovation with a longitudinal design.*
Research Context	
Industry Characteristics	Past research has demonstrated that manufacturing and service organizations differ with respect to innovation (Damanpour 1991). Due to the differences inherent between service providers and manufacturers, the impact of antecedents on innovation could be markedly different. Studies with pooled samples from both sectors face greater heterogeneity than studies focusing on only one sector. Therefore, studies that focus on only one industry will be better able to tease out the true impact of antecedents on innovation and the relationship between innovation and performance as compared with studies that examine innovation in both industries. Therefore it is hypothesized that: *H4: Samples investigating innovation within either a manufacturing or service context will yield different effect sizes than samples investigating innovation across both industries.*

Table 4: GLS Moderator Results

Moderator	*Beta*	*Variance*	*z-value*
MEASURE OF INNOVATION			
Measure 1 (Frequency Count)	0.848	0.0001	89.81*
Measure 2 (Dichotomous)	-0.692	0.0002	-43.96*
Measure 3 (R&D Intensity)	0.341	0.0002	26.88*
Measure 4 (Organizational Steps)	2.076	0.0001	172.78*
TYPOLOGY OF INNOVATION			
Product	0.446	0.0001	53.77*
Process	0.682	0.0002	52.41*
Radical	0.558	0.0001	61.65*
Incremental	-0.85	0.0005	-39.18*
RESEARCH DESIGN			
Cross-Sectional vs. Longitudinal	-0.069	0.0001	-7.55*
INDUSTRY CHARACTERISTICS			
Manufacturing	0.897	0.0001	83.51*
Service	0.493	0.0002	34.24*
ANTECEDENTS AND OUTCOMES			
Competition	-0.002	0.0001	-0.15
Turbulence	-0.364	0.0002	-28.38*
Age	-0.167	0.0001	-15.1*
Champion	0.096	0.0002	6.48*
Diversification	-0.113	0.0001	-11.71*
Education	0.988	0.0005	43.85*
Network	-1.003	0.0001	-102.58*
Professionalism	-0.587	0.0003	-36.25*
Resource	-0.37	0.0001	-44.43*
Size	0.529	0.0001	68.39*
Tenure	-0.813	0.0004	-42.07*
Competitor Orientation	-0.25	0.0009	-8.21*
Customer Orientation	-0.923	0.0009	-30.53*
Change	-1.498	0.0003	-86.67*
Centralization	-0.409	0.0003	-23.11*
Communication	-0.278	0.0002	-19.23*
Complex	0.023	0.0003	1.34
Formal	-0.174	0.0005	-8.15*
Team	-1.338	0.0004	-66.04*
Financial	-0.343	0.0001	-42.54*
Efficiency	1.218	0.0003	66.07*
Subjective	0.114	0.0003	6.72*

*p<.001.

innovations using pooled samples from multiple contexts will lead to weaker results than simply conducting the study within one context.

Study 1 provides an overall synthesis of the innovation literature and offers some explanation as to why there are so many inconsistencies present within the innovation domain through a multivariate moderator analysis. Overall results find that organizational resources explain the greatest proportion of unique variance in the innovation construct compared with that of motivation, process, and environmental variables. In addition, overall results find that innovation generation is negatively related to financial performance, but has a positive relationship with organizational efficiency. Finally, Study 1 highlights the impact of research design and context on innovation effect sizes. Innovation generation is a context-dependent phenomenon and future studies should take into account both the nature of the innovation and the context when conducting future studies.

CHAPTER 4

INNOVATION THEORY TESTING

While the focus of Study 1 is to provide a synthesis of the empirical literature investigating innovation generation and uncover potential reasons for the inconsistency present within the literature, the objective of Study 2 is to test a more comprehensive model of innovation than has been done in the past and thus aid in theory development within this domain. In addition, Study 2 seeks to resolve several conflicting results within the innovation literature. As mentioned earlier, there are multiple perspectives used to investigate innovation generation and past studies focus on examining only a narrow set of innovation relationships.

The Componential Model of Creativity and Innovation views the generation of organizational innovation as a product of resources, motivation, and organizational processes that lead to creative ideas (Amabile et al 1988; Amabile et al 1996). Resources consist of anything and everything the organization has available to aid in the generation of an innovation. Motivation refers to the basic orientation of the organization towards innovation and supports for creativity and innovation throughout the organization. Finally, organizational processes must also be present in order for the organization to capitalize upon these resources and the motivation to innovate. Building upon these organizational variables that must be present in order for innovation generation to occur, research has also suggested that there are factors external to the organization (i.e. environmental variables) that impact the generation of creative ideas and innovation

within the organization (Woodman et al 1993)[12]. Therefore, in addition to these organizational antecedents the role of environmental variables in the generation of organizational innovation is also examined.

Despite the overall findings of Study 1, past research has asserted that there is in fact a direct, robust relationship between organizational innovation and performance (Han et al. 1998). Additionally there is a lack of understanding surrounding the relationship between the antecedents of innovation (resources, motivation, processes, and environment), innovation itself, and organizational performance outcomes. These relationships have yet to be empirically investigated with one sample (Wolfe 1994). The Resource-Based View postulates that innovation is one possible mechanism by which organizations can gain a competitive advantage in the marketplace through unique organizational resources (Barney 1991). Product innovation can be the source of competitive advantage to the innovator and at the same time can lead to a sustainable increase in firm profits (Geroski, Machin and VanReenen 1993; Chandy and Tellis 1998). Past research supports the argument that innovation serves as a key mediator between antecedents of innovation and performance (Conner 1991; Damanpour and Evan 1984; Han et al 1998). In particular, innovation mediates the relationship between environmental uncertainty and performance. Firms faced with intense competition and turbulent environments often rely upon innovation as the primary driver of organizational

[12] Woodman et al (1993) called this approach to the generation of novel ideas the Interactionist perspective. The original conceptualization viewed creativity at the level of the individual. The generation of new ideas (and thus the extension to innovation), is the product of the interaction of the individual with the situation. In this case, the use of this theory is extended to the level of the organization and thus the generation occurs as a product of both organizational variables and variables external to the organization (i.e. the environment) (See Zhou and Shalley (2003) for a review of the literature on creativity).

performance (Gronhaug and Kaufman 1988). Innovation provides organizations with a means of adapting to the changing environment and often is critical for firm survival. Additionally, the relationship between organization level variables and performance are also mediated by innovation. Organization processes provides the internal configuration, including communication and resource flows, necessary for innovation to occur (Russell 1990). Organizational resources provide organizations with the inputs required for innovation that in turn can provide the organization with superior performance (Eisenhardt and Martin 2000).

4.1 Testing for Mediation

In addition to providing a quantitative integration of past research within a domain of study, meta-analysis is emerging as a means of testing alternative models within a research stream. By combining the principles of traditional meta-analysis and those of structural equations modeling, it is possible to test integrated models involving several constructs in order to advance theory development within the domain (Viswesvaran and Ones 1995). The combination of these two methodologies allows for the optimal testing of integrated models. Correcting artifacts present within a meta-analytical sample and using this data in a SEM analysis achieve accurate assessment of causal models and linkages between constructs of interest.

The first step in testing an overall model of innovation is the construction of a complete correlation matrix. Results from the first part of this study indicate that a pooling of correlations across innovation types will lead to significant confounding of the results. Therefore, in order to decrease the amount of variation in the dataset due to moderators, the correlation matrix was constructed for samples addressing only product

innovations. Due to an incomplete correlation matrix, several variables had to be excluded from the analysis. Therefore the model was tested using nine antecedents to product innovation (competition, turbulence, age, centralization, formalization, diversification, resource level, size, and innovation champion) and 1 performance outcome (financial performance) using LISREL 8.51 with maximum likelihood estimation. The harmonic mean of the sample size is used in the analysis so as to not give undue influence to studies with larger sample sizes (Viswesvaran and Ones 1995).

4.2 Alternate Models and Model Testing

Three models of innovation were analyzed and are reported below. The first model posits innovation as a key mediator between environmental and organizational antecedents and financial performance. Two alternate models were analyzed so as to serve as a robustness check for the full mediation model. The second model estimated allows innovation to serve as a partial mediator between these relationships. Finally, a third model was estimated in which innovation was included as an antecedent to innovation along with the other environmental and organizational variables. The results of the model testing are provided in Table 6.

Model 1 positions innovation as a key mediator, or mechanism by which environmental and organizational antecedents allow organizations to realize increased financial performance (Figure 3). The model yielded a good fit ($\chi^2_{(37)}$ of 116.71, GFI = 0.98, RMSEA = 0.050). Turbulence, diversification, resource level, size, innovation champion, and openness to change are all significantly related to innovation (see bottom of Table 6 for path coefficients). Organizational age, centralization, and formalization are not significant predictors of product innovation. The model does indicate that product

innovation is positively associated with financial performance, (β=0.16, $p<.01$), thus shedding additional light on the nature of the relationship between innovation and performance. Interestingly, while the overall analysis found a negative relationship between innovation and financial performance, this analysis suggests the opposite is true for product innovation. A detailed discussion of these results is presented in Section 4.4.

Table 5: Overview of Model Testing Theoretical Relationships

Variables	*Theoretical Relationship with Innovation*
Turbulence	Environmental turbulence creates an environment that can be characterized by uncertainty. Turbulence provides a stimulus for organizations to innovate in order to safeguard against this uncertainty. Organizations are forced to search for environmental information and opportunities and capitalize upon these opportunities through innovation. Therefore we hypothesize that: *H1: There is a positive association between environmental turbulence and innovation.*
Age	Older organizations are often thought of as being a creature of norms and habits. Older organizations have established formal and informal relationships both internal and external to the organization. They have been found to be more rigid and less open to change (Rao and Drazin 2000). On the other hand, some scholars posit that younger firms are less willing to make changes that might disrupt their current means of conducting business. In addition, past research has found support for a positive relationship between age and innovation (Chandy and Tellis 2000). Older organizations have a well-defined resource base and have demonstrated high potential for survival, which allows organizations the flexibility to pursue innovation (Kimberly and Evanisko 1981). Given the competing logics behind the relationship, the following is proposed. However, the direction of this relationship is unknown a priori. *H2: There is a significant association between age and innovation.*
Champion	Champions use power and influence to gain the necessary resources and support in order for the innovation to occur. Champions help nurture the innovation from conceptualization to implementation and therefore foster innovation within an organization (Chandy and Tellis 1998; Markham and Griffin 1998). *H3: There is a positive association between innovation champion and innovation.*

Variables	*Theoretical Relationship with Innovation*
Diversification	Organizations that have very diversified product offerings have to split their R&D resources among several different product lines. It is this scarcity of resources that can have a detrimental impact on innovation (Boeker 1997; Hoskisson et al 2002). On the other hand, because the organization offers so many different product lines, diversification creates a greater knowledge base within the firm to build upon. In addition, the promoting the dissemination of diverse ideas across the organization is likely to promote innovation (Day 1994; Hitt et al 1996). Given the competing logics behind the relationship, the following is proposed. However, the direction of this relationship is unknown a priori. *H4: There is a significant association between diversification and innovation.*
Resources	Resources provide organizations with the flexibility to pursue innovation (Meyer 1982). Not only do available resources provide the necessary inputs to innovation, but also reduce barriers and risks to the organization when implementing the innovation. Resources enable an organization to absorb the cost of the innovation and the possibility of failure (Rosner 1968; Burns 1989). On the other hand, too many resources may be an indication of management incompetence and organizational waste, which can detract from innovation (Bolton 1993; Boeker 1997). Given the competing logics behind the relationship, the following is proposed. However, the direction of this relationship is unknown a priori. *H5: There is a significant association between resource level and innovation.*
Size	Large organizations often have more a larger resource base to pull from than smaller organizations (Baldridge and Burham 1975; Chandy and Tellis 1998). Size also leads to greater levels of diversity within the organization, which can lead to a greater number of innovative ideas being developed. However, size can also be associated with organizational inertia and a failure to adapt to changing resource conditions (Bolton 1993; Boeker 1997). The greater the organization's size, the higher the level complexity present within the organization, which can lead to difficulty in processing information. Given the competing logics behind the relationship, the following is proposed. However, the direction of this relationship is unknown a priori. *H6: There is a significant association between size and innovation.*
Openness to Change	A favorable attitude towards change provides organizations with a culture supportive of innovation. A culture supportive of change provides organizations with not only the motivation necessary for

Variables	*Theoretical Relationship with Innovation*
	innovation, but also provides access to increased levels of resources necessary for innovation to occur. Based on this argument, we hypothesize the following relationship: *H7: There is a positive association between openness to change and innovation.*
Centralization	Centralization is thought to discourage innovation by decreasing employee's awareness, commitment and involvement. Centralization does not allow for lower level individuals to participate in decision-making and therefore they do not feel involved with the process of innovation or the outcomes associated with the innovation. Centralization does not foster information transfer within the organization and past research has argued that it is this free exchange of ideas that fosters innovation (Khan and Manopichetwattana 1989). On the other hand, other scholars have found the opposite relationship to be true. The concentration of power within the organization is often necessary to overcome organizational opposition to change and in fact increases the likelihood of innovation success (Dewar and Dutton 1986). Given the competing logics behind the relationship, the following is proposed. However, the direction of this relationship is unknown a priori. *H8: There is a significant association between centralization and innovation.*
Formalization	Formalization limits organizational flexibility and stifles the creativity of employees because of the focus on rules and procedures within the organization. Formalization results in standardized behavior from employees (Robbins 1990), thereby inhibiting innovation. *H9: There is a negative association between formalization and innovation.*
Performance	Innovation provides organizations with a new method of conducting business ahead of competition and the potential to gain a competitive edge in the marketplace (Stephens et al 1999; Ahuja 2000). In addition, innovation provides organizations with a new means of meeting customer needs and this can lead to increased financial performance. On the other hand, innovation takes up substantial resources and can be very risky for the organization. If the innovation fails in the marketplace it is likely to decrease financial performance (Markham and Griffin 1998). Given the competing logics behind the relationship, the following is proposed. However, the direction of this relationship is unknown a priori. *H10: There is a significant association between innovation and performance.*

Model 1

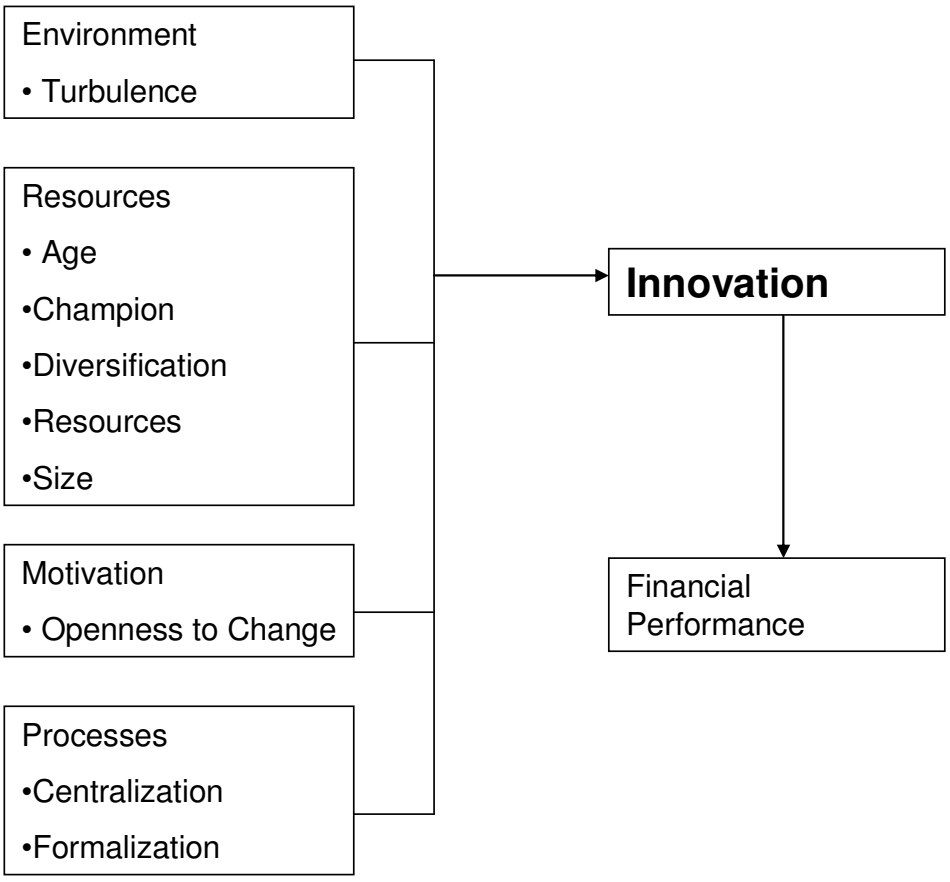

Figure 3: Innovation Modeled as a Key Mediator

Model 2

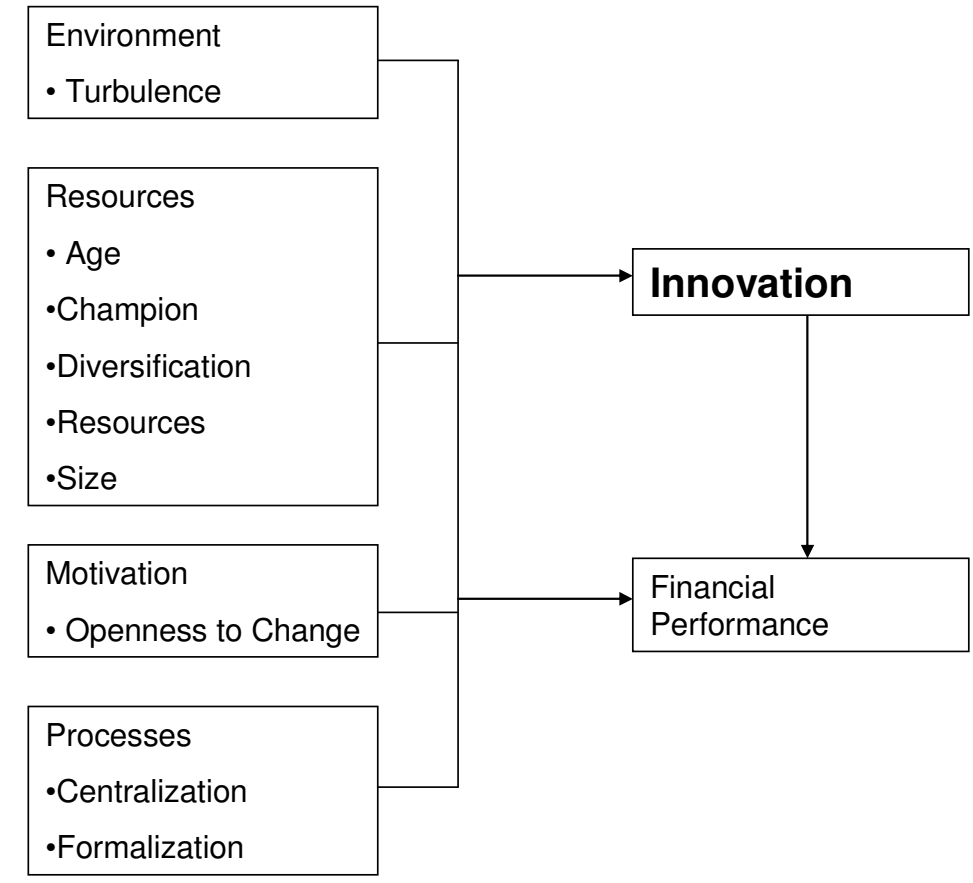

Figure 4: Innovation Modeled as a Partial Mediator

Model 3

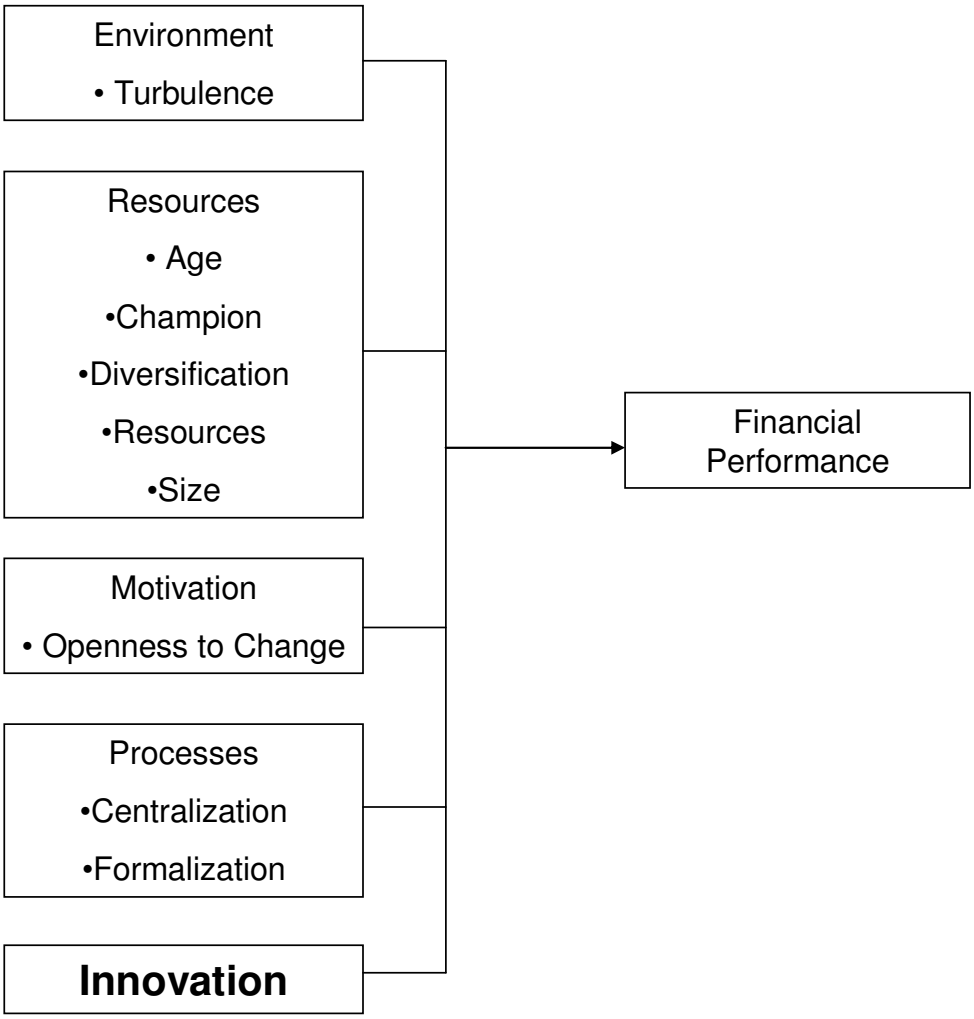

Figure 5: Innovation Modeled as an Antecedent

Table 6: SEM Model Testing Results

	Path to Innovation			Path to Performance			Mediation Test	
Variable	*Model 1*[a]	*Model 2*[b]	*Model 3*[c]	*Model 1*	*Model 2*	*Model 3*	*Sobel*	*Goodman*
Turbulence	0.10***	0.10***			0.05	0.05	1.67*	1.75*
Age	0.00	-0.02			-0.09**	-0.09**	0.02	0.03
Champion	0.32***	0.32***			0.01	0.01	2.17**	2.18**
Diversification	0.16***	0.15***			0.00	0.00	1.96**	2.00**
Resources	0.22***	0.22***			0.04	0.04	2.08**	2.11**
Size	0.23***	0.22***			0.09**	0.09**	2.09**	2.12**
Openness to Change	0.30***	0.29***			0.09*	0.08**	2.14**	2.17**
Centralization	0.06	0.05			0.06	0.06	1.09	1.19
Formalization	0.04	0.03			0.17***	0.17***	0.71	0.78
Innovation				0.16***	0.06	0.09***		

Model Fit	*Model 1*	*Model 2*	*Model 3*
Absolute Fit Indices			
χ^2	116.71	96.47	250.73
d.f.	37	28	37
χ^2/d.f.	3.15	3.45	6.78
RMSEA	0.050	0.051	0.078
SRMR	0.047	0.044	0.072
Incremental Fit Indices			
NNFI	0.81	0.79	0.50
CFI	0.87	0.89	0.67
GFI	0.98	0.98	0.95

[a] – where innovation is modeled as a key mediator between antecedents and performance; [b] – where innovation is modeled as a partial mediator; [c] – where innovation is modeled as another antecedent to performance

* p<0.10. **p<0.05. ***p<.01.

4.3 Robustness Checks

Much of the power associated with structural equations modeling is the ability to test alternate models. The second model positions innovation as a partial mediator between the antecedents and financial performance (Figure 4). The resulting fit is good ($\chi^2_{(28)}$ of 96.47, GFI = 0.98, RMSEA = 0.051). However, in this model innovation is not found to be a significant predictor of performance. Interestingly, while age is not a significant predictor of innovation, it does have a significant negative relationship with financial performance. Environmental turbulence, innovation champion, diversification, resource level, centralization, and innovation champion do not have a significant relationship with performance. Results suggest that size and openness to change have both a direct and indirect (through innovation) relationship with performance.

Because Model 1 (innovation as a mediator) and 2 (innovation as a partial mediator) are nested, it is possible to conduct a χ^2 difference test to compare the models. The test indicates that there is no significant difference between the two models (Comparison of Model 1 and Model 2: $\chi^2_{diff} = 20.24$, d.f.=9, $p>0.10$). Therefore, support is found for innovation as a mediator and can conclude that product innovation is a mechanism through which superior financial performance is achieved.

The final model tested did not include product innovation as a mediator, but rather tests the direct linkages between the antecedents of interest, including innovation, and financial performance (Figure 5). The purpose of testing this competing model is to show that innovation is not simply another exogenous construct that impacts firm performance as modeled in the majority of economic studies examining innovation, but rather that innovation does serve as a significant mediator in the relationship of these

antecedents with firm performance. This model provides a baseline with which to compare the mediation model and highlight the interrelationships with the other antecedents considered. This model yielded a significantly poorer fit ($\chi^2_{(37)}$ of 250.73, GFI = 0.95, RMSEA = 0.072). Results indicate that age, size, formalization, openness to change, and innovation are all significantly related to financial performance. However, turbulence, innovation champion, diversification, resource level, and centralization do not have a significant impact on performance. A comparison of Model 1 and Model 3 indicates that innovation does serve as a significant mediator between antecedents and financial performance (Comparison of Model 1 and Model 3: $\chi^2_{diff} = 134.02$, $p>0.10$).

In addition to overall model testing for mediation, more formal statistical tests of mediation are conducted (Barron and Kenny 1986; MacKinnon, Warsi and Dwyer 1995). These tests show the extent to which innovation mediates the relationship between environmental and organizational antecedents with financial performance. The formula used to conduct the mediation test follows (MacKinnon, Warsi and Dwyer 1995):

$$z = \frac{ab}{\sqrt{b^2 s_a^2 + a^2 s_b^2 + s_a^2 s_b^2}}, \qquad [6]$$

where the path from the independent variable to the mediator is a and its standard error is s_a^2, and the path from the mediator to the dependent variable is b and its standard error is s_b^2. Results show strong support for the role of innovation as a mediator for innovation champion, diversification, resource level, size, and openness to change with that of performance. Marginal support is found for the role of innovation as a mediator in the turbulence-performance relationship (See Table 5). Therefore, one can conclude that innovation does in fact play a role in organizational performance and serves as a link

between certain antecedents and financial performance, thereby supporting the mediation model and the resource-based view of the firm. Innovation created by the combination of organizational resources provides organizations with a unique resource that can be capitalized upon in the marketplace (Conner 1991).

4.4 Results and Discussion

In addition to using SEM to test model structures, the model testing analysis can also empirically answer the questions regarding the true relationship between innovation and other core constructs (as highlighted in Table 6). This section of the paper empirically addresses several of the inconsistent findings present within the innovation literature.

4.4.1 Environmental Variables.

Much of the focus of recent research regarding innovation has been on the role of the environment in the innovation process. Past research has shown that the environment has a positive impact on innovation and that innovation is influenced by environmental pressures (Dosi 1988; Nohria and Gulati 1996). Hypothesis 1 predicts that the level of turbulence present within the environment will be positively related to innovation. Strong support is found for Hypothesis 1 (γ=0.10, $p<0.01$) suggesting that innovation provides organizations with a mechanism for dealing with the uncertainty present within the environment. In times of high turbulence, the uncertainty present in the environment may drive innovation because organizations are constantly scanning their environment for new opportunities (Henderson and Clark 1990; Damanpour and Gopalakrishnan 1998). While environmental turbulence is a driver of innovation, it is not significantly related to financial performance.

4.4.2 Organizational Variables

While the theoretical rationale and proposed relationship behind both of the environmental antecedents are the same, the roles of organizational level variables on innovation all have considerable controversy. The impact of age on innovation has been studied quite extensively in the literature with mixed results (see Table 5). On the one hand, older organizations are thought to be better at innovation because they have established resources and procedures for survival (Chandy and Tellis 2000; Kimberly and Evanisko 1981). Yet other scholars have demonstrated that with age organizations become rigid and are less open to change (Rao and Drazin 2000). The results do not find support for Hypothesis 2 (γ=0.00, $p>0.10$), indicating that age is not significantly related to organizational product innovation. Perhaps even more surprising is that age is negatively related to financial performance. This finding is somewhat unexpected because past research has found that older firms demonstrate a high potential for survival and are thought to have the capabilities necessary to achieve superior financial performance (Kimberly and Evanisko 1981).

Hypothesis 3 predicts a positive relationship between the presence of an innovation champion and the generation of organizational innovation. Champions nurture the innovation from conceptualization and use their influence to gain the necessary inputs in order for innovation to occur. Results support this argument and Hypothesis 3 (γ=0.32, $p<0.01$). Therefore, organizational innovations are more likely to occur when there is an innovation champion. Not surprisingly, the relationship between innovation champion and financial performance was nonsignificant.

Diversification has also been subject to conflicting predictions as to its association with innovation. The model testing finds that diversification is positively related to product innovation, thereby supporting Hypothesis 4 (γ=0.16, $p<0.01$). However, diversification is not significantly related to financial performance. It appears that firms that are highly diversified can take advantage of this greater knowledge base and increase their level of product innovation (Hitt et al 1996). However, diversification by itself does not promote or hurt financial performance.

Hypothesis 5 examines the relationship between resource level and innovation. The results of the model testing demonstrate with certainty that resources are a necessary input to product innovation (Goes and Park 1997), thus supporting Hypothesis 5 and the notion that the greater the resource levels of a firm the greater their flexibility to pursue new product innovations (γ=0.22, $p<0.01$). However, the resource level of an organization does not have a significant relationship with firm financial performance in the model.

As a follow-up to the resource level argument, organizational size is thought to promote innovation through resource availability and knowledge diversity arguments and the model supports this notion and Hypothesis 6 (γ=0.23, $p<0.01$). Additionally, size is positively related to financial performance. Therefore, results suggest that organizational size does in fact promote innovation through the communication of diverse ideas within the organization and increased access to resources and has both a direct and indirect relationship with performance.

Hypothesis 7 predicts that an organization's openness to change will have a positive relationship with organizational innovation. Openness to change is indicative of

an organization's tolerance for change and a culture open to the expression of new ideas (Meyer and Goes 1988; Chandy and Tellis 1998). Results support Hypothesis 7 (γ=0.30, $p<0.01$). In addition, overall results find that openness to change also has a positive impact on financial performance.

Both the overall meta-analysis and the model testing of product innovation find that the relationship between centralization and innovation is not significant. Therefore Hypothesis 8 is not supported. Not only is centralization unrelated with innovation, it does not have a significant relationship with financial performance in this model either. The take-away from this finding is that a concentration of power within an organization may not directly impact the generation of innovation or financial performance.

Formalization is thought to detract from organizational innovation generation because it limits organizational flexibility (Robbins 1990). Therefore, Hypothesis 9 posits there to be a negative relationship between formalization and innovation. The results do not support this hypothesis and find no significant relationship between formalization and innovation. There is however, a significant positive relationship between formalization and financial performance (γ=0.17, $p<0.01$). Therefore, results suggest that organizational procedures and processes appear to enhance firm financial performance.

4.4.3 Performance Outcomes

Finally, this analysis was able to empirically examine the impact of product innovation on financial performance. Innovation provides organizations with a means of creating a competitive advantage in the marketplace that in turn will provide organizations with superior financial performance (Ahuja 2000; Han et al 1998).

However, scholars have often posited that while innovation has the potential to create the opportunity for increased performance, the act of innovation can be very costly and risky and has the potential to decrease financial performance (Markham and Griffin 1998). Results support for this first argument, and thus Hypothesis 10, and suggest that product innovation does increase financial performance (γ=0.16, $p<0.01$). The findings indicate that innovation is a mechanism through which organizations can achieve a competitive advantage in the marketplace.

CHAPTER 5

CONCLUSION

The key objectives of this study were three-fold. The first objective was to provide an up-to-date synthesis of 35 years of innovation research findings from economic, organization theory, strategy, and marketing literatures on innovation generation through meta-analysis. While past research on innovation has primarily focused on innovation adoption, this study is the first to isolate out the generation of innovations at the organizational level. Secondly, this paper sought to highlight and explain sources for the conflicting findings that have plagued the innovation literature. Finally, emerging techniques in meta-analysis are used to test a more comprehensive model of innovation. Results provide empirical evidence of the nature of the relationship between innovation generation and its antecedents and consequences, while at the same time provide answers to conflicting conclusions within this field. The conclusions reached in Study 1 impart a greater understanding of the drivers of innovation generation as well as the implications associated with the phenomena. This research is able to focus on the impact of examining product or process innovations on observed effect sizes, as well as understand the biasing impact of examining radical versus incremental innovations. Moreover, Study 1 is the first to empirically examine the impact of measurement on observed effect sizes within the innovation literature. Study 2 sought to aid in building a strong theoretical foundation relating to the nature of the relationship of innovation with key antecedents and outcomes by testing the most comprehensive model of innovation to date. This paper is able to demonstrate that innovation serves as a mediator of the

relationships between organizational and environmental antecedents and firm performance.

5.1 Discussion

This research shed some much needed light on the nature of innovation generation at the organizational level. The distinction between innovation generation and adoption is critical because the activities associated with each type are very different. Therefore the conclusions garnered from adoption research may not generalize to issues relating to the generation of innovations. In turn, the performance implications associated with innovation generation and adoption are thought to be different as well. If one looks at past syntheses of organizational adoption, the focus has primarily been on the impact of organizational structure and demographics in the prediction of organizational innovation. This study took a different approach and instead focused on the inputs necessary to generate innovation and the performance implications associated with innovative activities. The results indicated that organizational resources are absolutely essential in the generation of innovations, which in turn generated superior performance outcomes for the organization. Future studies need to be clear as to whether they are focusing on innovation generation or adoption.

In the past, studies have tended to treat all innovation as being equal thus leading to inconclusive results and generalizations. This research demonstrated that one such cause of this inconsistency stemmed from the use of different innovation typologies within the literature. The question addressed in this research is whether or not the innovation relationships examined will be stronger or weaker depending upon the type of innovation studied. Results strongly suggest that the typology of innovation utilized does have a

major impact on the conclusions generated by the research. Studying product innovation or process innovation in isolation of one another strengthened the relationship observed as compared with those studies that combined the types of innovation into one broad innovation study. Furthermore, the results from the moderator analysis highlighted some interesting differences between product and process innovations. The overall results from the meta-analysis did not find a significant relationship between innovation and performance. However, when product innovation was examined in isolation, the relationship between product innovation and financial performance became significant and positive. Some studies have questioned the value of product innovation for the firm (or not found the result) and this study, by aggregating across 107 studies, found that product innovation does enhance firm performance and can be considered a source of competitive advantage as suggested by the Resource-Based View of the firm. Therefore, by focusing on innovation generation this research was able to answer the controversy as to whether firms should invest in product innovations, and the answer obtained is a resounding yes. The impact of process innovation on firm performance is not quite as clear. It could be the case that perhaps process innovations take longer to pay off for the organization or in fact, they may not directly impact a firm's financial performance. Future research should clarify this relationship between process innovations and financial performance.

Furthermore, results suggested that examining radical versus incremental innovations yield significantly different conclusions. Radical innovation studies enhanced the effect size observed, while studies examining incremental innovation in isolation negatively biased the observed effect. Results support the argument that innovations that are

exploratory (radical) do behave differently than those innovations that are exploitative in nature (incremental). Future studies on innovation need to be clear as to whether they are focusing on product or process innovations, and radical or incremental innovations because the results will vary depending on the type of innovation. Therefore, studies that lump innovations together will cover up the true effects and thus lead to different conclusions than those focused on only one type of innovation. The objective of innovation research should no longer be to find one overarching theory that can explain every type of innovation, but rather examine different types of innovation and be able to explain that one phenomenon well.

This study was also the first in this area to empirically examine the impact of measurement on the conclusions reached within the literature. There are five primary measures used in innovation literature and our results support that each measure is different and significantly influences the results observed. The measure of innovation used can significantly alter the conclusions garnered from a particular study. Overall, a dichotomous measure of innovation negatively biased the observed correlations. Future research should seek to utilize the measure of innovation that is best suited for the particular research question being addressed and if possible, use a combination of innovation measures. Studies focused on the implementation of innovations generated by the organization would do well to use a frequency count of innovations. However, studies focused on the development or beginning phases of innovation, would be better suited to use a measure like R&D intensity or scale of organizational steps used to promote innovation over a frequency count measure which only taps into the implementation side of the innovation process.

Finally, this study was able to also empirically test relationships with conflicting theoretical rationale and provide some clarity regarding these relationships. In alignment with past research, the focus of this study remained on innovation main effects. Although unable to do so in this study, the possibility for nonlinear relationships between organizational antecedents and innovation, as well as interactions between the independent variables, is recognized. For example, variables such as age, size, and resource level may have an inverted-U relationship with innovation, yet it is not possible to examine this hypothesis in the current study. This remains an area for future research.

While there is a vast amount of research within the innovation domain, there is no one overarching theory of innovation. As pointed out earlier, the majority of the theoretical development within this area has been piecemeal. This research supports the role of organizational resources and motivation in innovation generation, and these groups of antecedents accounted for the majority of the unique variance explained within the innovation construct, while environmental and organizational process variables explained very little in the creation of an innovation. This result adds to the growing literature on innovation by clearly pointing out the variables that are the key drivers of innovation. Results further suggest that managers should invest in these resource and motivation inputs in order to promote the generation of new products within the organization.

The focus of the majority of the innovation research has been either on the relationship between innovation and its antecedents or the relationship between innovation and associated performance outcomes. Very few studies have attempted to model the entire relationship and focus on the role of innovation as a mediator, despite the theoretical rationale for its role as a mechanism through which organizational inputs

can be transformed into a competitive advantage for the organization. Results from Study 2 empirically supported innovation's role as a mediator, and in accordance with the Componential Theory of Creativity and Innovation and Resource-Based View provide strong evidence that product innovation does in fact provide organizations with a means of achieving a competitive advantage in the marketplace. Innovation served a key mediator for variables such as innovation champion, diversification, resource level, organizational size, and openness to change. Additionally, environmental turbulence had both a direct and indirect (through innovation) relationship with financial performance. Organizational variables by themselves are simply not enough to achieve superior performance, but rather the impact of these resources on performance occurred via innovation. Results support the argument that innovation is a means by which organizations can address the dynamism present within their environments and still thrive. Future research should attempt to model both drivers of innovation and the performance implications associated with innovation, as well as test the boundary conditions of innovation's role as a mediator.

5.2 Limitations

Despite the advantages of conducting a meta-analysis, the procedure is not without limitations. Four primary limitations have been addressed in the past: (1) it requires substantial effort and expertise, (2) authors are comparing apples and oranges, and (3) there is a publication bias present in the analysis (Lipsey and Wilson 2001).

Conducting a meta-analysis can be very time consuming and is very labor intensive compared to a traditional qualitative review of the same literature. In addition, conducting the analysis requires specialized knowledge especially in regards to the

selection and computation of the appropriate effect size. Additionally, expertise is required in simply conducting the actual analysis on the effect sizes. There are several textbooks however that are designed to help researchers overcome these drawbacks (Hunter and Schmidt 1990; Lipsey and Wilson 2004; and Wolf 1986). Furthermore, for this study, several different approaches were used to ensure that the analysis was approached correctly. In addition, to having an independent coder to ensure reliability in the coding of the effect sizes, several different methodologies were used to analyze the data. For example, when examining the data for the presence of moderators, both the traditional chi-square test and a multi-group structural equations model were estimated to show convergence in the results.

The second criticism of meta-analysis is that conclusions from the analysis cannot be drawn because authors are comparing and aggregating studies that use different measurement techniques, definitions of variables, and subjects (this is referred to as the "apples and oranges problem"). However, coding the characteristics for each study and statistically testing to determine if the differences in each study are related are due to these characteristics can address this issue. In this study, there were four major categories of moderators coded and examined in order to ensure that apples were being compared to apples. Most prior research using meta-analysis has examined moderators univariately, or one at a time, and thus could have drawn erroneous conclusions. However, the moderator analysis utilized in this study was a multivariate GLS analysis which is able to model the impact of all of the moderators at the same time. Therefore, this analysis is able to account for not only moderator variables specified, but is also capable of modeling the interdependencies present within the data.

Often times critics argue that meta-analysis favors significant findings because findings that are not significant are usually not published. Therefore the conclusions drawn by a meta-analysis are upwardly biased. A means of addressing this criticism is to include dissertations, books, and conference papers in the search for articles, as was the case in this study. Another means of addressing this concern is to calculate the number of nonsignificant results that would have to be present in order to nullify the conclusions drawn from the meta-analysis (in other words, calculate a fail-safe N). These attempts to address the file-drawer problem and the confidence one can have in the results obtained from a meta-analysis

Finally, meta-analysis is limited to examining only what has been studied in the past. While ideally it would be nice to examine interactions among the independent variables in predicting innovation, or perhaps curvilinear relationships, it is simply not possible to do so with this type of data. Because only effect sizes are coded and the researcher does not have access to the raw data, only the effect sizes of the relationship examined in prior studies can be used in the meta-analysis.

5.3 Future Research Directions

The focus of this research has been on innovation generation inside the organization. Future research should use the findings of this current study as a foundation for subsequent studies examining innovation. One such extension of this research should focus on the generation of innovation outside traditional organizational settings. For example, one of the key drivers of innovation is that of resources. However, the majority of new innovations created occur in small businesses that are often severely constrained in the level of resources available (National Innovation Initiative

Report 2004). Therefore, future studies should focus on which antecedents become more important in fostering innovation when resource levels are limited.

Meta-analysis allows one to not only integrate the research that has been conducted in one arena, but also highlights the gaps present within the domain. The majority of the research within innovation has primarily dealt with the role of resources and organizational demographics and structure in promoting innovation. The main effects of these variables on innovation have been over studied. Future research on the impact of these variables should explore interactions between the antecedents as well as non-linear relationships. Furthermore, several gaps remain in the literature. For example, the role of organizational culture in promoting innovation remains an area for future studies. In addition, there were not enough studies focused only on process innovation to permit a comprehensive model testing.

Finally, in today's competitive environment, the process of innovation is evolving. Most research focused on innovation inside organizations views the innovation process as one that is linear where organizations start with an idea and then follow a sequence of steps through commercialization. However, the reality surrounding the process of innovation is markedly different. Future research should examine these shifting paradigms to approaching innovation as well as the increased multidisciplinary nature of generating innovation.

PART 2

MARKETING STRATEGY FORMULATION FOR NEW TECHNOLOGIES:

A DYNAMIC CAPABILITIES FRAMEWORK

CHAPTER 6

INTRODUCTION TO PART II

Innovation is a key driver of the U.S. economy. While past research has focused primarily on innovation that occurs within organizations, there has been very little systematic research that attempts to understand how innovations are commercialized outside traditional organizational settings. At any given time there are approximately 10.1 million individuals attempting to create a new venture (Reynolds et al 2002). In other words, about 6.2 in every 100 U.S. adults are engaged in trying to take a new idea to market. Furthermore, over fifty percent of these ideas are commercialized by teams of individuals, representing over 5.6 million potential new businesses within the U.S. economy. Despite the astounding number of new ventures being created, the percentage of those actually succeeding in their commercialization efforts is relatively small (only 30 percent survive their first 5 years in business). Perhaps one of the most cited reasons behind this high failure rate is a lack of planning or direction for the venture (i.e. no clear strategy). Moreover, high technology start-ups are particularly prone to this failure because they are focused on the technology and tend to ignore the market (www.glocalvantage.com).

Given how pervasive start-up activities are in our economy, there is a real need to evaluate how innovations generated outside of the organizational setting are commercialized. How do inventors of new technologies determine their strategy to market? While marketing strategies are recognized as being of vital importance to organizations, very little research has addressed how marketing strategies are actually

formulated, and in particular how marketing strategies are developed for breakthrough technologies that may not occur within a traditional organizational context. The sample for this research comes from a unique panel of university prestart-up teams focusing on the commercialization of new technologies.

Marketing strategy development often occurs within teams. The use of teams within organizations charged with new product development has proven to be a critical resource for the development of strategic outcomes (Bharadwaj and Menon 2004). Teams provide organizations with a means of achieving learning and creativity, as well as knowledge dissemination throughout the organization. While cross-functional teams have received some attention within the marketing literature, the majority of the research has either focused on individual or organizational level outcomes (e.g. Ancona and Caldwell 1990; Keller 1994; Moorman and Miner 1998; Sarin and Mahajan 2001; Sethi, Smith and Park 2001). This research aims to extend the current literature and enhance our understanding of the role of the team itself, and in particular teams that formed outside of the organizational context, in the development of marketing strategy effectiveness.

6.1 Why Strategies are Important

Strategy can be defined as a firm's positioning to gain a competitive advantage in the marketplace (Teece et al 1997; Juga 1999). The primary objective of a strategy is to secure organizational effectiveness by performing the right activities at the right time. The central focus of a strategy is that the organization achieves the right fit with the external environment. Building upon this idea, a marketing strategy allows firms to develop a plan that enables them to offer the right product to the right market with the

intent of gaining a competitive advantage. In other words, a marketing strategy provides an overall vision of how to correctly position products in the marketplace while accounting for both internal and external constraints.

Marketing strategy research has primarily been focused in either one of two arenas: marketing strategy formulation or marketing strategy implementation. Marketing strategy *formulation* research examines the impact of certain variables on the development of marketing strategies themselves. In addition, this stream of research tends to focus on what should be done in practice or the role of marketing strategy in practice (Mintzberg 1994). On the other hand, marketing strategy *implementation* research treats the strategy as a given and examines the outcomes associated with the successful implementation of the strategy. The focus of this research falls within the marketing strategy *formation* domain and concentrates on the ability of teams to effectively formulate marketing strategies for new technologies. This research does not examine implementation of marketing strategies because of the stage at which these prestart-up teams are. Effectiveness of marketing strategy formulation is made up of three components: (1) marketing strategy performance, (2) marketing strategy creativity, and (3) marketing strategy improvisation.

Marketing strategy performance is defined as the extent to which a team is able to develop a comprehensive marketing strategy for their technology. This is a global measure of performance at the team level. In this case, performance does not refer to the market performance of the technology. These technologies are at such an early stage that even being able to formulate a marketing strategy is a significant performance milestone. *Marketing strategy creativity* is defined as the extent to which the strategic plan

developed by the team in an effort to commercialize a new technology represents a meaningful difference from marketing practices within the industry (Andrews and Smith 1996). The process of creativity has been shown to enhance performance through a focus on identifying problems, developing hypotheses, communicating ideas openly with others, and challenging the status quo (Gilson and Shalley 2004). *Marketing strategy improvisation* is defined as the degree of change in the marketing strategy formulation over time and is built around an earlier definition by Brown and Eisenhardt (1997) that describes improvisation as a means of creating while simultaneously adapting to changing markets and technologies. Improvisation occurs when an organization (or in this case, a team) faces a situation that it perceives as being unexpected and does not have a preplanned course of action set and yet the situation is perceived as requiring a course of action (Moorman and Miner 1998a, 1998b; Weick 1993, 1998). Thus, improvisation is influenced by both environmental uncertainty and real-time information flows. In uncertain environments, individuals may find improvisation necessary in order to survive. Individuals that maintain access to internal and external information are more likely to be exposed to unexpected real-time information that may trigger improvisation.

The objective of this research is to address the following gaps in the marketing strategy literature. First, very little empirical research has focused on the formation of marketing strategies outside traditional organizational boundaries. Secondly, this study focuses on the unique challenges of effective marketing strategy formation for new technologies, including technologies that may have been developed without a target market in mind. Finally, this paper is able to examine for formation of marketing strategies over time using a panel of commercialization teams that stay in tact over a

period of two years. More specifically, the objective of this research is to address the following questions: (1) What impact do market and technical network ties have on the effective development of marketing strategies?, and (2) Does obtaining market information early on in the commercialization process pay off in terms of the ability to effectively formulate marketing strategies?. The paper is organized as follows. First, I present a discussion of a theoretical model based on the dynamic capabilities framework focused on the role of network ties and absorptive capacity on the effective formation of marketing strategies. From this discussion, ten hypotheses are developed illustrating the impact of network ties and absorptive capacity on marketing strategy effectiveness. Finally, the methods by which I test these hypotheses and the empirical results obtained are presented followed by a discussion of the contributions of the study to the literature.

CHAPTER 7

A DYNAMIC CAPABILITIES FRAMEWORK

The term dynamic capability refers to the ability to integrate, build, and reconfigure both internal and external competencies to address rapidly changing environments (Teece et al 1997). The key to building a conceptual framework based upon the dynamic capabilities perspective is to identify the building blocks upon which competitive advantages can be formed, sustained, and improved. One such foundation is considered to be that of effective knowledge transfer. These technologies are developed outside of the organization; teams do not have access to well-established resources like those available within organizations. What the teams do have is novel technology and access to information. Given this, the focus of this research is on two distinct components of knowledge transfer: (1) network ties and (2) absorptive capacity. Past research has demonstrated that network ties provide access to information that can be beneficial to performance outcomes (Tsai and Ghoshal 1998; Tsai 2001). In addition to this external source of information, an internal learning capacity must also be present in order to absorb and utilize the information coming in. Both network ties and absorptive capacity have been found to play a key role in both innovation and superior performance outcomes (Cohen and Levinthal 1990; Tsai 2001). Therefore it is expected that both network ties and absorptive capacity will have an impact on marketing strategy effectiveness. Furthermore, because both an internal and external capability is necessary for effective knowledge transfer, an interaction between network ties and absorptive capacity is also expected (See Figure 6).

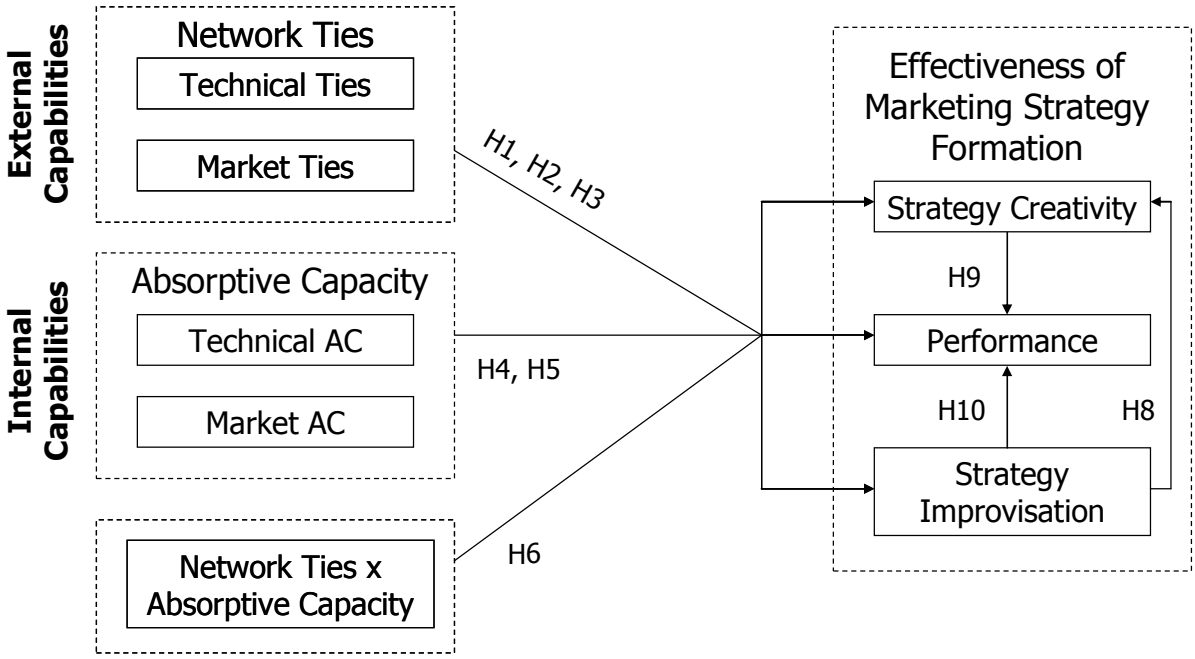

Figure 6: Dynamic Capability Framework

7.1 Network Ties

Network theory is focused on the exchange of knowledge and information among a defined set of persons, objects or events. Networks can provide individuals with a key component of the learning process whereby individuals discover new opportunities and acquire new information through interpersonal interaction. Relationships serve as the building blocks of networks (Knoke and Kuklinski 1982). The importance of these relationships has been documented throughout the literature. In fact,

> "the structure of relations among actors and the location of individual actors in the network have important behavioral, perceptual, and attitudinal consequences for the individual units and for the system as a whole" (Knoke and Kuklinski 1982, p. 13).

Several studies have found the linkage between an organization's network and innovative output and performance to be positive and significant (Ahuja 2000; Hansen 1999; Powell et al 1996; Tsai 2001; Walker et al 1997). These network relationships provide an organization with access to information that would otherwise be unavailable.

Most of the research conducted with regards to the importance of networks in key performance outcomes has utilized the strength of ties perspective as set forth by Granovetter (1973). An individual's network of contacts varies in terms of the strength of the interpersonal relationship. The strength of a tie is defined by the frequency of interaction, emotional intensity, intimacy, and reciprocal services comprising the relationship. It is also plausible for network ties to be absent as well.

Distinguishing between strong and weak ties becomes important when examining the information flow between parties. Network members that are close to one another, or spend a great deal of time together (strong ties), are more likely to have similar ideas and access to the same information. On the other hand, network members that are not close friends (weak ties) are more likely to be different from one another. In turn, these weak ties can provide access to a diverse set of information and resources that contains less redundant knowledge than strong ties. Furthermore, weak ties often serve as links between networks thus increasing the diversity of information flow among network members (Granovetter 1973).

In addition to differentiating among network relationships by their strength, it is also possible to categorize networks in terms of their information content. For the purpose of this study, I distinguish between network ties that are *technical* in nature and those that are used to gather *market* information. This is the first study to distinguish

among these two types of ties. This distinction becomes very important in the context of technology commercialization, where teams are focused on devising a marketing strategy for the application of new technology. Technical network ties are those members of an individual's network with which they discuss the technical components of their *technology*. This can include gathering both general technical information, or seeking advice regarding the specific technology. Therefore the information content with which technical ties are used relates to the technology itself. Market network ties are those relationships with which the *market* applications of the technology are discussed. Market ties are used to gather information relating to the market, whether that is information about market trends, competition, demand, consumer needs, etc. In the commercialization of new technologies, it is imperative that teams have access to both types of information: market and technical. Therefore, it is expected that teams with network ties that are both market and technical in nature should have increased levels of marketing strategy performance due to exposure to relevant market and technical information. They will have increased access to information that is relevant to both the technology and the potential market applications of their technology. Information about both the technology and the market and will aid in the development of a superior and more comprehensive marketing strategy for the technology. Furthermore, these ties will provide teams with new information that can stimulate both marketing strategy improvisation and marketing strategy creativity. Based on this logic, the following is hypothesized.

Hypothesis 1a: Technical network ties are positively related to (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation.

Hypothesis 1b: Market network ties are positively related to (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation.

While network ties provide individuals (teams, organizations) with desired outcomes, research has postulated that too many network ties may actually hinder performance. Thus, the argument is that there is some optimal level of network ties that should be utilized. Maintaining network connections requires effort and energy by the individual (whether it is a strong or weak tie) which leaves less time to actually process the information and relate it to the marketing strategy effort. Having too few network ties does not allow for enough dissemination of information and ideas to enhance performance to the fullest extent, but having too many ties may cause information overload and take away energy from the task at hand (Perry-Smith and Shalley 2003). Therefore the following relationship is hypothesized:

Hypothesis 2a: Technical network ties have an inverted-U relationship with (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation.

Hypothesis 2b: Market network ties have an inverted-U relationship with (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation.

Recall that tie strength is the frequency of interaction, emotional intensity, intimacy, and reciprocal services defining the relationship and those weak ties often serve to provide individuals with a diverse set of information. Strong ties often lead to increased knowledge sharing (Ahuja 2000). Network theory traditionally suggests that strong network ties foster the transmission of redundant information (Perry-Smith and

Shalley 2003). Therefore, it is through weak ties that performance and creativity are increased due to exposure to diverse ideas that may trigger alternate solutions. However, past research has alluded to the fact that there may be moderators to the tie strength-performance relationship (Perry-Smith and Shalley 2003). One such moderator may be the complexity of the information being transferred. In this context, the technology, or innovation, itself is very complex. In order to gain meaningful information from others relating to the technology, network ties should have similar knowledge regarding the technology. It is unlikely that someone who is from a very different background will be familiar enough with the merits of the technology to provide meaningful information regarding the technology. Therefore, it is expected that teams with strong technical ties will gain access to more relevant information than teams with weak technical ties; hence strong network ties should positively impact team marketing strategy formulation efforts. Contrary to traditional network theory arguments, strong technical ties will have a positive impact on marketing strategy effectiveness.

Hypothesis 3a: Strong technical ties are positively related to (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation.

In alignment with the strength of ties perspective, the opposite finding is expected for the relationship between market network tie strength and effectiveness (Granovetter 1973). Teams with weak market ties are likely to have a more advantageous network position than teams with strong market ties. Weak ties provide the team with the ability to conduct searches of nonredundant information (Hansen 1999). Nonredundant information can comprise one of two types: (1) information relating to potential

opportunities, and (2) knowledge regarding the team's current undertaking (Hansen 1999). While weak ties do provide a diverse set of information, the quantity of information received from strong market ties will be greater. Tie strength is associated with greater knowledge transfer (Reagans and McEvily 2003). Therefore it is hypothesized that strong market network ties will increase performance because of the great quantity of information regarding the market that can be obtained. However, weak market ties can provide teams with a diverse set of information that may increase strategy creativity and improvisation. Based on this argument, the following is hypothesized.

Hypothesis 3b: Strong market ties are (a) positively related to marketing strategy performance and (b) negatively related to marketing strategy creativity and marketing strategy improvisation.

7.2 Absorptive Capacity

Absorptive capacity can be defined as the ability to acquire, assimilate, transform, and exploit knowledge to produce a dynamic capability (Zahra and George 2002). A recent review of empirical studies examining the impact of absorptive capacity on organizational outcomes found that absorptive capacity plays a strategic role in creating a competitive advantage for organizations (Zahra and George 2002). Absorptive capacity can further be categorized into potential and realized absorptive capacity. Realized absorptive capacity focuses on knowledge transformation and exploitation, while potential capacity encompasses knowledge acquisition and assimilation capabilities. Zahra and George (2002) point out the need for more empirical research addressing the role of potential absorptive capacity in creating superior performance outcomes. For the purpose of this study, absorptive capacity is defined as the ability to value, assimilate, and apply knowledge (Cohen and Levinthal 1990) and is well aligned with the concept of

potential absorptive capacity. Therefore this study seeks to understand the impact of potential absorptive capacity in the creation and the effectiveness of marketing strategies for new technologies. Potential absorptive capacity allows for flexibility and the ability to adapt to rapidly changing environments. It is expected that absorptive capacity will play a large role in the potential marketing strategy performance of these teams because of the volatility and uncertainty surrounding technology commercialization.

While the focus of this study is on potential absorptive capacity, it is also important to distinguish between the two types of absorptive capacity that are relevant within this context. When developing a marketing strategy for a new technology, it is imperative to consider both *market* and *technical* absorptive capacity. Market absorptive capacity is defined as the ability to value, assimilate, and apply market knowledge, while technical absorptive capacity is the ability to value, assimilate, and apply technical knowledge. One would expect that a team must be able to absorb both types of information in order to increase their strategy effectiveness. Absorptive capacity requires a learning capability and leads to the development of problem-solving skills (Kim 1998). Technical absorptive capacity allows team members to fully understand and learn about the complex nature of their technology, while market absorptive capacity provides the same benefits with regards to market information. Absorptive capacity allows for the creation of knowledge within the team and furthermore allows the team to deploy the knowledge necessary for the development of a clear and comprehensive strategy. Based on this logic, it is clear that both market and technical absorptive will lead to better marketing strategy performance. The increased ability to approach problems with the necessary technical and market knowledge base also should allow for the creation of

novel strategies, as well as provide teams with a means of assimilating real-time information that is relevant for strategy improvisation. More formally, the following is hypothesized:

Hypothesis 4a: Technical absorptive capacity is positively related to (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation.

Hypothesis 4b: Market absorptive capacity is positively related to (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation.

In addition to the direct impact of market and technical absorptive capacity, I expect there to be an interaction between market and technical absorptive capacities. This is the first study to distinguish between types of absorptive capacity so little is known a priori about the relationship between them. However, the teams under investigation are focused on developing marketing strategies for the commercialization of new technologies. One could argue that teams with higher levels of technical absorptive capacity are better equipped to utilize the market knowledge they ascertain as it relates to the technology. There must be some understanding of the technology in order to utilize market information to its fullest extent. Teams that are not able to assimilate technical knowledge may have high levels of market absorptive capacity, but may not be able to incorporate that market information into a market strategy that is meaningful to the technology. It is expected that teams with high levels of technical absorptive capacity will be better able to value, incorporate, and apply market knowledge within the context of their technology.

Hypothesis 5: The greater the technical absorptive capacity of the team, the stronger the relationship between market absorptive capacity and (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation.

7.3 Interaction between Network Ties and Absorptive Capacity

Absorptive capacity has been shown to moderate the impact of network ties on performance (Tsai 2001). Past research has highlighted that internal capabilities and external collaboration are complementary assets and are not substitutes for each other (Arora and Gambardella 1994; Powell et al 1996). Absorptive capacity allows for the identification of relevant materials from these external connections and facilitates knowledge transfer. Therefore, while network ties (external assets) provide individuals with access to knowledge and information, the true impact of this knowledge depends on the ability to absorb the knowledge, or engage in effective knowledge transfer. If a team is not engaged in knowledge transfer via network ties, then it may not be as imperative for the team to have a high level of absorptive capacity (internal capability) to utilize this information. However, teams that have high levels of network linkages need the increased levels of absorptive capacity in order to value, assimilate, and apply the knowledge coming in from these ties. Based on this reasoning, I expect there to be an interaction between network tie strength and absorptive capacity.

Hypothesis 6a: Market network ties are more positively related to (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation when market absorptive capacity is high.

Hypothesis 6b: Technical network ties are more positively related to (a) marketing strategy performance, (b) marketing strategy creativity, and (c) marketing strategy improvisation when technical absorptive capacity is high.

7.4 Longitudinal Hypothesis

Based on the dynamic capabilities framework, internal and external capabilities are not static in nature. Instead they must be reconfigured so as to address and respond to changes within the surrounding environment as it relates to commercialization activities. As mentioned earlier, technology commercialization is an uncertain and unpredictable undertaking. Past research has outlined four stages of the product development process (Veryzer, Jr 1998). The first phase deals primarily with concept generation and exploration and then progress into the second phase, or technical development and design. The third phase involves prototype construction. The product development process concludes with commercialization. Because this research focuses on marketing strategy formulation for prestart-ups, only the first 3 phases of the commercialization process are relevant[13].

As teams progress throughout the commercialization process, it is likely that the impact of market network ties and market absorptive capacity on effectiveness will change. Throughout each of these phases, the presence of different capabilities may have a differential impact on performance. Teams with access to market information early on

[13] When the teams are initially formed, they work on issues relating to the technology, including concept generation and exploration. For example, teams prepare an invention disclosure and conduct a patent search of prior art relating to the technology. Some initial market applications of the technology are also considered. After several months, the teams then begin working on a commercialization plan for the technology. It is during this phase that they focus on market applications of the technology as well as further development the technology itself. Finally, teams complete a business plan outlining the value proposition associated with the technology and their strategy for taking the technology to the market. It is during this phase that the technology is reduced to practice.

in the development process, and the absorptive capacity necessary to absorb this information, should have superior performance as compared with teams that gain access to this information later on in the commercialization process. Access to market information will aid in the early definition of a market, which can be a driver of performance. Teams are better able to nail down their target market and tailor their product and offerings to achieve a superior match with the needs of their market. Additionally, the team will be able to gain a greater knowledge base that is relevant to their technology within that domain, thus increasing their marketing strategy effectiveness based on this early market definition. This early market information will aid in the development of a comprehensive go-to-market strategy for their technology. Therefore it is hypothesized that:

Hypothesis 7: Teams that utilize market ties early in the commercialization process will have higher levels of marketing strategy performance.

7.5 Relationships among Outcome Variables

In this model, it is also the case that there may be significant relationship among the outcome variables. Marketing strategy creativity and marketing strategy improvisation can be thought of as intermediate outcomes that both impact performance. Additionally, there is some literature to suggest that improvisation will also influence creative outcomes. Improvisation is the process of responding to information to create something original and beneficial to the situation at hand (Crossan, Cunha, Vera and Cunha 2005).

Marketing strategy creativity and improvisation are also drivers of team performance, in addition to both internal and external capabilities impact on marketing

strategy performance. An inherent part of creativity includes approaching problems from all angles and developing alternative solutions to the task at hand (Amabile 1995). While the empirical evidence surrounding the relationship between improvisation and performance is somewhat mixed, improvisation has been shown to increase performance in times of great uncertainty (Moorman and Miner 1998). It should be expected that teams who approach problems creatively by discussing alternative solutions and are flexible enough to respond to both internal and external uncertainty also should have increased levels of performance. It is hypothesized that marketing strategy creativity and strategy improvisation will have a positive association with performance.

Hypothesis 8: Marketing strategy improvisation will be positively related to marketing strategy creativity.

Hypothesis 9: Marketing strategy creativity will be positively related to marketing strategy performance.

Hypothesis 10: Marketing strategy improvisation will be positively related to marketing strategy performance.

CHAPTER 8

METHODOLOGY

8.1 Sample

The sample for this study consists of student teams participating in the Technological Innovation: Generating Economic Results (TI:GER) Program at Georgia Tech and Emory University. These teams are comprised of Science and Engineering PhD students from Georgia Tech, MBA students from Georgia Tech, and JD students from Emory University. The teams participate in the TI:GER program over the course of two years with the primary objective of developing a commercialization strategy for each Science and Engineering PhD student's research. This research surveys 20 teams (80 students) during their participation in the program and examines the impact of internal and external capabilities on the effectiveness of the marketing strategy developed for their technology. Each student is asked to complete multiple surveys throughout their participation in the program. In addition, objective outcome measures for marketing strategy effectiveness are collected from outside industry experts and team supervisors.

Data was collected over six different time periods from the April 2004 through April 2005. During this time, three different cohorts of TI:GER teams were surveyed. Therefore the data collection includes 4 teams during their last semester of participation in the program, 9 teams throughout both years of participation, and 7 teams during their first year in the program. Table 7 provides a description of the data collection efforts.

Table 7: Overview of Data Collection

Time	***Cohort Surveyed***	***# Teams Responded***	***# Surveys Collected***
April 2004	TI:GER Teams (c/o 2004) TI:GER Teams (c/o 2005)	13	30
September 2004	TI:GER Teams (c/o 2005)	9	20
October 2004	TI:GER Teams (c/o 2006)	7	22
December 2004	TI:GER Teams (c/o 2005)	9	28
February 2004	TI:GER Teams (c/o 2006)	7	24
April 2004	TI:GER Teams (c/o 2006)	7	20

8.2 Measures

Existing measures present in the literature were adapted for this study. Table 8 provides a summary of the definitions used in this research for the independent and dependent variables. The individual items proposed for each measure can be found in Appendix C.

Network Ties. The measure for network ties is adapted from Smeltzer, Van Hook and Hutt (1991) and Reagans and McEvily (2003). This measure captures the use of network sources for information, the frequency of interaction, the relationship with the source, the quantity and quality of information received from the source, as well as the type of information gained (market or technical).

Several different network indicators are needed to test the hypotheses are constructed from this measure. *Use of technical ties* and *Use of market ties* will be a continuous variable of technical and market ties used by the team. *Technical tie strength* and *Market tie strength* are calculated as weighted indices. For this calculation, the strength of tie weight will be computed from the relationship of the source to the respondent, where 3=close acquaintance (strong tie); 2=casual acquaintance; and

Table 8: Definitions of Dependent and Independent Variables

Dependent Variables	
Marketing Strategy Performance	• Extent to which a team is able to meet established objectives (Hoegl, Weinkauf and Gemuenden 2004)
Marketing Strategy Creativity	• Extent to which the actions taken by the team in an effort to commercialize a new technology represent a meaningful difference from marketing practices in the industry. (Andrews and Smith, 1996)
Marketing Strategy Improvisation	• The degree of change in the marketing strategy formulation over time (Brown and Eisenhardt 1997)
Independent Variables	
Market Network Ties	• Linkage between a team member and individuals from outside the team in which market resources and information flow (adapted from Granovetter 1973)
Technical Network Ties	• Linkage between a team member and individuals from outside the team in which technical resources and information flow (adapted from Granovetter 1973)
Market Absorptive Capacity	• Ability to value, assimilate, and apply market knowledge (adapted from Cohen and Levinthal 1990)
Technical Absorptive Capacity	• Ability to value, assimilate, and apply technical knowledge (adapted from Cohen and Levinthal 1990)

1=previously not known (weak tie). These weights will be multiplied by the amount of market and technical information sought (Column 6). Table 9 reports the descriptive statistics associated with the market and technical network ties for each team. The average quantity of market information obtained from ties is 12.25, while the average quantity of technical information obtained is 10.30.

Table 9: Descriptive Statistics for Network Measures

Network Measure	*Mean*	*s.d.*
Market Ties	12.25	11.85
Technical Ties	10.30	9.80
Market Strength Index	23.77	24.77
Technical Strength Index	20.47	21.30

Absorptive Capacity. The 6-item measure for both market and technical absorptive capacity is a 7-point Likert scale and is adapted from Szulanski (1996). These measures seek to ascertain the extent to which team members have the ability to value, assimilate, and apply market and technical knowledge. An exploratory principle-components factor analysis with varimax rotation was run on the correlation matrix at the individual level of analysis. The items loaded on two factors: Market Absorptive Capacity and Technical Absorptive Capacity. One item from each scale was dropped due to poor factor loadings ("Team members have a common vision of what it is trying to achieve in regards to the technology (marketing strategy)"). After these items were deleted, a confirmatory factor analysis (CFA) was performed on the remaining factor items. The CFA yielded acceptable fit for this measurement model ($\chi^2_{(34)}$=108.31; CFI=0.94); Table 4 provides the results from the CFA on the overall sample. Because data is collected over multiple time periods, it is necessary to conduct CFA for each time period. The CFA results for each time period can be found in Appendix D. Cronbach's alpha was calculated for the two scales and found to be greater than 0.70 as suggested by Nunnally (1978). In addition, the composite reliability was also calculated and found to be of an acceptable level (Hair, Anderson, Tatham and Black 1998). For each scale, I also calculated the average variance extracted (shown in Table 10) and both exceed the commonly accepted threshold of 0.50 (Hair et al. 1998).

Table 10: CFA for Market Absorptive Capacity and Technical Absorptive Capacity Scales (Overall Sample)

Factor Item	*α*	*CR*	*AVE*	*SL(t)*	*SMC*
Market Absorptive Capacity	0.88	0.91	0.68		
1. Team members have a common language to interpret market information.				0.46 (4.98)	0.21
2. Team members have the necessary skills to respond to market information.				0.64 (7.47)	0.42
3. Team members have the competency to absorb market information.				0.95 (13.20)	0.89
4. Team members have the ability to understand market information.				0.96 (13.48)	0.91
5. Team members have the overall capacity to absorb market information.				0.96 (13.56)	0.92
Technical Absorptive Capacity	0.86	0.87	0.60		
1. Team members have information on the state-of-the-art developments related to the technology.				0.41 (4.34)	0.20
2. Team members have the competency to absorb information relating to the technology.				0.69 (8.00)	0.47
3. Team members have the ability to understand technical information.				0.91 (12.12)	0.83
4. Team members have the overall capacity to absorb technical information.				0.95 (13.09)	0.90
5. Team members have a common language to interpret the technology.				0.76 (9.23)	0.58

where α=Cronbach's alpha; CR=composite reliability; AVE=average variance extracted; SL(t)=standardized loading (t-value); and SMC=squared multiple correlation.

In addition, the measurement equivalence of the factor structure of the two absorptive capacity scales over the different time periods was determined by performing a series of multisample (one for each data collection) confirmatory factor analyses. First, a correlation matrix was calculated for each time period at the individual level of analysis (Schneider, Hanges, Smith and Salvaggio 2003). A multi-group CFA was estimated using LISREL 8.7 (Joreskog and Sorbom 2004) based on maximum likelihood estimation. The first analysis imposed the constraint that the factor structure is invariant

across time periods (although the exact factor loadings for the items are not constrained to be the same across the data collections). The indices of fit were acceptable (Market Absorptive Capacity: $\chi^2_{(30)}$ = 182.28, CFI=0.93; Technical absorptive capacity: $\chi^2_{(30)}$ =135.77, CFI=0.95) indicating that the factor structure extracted is consistent over time.

The next CFA is designed to assess whether the factor loadings remain invariant over the different data collections. This provides a more stringent test to equivalence of the factor structure across data collections. In this analysis, not only is the same factor structure constrained, but also the factor loadings of the items should be equivalent over time. The fit indices for this model indicate reasonable fit (Market Absorptive Capacity: $\chi^2_{(50)}$ = 212.30, CFI=0.93; Technical absorptive capacity: $\chi^2_{(50)}$ =174.68, CFI=0.94) suggesting that the measures of absorptive capacity are equivalent over time. Because the models are nested with one another, it is possible to conduct a chi-square difference test to examine if the models are significantly different from one another. Results indicate that they are not significantly different and therefore the market and technical absorptive capacity scales are invariant over time (market absorptive capacity $\chi^2_{d\ (20)}$ = 30.02, p>0.05; technical absorptive capacity $\chi^2_{d(20)}$ = 38.91, p>0.05).

Because this is the first study to empirically distinguish among different types of absorptive capacity, it is also necessary to examine the validity of the market and technical absorptive capacity scales. To demonstrate convergent validity, one must show that measures that should be related are in fact related. Convergent validity is judged by the strength of the factor loadings of each item on its predicted factor. As shown in Table 10, each item has a significant loading on its proposed factor as evidenced by significant t-values (shown in parentheses). Furthermore, the average squared multiple correlations

for market absorptive capacity is 67 percent and is 60 percent for technical absorptive capacity (Anderson and Gerbing 1988). Discriminant validity, on the other hand, requires one to demonstrate that measures that should not be related are in fact not related. Discriminant validity among market and technical absorptive capacity can be shown by calculating confidence intervals around factor correlations. For the overall sample, the confidence interval surrounding the factor correlation between market and technical absorptive capacity does not contain 1.0 (the confidence interval is 0.50-0.78). Therefore, results suggest that market and technical absorptive capacity demonstrate discriminant validity (Anderson and Gerbing 1988).

Finally, because the data is designed to assess the team level it is necessary to aggregate the data from that of the individual to the team. In order to justify the appropriateness of aggregation, I calculated several commonly used statistics justifying aggregation (r_{wg}, ICC(1), and ICC(2)). The average median r_{wg} for market absorptive capacity and technical absorptive capacity is 0.96 and 0.92 respectively, which is well over the 0.70 cutoff criterion suggested by James et al (1984). The average ICC(1) and ICC(2) for market absorptive capacity is 0.29 and 0.49, while technical absorptive capacity ICC(1) and ICC(2) is 0.27 and 0.47, respectively[14]. These indices indicate sufficient agreement and reliability of individuals on a team with respect to these measures to justify aggregation to the team level.

Marketing Strategy Effectiveness. Effectiveness is measured using a 16-item measure developed for this study. These items are collected from team members, team supervisors, and outside experts and will assess: (1) marketing strategy performance

[14] The average ICC(1) reported in the organizational literature is 0.12 (James 1982 ; Schneider et al 2003).

(comprehensiveness), (2) marketing strategy creativity, and (3) marketing strategy improvisation. Marketing strategy performance is measured with a 4-item scale and includes items such as, "This team has developed a comprehensive plan for commercializing their technology" and "Overall, the marketing strategy developed by this team is likely to be successful." Marketing strategy creativity is measured with a 6-item measure adapted from Menon, Bharadwaj, Adidam and Edison (1999)[15]. Finally, marketing strategy improvisation will be measured using a 6-item seven point scale adapted from Moorman and Miner (1998). Improvisation is the only dependent measure that will only be evaluated by self-report responses.

Again, the items for marketing strategy effectiveness collected from external evaluations were analyzed with principle-components factor analysis with varimax rotation. The items loaded on two factors: (1) Marketing strategy performance (comprehensiveness) and (2) Marketing strategy creativity. A separate factor analysis was run for the self-report measures of marketing strategy improvisation. Once the items were purified, the measures were analyzed through confirmatory factor analysis (CFA). One item from the marketing strategy performance scales was deleted due to poor fit and along with two items from the marketing strategy improvisation scale[16]. Results from the overall CFA are shown in Table 11.

[15] 3 of the items used to assess Marketing strategy creativity are formative in nature and therefore are not included in the EFA or CFA analyses.

[16] The marketing strategy performance item deleted was "This team's marketing strategy will require a great deal of modification before it can be used to commercialize this technology. R" and the two improvisation items deleted were: (1) "Our team improvised in carrying out this strategy development.", and (2) "the marketing strategy developed for this technology was ad-libbed."

Table 11: CFA Results for Marketing Strategy Effectiveness (Overall Sample)

Factor Items	***α***	***CR***	***AVE***	***SL(t)***	***SMC***
Marketing Strategy Performance – External Evaluation	0.74	0.76	0.53		
1. Overall, the marketing strategy developed by this team is likely to be successful.				0.89 (9.39)	0.79
2. This team has developed a comprehensive plan for commercializing their technology.				0.69 (7.18)	0.47
3. The team is well positioned to capitalize upon protectable intellectual property rights.				0.55 (5.67)	0.31
Marketing Strategy Creativity – External Evaluation	0.89	0.89	0.72		
1. This team's chosen strategy to market is different from others developed in the past in this industry.				0.76 (9.05)	0.58
2. Compared to other technologies in this industry, at least some parts of this team's marketing strategy are bold.				0.90 (11.36)	0.81
3. Compared with other technologies in this industry, this team's marketing strategy is original.				0.88 (11.00)	0.77
Marketing Strategy Improvisation – Self-Report	0.80	0.81	0.54		
1. Our team figured out the marketing strategy for this technology as we went along.				0.56 (5.95)	0.31
2. Our team updated the strategy as information came to light.				0.90 (10.69)	0.80
3. We are making changes to our strategy as we go along.				0.56 (6.02)	0.32
4. Our team was willing to make changes to the strategy as information came along.				0.84 (9.77)	0.70

where α=Cronbach's alpha; CR=composite reliability; AVE=average variance extracted; SL(t)=standardized loading (t-value); and SMC=squared multiple correlation.

Once again, because the data is designed to assess the team level it is necessary to aggregate the data from that of the individual to the team. In order to justify the appropriateness of aggregation, I calculated several commonly used statistics justifying aggregation (r_{wg}, ICC(1), and ICC(2)). For the external evaluations of performance, this

calculation is necessary to ensure that there is appropriate agreement between the external evaluations of team marketing strategy performance. The average median r_{wg} for marketing strategy performance is 0.81 and is 0.88 for marketing strategy creativity among external evaluations, which is well over the 0.70 cutoff criterion suggested by James et al (1984). The average ICC(1) and ICC(2) for marketing strategy performance is 0.24 and 0.39 respectively. The average ICC(1) and ICC(2) for marketing strategy creativity is 0.25 and 0.43 respectively. The average r_{wg} for marketing strategy improvisation is 0.94 and ICC(1) and ICC(2) are 0.20 and 0.38. These indices indicate sufficient agreement and reliability of individuals to justify aggregation to the team level.

Use of Market Ties Early. To measure the use of market ties early in the commercialization process, a dummy variable was created from the network measures discussed earlier and the stage of the technology. Teams that used market ties to collect information when the technology was in the concept generation and conceptualization stage were coded as a "1", while teams that did not use market ties during this phase were coded as a "0". A description of the technology phases is provided in Appendix E.

Controls. In addition to the primary variables of interest, other variables found to be relevant within this team context are also measured and accounted for in the data analysis. Appendix E provides a description of the control variables and the measurement items associated with each.

8.3 Data Analysis

The panel data collected from the TI:GER teams throughout their participation in the program were analyzed using fixed and random effects regression. Standard regression may yield biased results in this case because they require assumptions that do

not hold when repeated measurements of individuals are taken. Therefore, analysis of panel data requires that special attention be given to the covariance structure of the data due to the sequential nature of data collection. This sequential nature arises because data collected close in time can have higher correlations with each other than those collected with further intervals in between. Standard OLS cannot be used to estimate a random effects model because of biased estimated standard errors. Therefore GLS will be used to estimate the models.

In order to overcome this interdependence, a fixed effects model will be estimated to examine the impact of internal and external capabilities on marketing strategy effectiveness. A fixed effects model is appropriate to use because it is able to model a group-specific constant term in the regression model and that this group specific constant (α_i) does not vary over time (Greene 2003). The fixed effect model assumes that this constant, α_i, is correlated with the set of independent variables being estimated.

Additionally, a random effects model can be used to analyze panel data. In this case, the random effects model assumes that the group specific constant is uncorrelated with the independent variables and is a random element. The general model is represented as:

$$Y_{it} = X_{it}\beta + \epsilon_{it,}$$

$$\text{where} \quad \epsilon_{it} = \alpha_i + \eta_{it}$$

A random effects model assumes that η_{it} is uncorrelated with X_{it}. In order to test this assumption, a fixed effects model will also be estimated and the Hausman specification test will be used to ascertain whether the measured factors (X_{it}) are orthogonal to the

measured covariates (η_{it}). A random effects model also posits that η_{it} varies unsystematically across time and individuals. In addition, α_i represents the effect of the individual in the regression equation. Overall, this equation captures the notion that two observations from the same respondent will be more alike than observations from two different respondents (Johnston and DiNardo 1997).

In order to test which assumption holds, both a fixed effects model and random effects model are estimated and then the constant and the independent variables, a Hausman specification test will be run to ascertain whether the measured factors are orthogonal to the measured covariates.

To estimate the models, I use a generalized least squares (GLS) procedure for an unbalanced panel (Wooldridge 2001). I run both the fixed effects model for the individual level data (with a fixed effect for the individual and team) and for the team level data (with the group as the fixed effect). I then run the random effects model and perform the Hausman specification test. A significant Hausman χ^2 indicates that the fixed effects model provides more consistent estimates than the random effects model. I estimate the models for both the individual and team level so as to provide a robustness check of the estimates[17].

The following equations are estimated to formally test the hypotheses at the individual level with a fixed effect for both the individual and the team:

[17] In cases where the Hausman specification test is not significant, the results from the random effects model are provided and used for hypothesis testing. Additionally, the results for the estimates are similar across the individual and team analyses with the exception of significant interactions. The regressions performed on the team data yielded some significant interaction effects whereas these interactions were not significant predictors of marketing strategy performance in the individual level data analyses.

$$Perf_{ijt} = \beta_0 + \sum_{t=1}^{t} \sum_{k=1}^{14} \beta_k X_{ijk} + \alpha_{ij} + \varepsilon_{ijt}$$

$$Create_{ijt} = \beta_0 + \sum_{t=1}^{t} \sum_{k=1}^{13} \beta_k X_{ijk} + \alpha_{ij} + \varepsilon_{ijt}$$

$$\text{Im}\, prov_{ijt} = \beta_0 + \sum_{t=1}^{t} \sum_{k=1}^{12} \beta_k X_{ijk} + \alpha_{ji} + \varepsilon_{ijt}$$

where

$Perf_{ijt}$ = Marketing strategy performance for individual i in team j in period t

$Create_{ijt}$ = Marketing strategy creativity for individual i in team j in period t

$Improv_{ijt}$ = Marketing strategy improvisation for individual i in team j in period t

x_{ij1} = Technical absorptive capacity for individual i in team j

x_{ij2} = Market absorptive capacity for individual i in team j

x_{ij3} = Technical ties (frequency count) for individual i in team j

x_{ij4} = Market ties (frequency count) for individual i in team j

x_{ij5} = Technical ties^2 for individual i in team j

x_{ij6} = Market ties^2 for individual i in team j

x_{ij7} = Technical tie strength for individual i in team j

x_{ij8} = Market tie strength for individual i in team j

x_{ij9} = Use of market ties early (dummy variable) for individual i in team j

x_{ij10}=Interaction between market and technical absorptive capacity for individual i in team j

x_{ij11}=Interaction between market ties and market absorptive capacity for individual i in team j

x_{ij12}=Interaction between technical ties and technical absorptive capacity for individual i in team j

x_{ij13} = Marketing strategy improvisation for individual i in team j

x_{ij14} = Marketing strategy creativity for individual i in team j

The following equations are estimated to formally test the hypotheses at the team level:

$$Perf_{it} = \beta_0 + \sum_{t=1}^{t} \sum_{j=1}^{14} \beta_j X_{ij} + \alpha_i + \varepsilon_{it}$$

$$Create_{it} = \beta_0 + \sum_{t=1}^{t} \sum_{j=1}^{13} \beta_j X_{ij} + \alpha_i + \varepsilon_{it}$$

$$\text{Im } prov_{it} = \beta_0 + \sum_{t=1}^{t} \sum_{j=1}^{12} \beta_j X_{ij} + \alpha_i + \varepsilon_{it}$$

where

$Perf_{it}$ = Marketing strategy performance for team i in period t

$Create_{it}$ = Marketing strategy creativity for team i in period t

$Improv_{it}$ = Marketing strategy improvisation for team i in period t

x_{i1} = Technical absorptive capacity for team i

x_{i2} = Market absorptive capacity for team i

x_{i3} = Technical ties (frequency count) for team i

x_{i4} = Market ties (frequency count) for team i

x_{i5} = Technical ties^2 for team i

x_{i6} = Market ties^2 for team i

x_{i7} = Technical tie strength for team i

x_{i8} = Market tie strength for team i

x_{i9} = Use of market ties early (dummy variable) for team i

x_{i10}=Interaction between market and technical absorptive capacity for team i

x_{i11}=Interaction between market ties and market absorptive capacity for team i

x_{i12}=Interaction between technical ties and technical absorptive capacity for team i

x_{i13} = Marketing strategy improvisation for team i

x_{i14} = Marketing strategy creativity for team i

Table 12 provides a summary of the hypotheses, measures used to test each hypothesis, and the test used for each.

Table 12: Summary of Hypothesis Testing

Hyp	***Independent Variable***	***Dependent Variable***	***Test***
1	Market ties Technical ties	Performance, Improvisation, and Creativity	$\beta_3>0$ $\beta_4>0$
2	Market ties^2 Technical ties^2	Performance, Improvisation, and Creativity	$\beta_5<0$ $\beta_6<0$
3	Market tie strength Technical tie strength	Performance, Improvisation, and Creativity	$\beta_7>0$ $\beta_8<0$
4	Market absorptive capacity Technical absorptive capacity	Performance, Improvisation, and Creativity	$\beta_1>0$ $\beta_2>0$
5	Market absorptive capacity x Technical absorptive capacity	Performance, Improvisation, and Creativity	$\beta_{10}>0$
6	Technical ties x Technical absorptive capacity Market ties x Market absorptive capacity	Performance, Improvisation, and Creativity	$\beta_{12}>0$ $\beta_{11}>0$
7	Use of market ties early	Performance	$B_9>0$
8	Improvisation	Creativity	$\beta_{13}>0$
9	Creativity	Performance	$\beta_{14}>0$
10	Improvisation	Performance	$\beta_{13}>0$

CHAPTER 9

RESULTS

The descriptive statistics for the independent variables are provided in Table 13. Tables 14 through 24 present the results of hierarchical regression analyses used to test the hypothesized relationships between absorptive capacity and network ties on marketing strategy effectiveness.

Table 13: Descriptive Statistics and Correlations

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1 Market AC	1.00								
2 Technical AC	**0.61**	1.00							
3 Market Ties	0.13	**0.17**	1.00						
4 Technical Ties	**0.30**	**0.20**	**0.31**	1.00					
5 Market Tie Strength	0.10	0.13	**0.73**	**0.30**	1.00				
6 Technical Tie Strength	0.12	0.13	**0.74**	**0.26**	**0.69**	1.00			
7 Task-focused Interaction	**0.42**	**0.59**	0.15	**0.22**	0.15	0.14	1.00		
8 Task Complexity	0.12	0.12	0.10	0.14	0.13	0.08	0.03	1.00	
9 Uncertainty	0.12	0.02	**-0.16**	-0.07	-0.14	-0.06	-0.02	0.07	1.00
Mean	4.86	4.72	12.25	10.30	23.77	20.47	4.86	5.23	4.12
s.d.	1.08	1.16	11.85	9.80	24.77	21.30	1.13	1.26	1.07

n=20 teams. **p<.05.**

It is also necessary to examine the level of collinearity among the independent variables before analyzing the data. A measure for collinearity in regression models is the variance inflation factor, VIF, which should be smaller than 10 for all variables (Hair et al. 1998). This criterion was easily met for all variables since our tests indicated that a mean variance-inflation factor of 3.11 with the highest being 6.23. Another measure of

collinearity, the condition index, was below the critical value of 30 (Belsley, Kuh, and Welsch 1980). This criterion was also satisfied since our tests indicated that the condition index ranged from 1.00 to 17.06.

Finally, the data was checked to ensure that the error terms were not serially correlated. The Durbin-Watson statistic tests the null hypothesis that the correlation between the error terms is equal to zero. The Durbin-Watson statistic is 1.588. For the critical value of d_L is 1.46 and therefore the null hypothesis cannot be rejected, suggesting that autocorrelation will not bias the results of the analysis.[18] Therefore, random and fixed effects estimation is appropriate to use.[19]

9.1 Network Ties

The first hypothesis examines the relationship between network ties and marketing strategy effectiveness. Hypothesis 1a predicts a positive relationship between the information gained through technical network ties and marketing strategy performance, creativity, and improvisation. Results from the individual and team level analysis support the positive association between technical network ties and marketing strategy performance (Model 5 in Tables 14 and 16). Technical network ties also have a significant relationship with marketing strategy creativity but in the opposite direction hypothesized. Results suggest that technical network ties have a negative relationship with marketing strategy creativity (Model 5 in Table 18) [20]. Therefore, while gathering information about the technology enhances marketing strategy performance, it can

[18] The null hypothesis for the Durbin-Watson test should be rejected if the statistic obtained is less than d_L.
[19] In cases where autocorrelation is present, it is necessary to use feasible generalized least squares to provide more efficient estimation of regression coefficients.
[20] The impact of technical ties on marketing strategy creativity is significant only in the team level analysis.

actually hinder marketing strategy creativity. It could be that teams remain focused on the technology that while they are able to develop comprehensive strategies they are not creative in nature. Finally, network ties that are technical in nature are not significantly related to marketing strategy improvisation. Based on these results, Hypothesis 1a is partially supported.

Hypothesis 1b explores the relationship between market ties and marketing strategy effectiveness. Results show that market ties do significantly enhance marketing strategy performance (Model 5 in Table 16). In addition, market ties also have a significant positive relationship with marketing strategy improvisation (Model 4 in Tables 22 and 23). While market ties enhance marketing strategy performance and improvisation, the opposite is true for the relationship with marketing strategy creativity. Results indicate that market ties are negatively related with marketing strategy creativity (Model 5 in Tables 18 and 20). Therefore, Hypothesis 1b is supported by the results.

Hypothesis 2 examines the nonlinear effect of network ties on marketing strategy effectiveness. To support an inverted-U relationship between market network ties and marketing strategy effectiveness, the coefficient for market ties should be positive and the estimates for market ties squared should be significant and negative. Hypothesis 2a predicts that there will be an inverted-U relationship between technical network ties and marketing strategy effectiveness. Results from the analyses for marketing strategy performance, marketing strategy creativity, and marketing strategy improvisation do not support this hypothesis. Therefore, Hypothesis 2a cannot be supported by the results obtained. However, results do support an inverted-U relationship for market network ties and marketing strategy creativity (Model 5 in Tables 18 and 20) and marketing strategy

improvisation (Model 4 in Tables 22 and 23). Therefore it does appear that there is an optimal level of market network ties, and that the more market ties utilized does not necessarily translate into superior marketing strategy creativity and improvisation. Results did not support a non-linear relationship between market ties and marketing strategy performance. Therefore, results partially support Hypothesis 2b.

Hypothesis 3a proposes that strong technical network ties will enhance marketing strategy creativity. To support this relationship, the coefficient estimate for network tie strength should be positive. The results for the team level analysis (Model 5 in Table 16) support a significant positive relationship between technical tie strength and marketing strategy performance. Teams that rely on stronger ties to discuss the nuances of the technology were able to develop more comprehensive strategies as compared with using weaker ties to gather this information. While strong technical ties enhanced marketing strategy performance, results indicate that the opposite is true for the relationship with marketing strategy improvisation. Results show that the relationship between strong technical ties and marketing strategy improvisation (Model 4 in Tables 22 and 23) is negative. Therefore, teams that gather information relating to the technology from those they are close to are less likely to make changes or updates to their marketing strategy. Strong technical ties are not significantly related to marketing strategy creativity. Therefore, Hypothesis 3a is partially supported in this analysis.

The goal of Hypothesis 3b is to examine the relationship between market tie strength and marketing strategy effectiveness. It is expected that market tie strength will be positively related to marketing strategy performance, while at the same time, detract from marketing strategy creativity and improvisation due to redundant information.

Interesting, results indicate that marketing tie strength is significantly related to marketing strategy performance, but in the opposite direction hypothesized (Model 5 in Tables 8 and 16). Therefore, teams that rely on stronger ties for market information have lower levels of marketing strategy performance than teams that use weaker ties. The implication is that when gathering information relating to the market, teams need to talk to people they are not close to in order to gather a diverse set of information that can be used in formulated a more comprehensive marketing strategy. Market tie strength is not significantly related to marketing strategy creativity or marketing strategy improvisation. Therefore, results find partial support for Hypothesis 3b.

9.2 Absorptive Capacity

Hypothesis 4 considers the impact of absorptive capacity on marketing strategy effectiveness. Recall that absorptive capacity provides teams with a learning capability necessary to value, assimilate, and apply knowledge (Cohen and Levinthal 1990). In this study, two types of absorptive capacity are considered: market and technical. Hypothesis 4a posits a significant positive relationship between technical absorptive capacity and marketing strategy effectiveness (marketing strategy performance, marketing strategy creativity, and marketing strategy improvisation). Results do not support a significant impact of technical absorptive capacity on marketing strategy performance. Furthermore, results do not find support for the relationship between technical absorptive capacity and marketing strategy creativity and marketing strategy improvisation. Therefore, Hypothesis 4a cannot be supported.

Hypothesis 4b considers the relationship between market absorptive capacity and marketing strategy effectiveness. Results do not find support for the linkage between

market absorptive capacity and marketing strategy performance. However, market absorptive capacity does have a significant positive relationship with marketing strategy creativity (Model 5 in Tables 18 and 20) and marketing strategy improvisation (Model 4 in Tables 22 and 23). As a follow-up analysis, the indirect relationship of market absorptive capacity on marketing strategy performance is examined. The impact of market absorptive capacity on performance could be mediated through marketing strategy creativity and marketing strategy improvisation. Following the procedure set forth by Baron and Kenny (1986) to test for mediation, the results of two regression analyses were compared. The first regression equation had market absorptive capacity predicting marketing strategy creativity. Then a second regression equation was estimated where market absorptive capacity and marketing strategy creativity both predicted marketing strategy performance. Results support the mediated relationship between market absorptive capacity and marketing strategy performance via marketing strategy creativity (Sobel test of mediation: $z=1.29$, $p<0.10$). Results of the mediation test do not support the role of marketing strategy improvisation as a mediator. Therefore, Hypothesis 4b is partially supported by these analyses.

In addition to the main effect of market and technical absorptive capacity on marketing strategy performance, Hypothesis 5 predicts that there will be a significant interaction between market and technical absorptive capacities[21]. Because the teams are focused on developing marketing strategies for new technologies, teams that have high levels of both market and technical absorptive capacity should be more effective in their

[21] All interaction variables were mean-centered in order to reduce the multicollinearity that arises when testing interaction terms in the same regression equation with the variables that comprise that interaction.

marketing strategy formation efforts than teams that have high levels of either market or technical absorptive capacity. Using mean-centered variables to test this interaction, results suggest that there is a significant interaction between market and technical absorptive capacity on marketing strategy performance, but in the opposite direction hypothesized (Model 5 in Table 16)[22]. Teams that have high levels of both market and technical absorptive capacity had lower levels of marketing strategy performance. Figure 7 shows a graph of this interaction. As shown in the graph, teams that have low levels of technical absorptive capacity and high levels of market absorptive capacity (or low levels of market absorptive capacity and high levels of technical absorptive capacity) have higher levels of performance than those teams that have either high levels of both or low levels of both. Therefore, it may not be preferable for teams to have both high market and technical absorptive capacity. In fact, it appears that teams have the highest level of marketing strategy performance when technical absorptive capacity is high and market absorptive capacity is low. In addition, the interaction between technical and market absorptive capacity is also a significant predictor of marketing strategy improvisation. Again the direction of this relationship is negative (Model 4 in Table 23). Figure 8 provides a graph of this interaction. Results suggest that teams with high technical absorptive capacity and high market absorptive capacity yield the highest level of improvisation. However, for teams with low levels of technical absorptive capacity, a high level of market absorptive capacity significantly hinders the level of improvisation in the formulation of marketing strategies. The interaction between market and technical

[22] This result is only significant when the data is analyzed at the team level. This interaction is not significant for the individual level fixed effects model.

absorptive capacity is not a significant predictor of marketing strategy creativity. Therefore, results partially support Hypothesis 5.

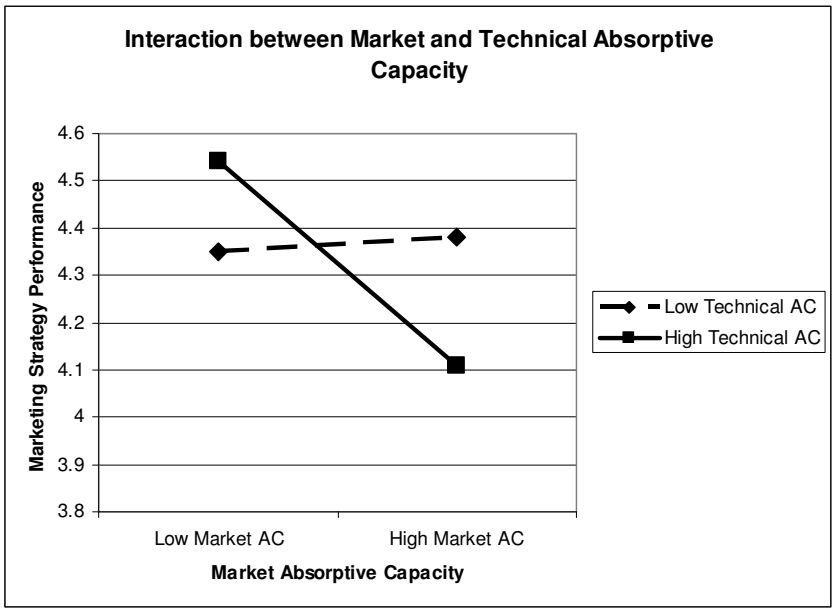

Figure 7: Interaction between Market and Technical Absorptive Capacity on Marketing Strategy Performance

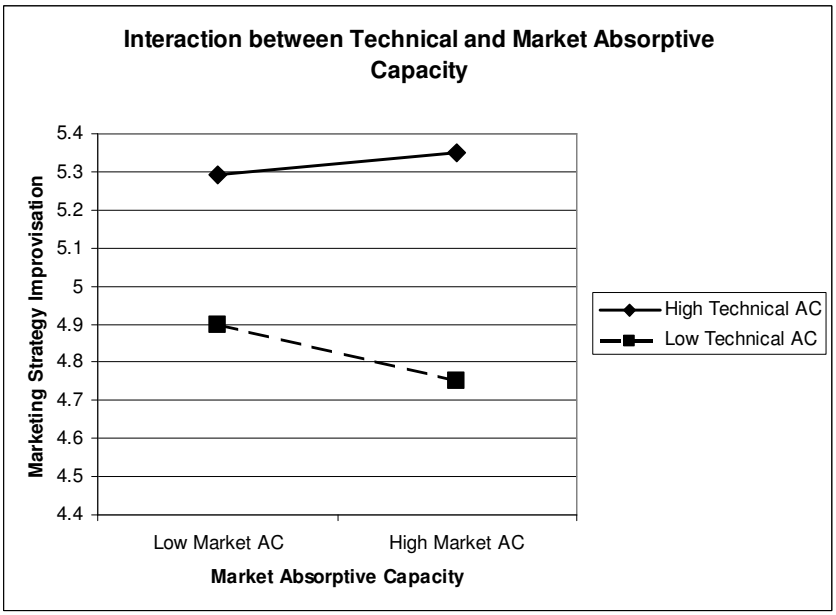

Figure8: Interaction between Market and Technical Absorptive Capacity on Marketing Strategy Improvisation

9.3 Interaction between Network Ties and Absorptive Capacity

The next hypothesis predicts that there will be a significant interaction between network ties and absorptive capacity. In other words, having both access to information and the ability to process that information will provide a synergistic impact on marketing strategy performance for the teams. Hypothesis 6a predicts that market network ties will be more positively related to marketing strategy performance when market absorptive capacity is high. While results do not support this hypothesis for marketing strategy performance, results do find that there is a significant interaction between market ties and market absorptive capacity on marketing strategy creativity and improvisation. Results in Model 5 in Tables 18 and 20 show that there is in fact a synergistic effect of these variables on the creativity of the marketing strategy (See Figure 9). Furthermore, teams that have high market absorptive capacity in conjunction with market network ties have significantly higher levels of marketing strategy improvisation (Model 4 in Table 23)[23]. Figure 10 provides a graph of this interaction. It could be the case that the relationship between this interaction of market ties and market absorptive capacity on marketing strategy performance is mediated through creativity and improvisation. Again, following the procedure set forth by Baron and Kenny (1986), I formally test the role of marketing strategy creativity and improvisation as mediators in this relationship. Support is found for the role of marketing strategy creativity as a mediator between the interaction of market ties and market absorptive capacity (Sobel test of mediation: $z=1.44$, $p<0.10$). Additionally, results of the mediation test also find support for marketing strategy

[23] This result is only significant when the data is analyzed at the team level. This interaction is not significant for the individual level fixed effects model.

improvisation as a mediator in this relationship (Sobel test of mediation: $z=1.40$, $p<0.10$). Therefore, there is an indirect relationship between the interaction of market ties and market absorptive capacity and performance through marketing strategy creativity and marketing strategy improvisation.

Hypothesis 6b expects that the relationship between technical network ties and marketing strategy performance is more positive when technical absorptive capacity is high. Again, teams that have the learning capability necessary to value, assimilate, and apply technical knowledge in combination with information gleaned from technical ties will have higher levels of marketing strategy performance. Results do not support this argument. However, the interaction between technical network ties and technical absorptive capacity does significantly enhance marketing strategy improvisation (Model 4 in Table 23; See Figure 11). Furthermore, the impact of the interaction between technical ties and technical absorptive capacity on marketing strategy performance is mediated through marketing strategy improvisation (Sobel test of mediation: $z=1.33$, $p<0.10$). Therefore, partial support is found for Hypothesis 6b.

9.4 Longitudinal Hypothesis

Hypothesis 7 predicts that teams utilizing market ties early in the commercialization process will have higher levels of those teams that wait to collect market information through network ties. To test this hypothesis, a dummy variable was used that indicated whether or not teams used market ties in the early phases of commercialization (i.e. based on the stage of technology). A separate analysis was performed to test this hypothesis and the results are presented in Table 24. Interestingly, using market ties early in the commercialization process does significantly impact

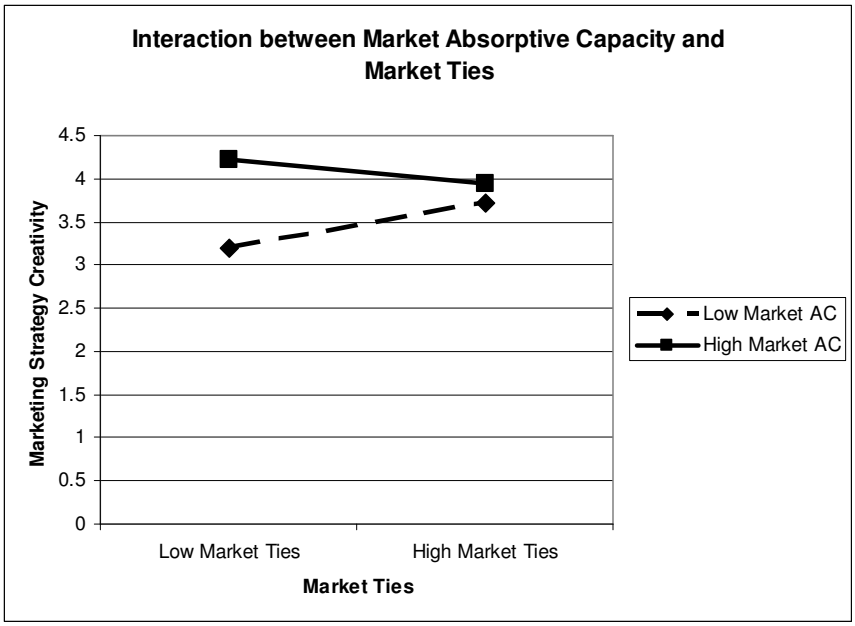

Figure 9: Interaction between Market Absorptive Capacity and Market Ties on Marketing Strategy Creativity

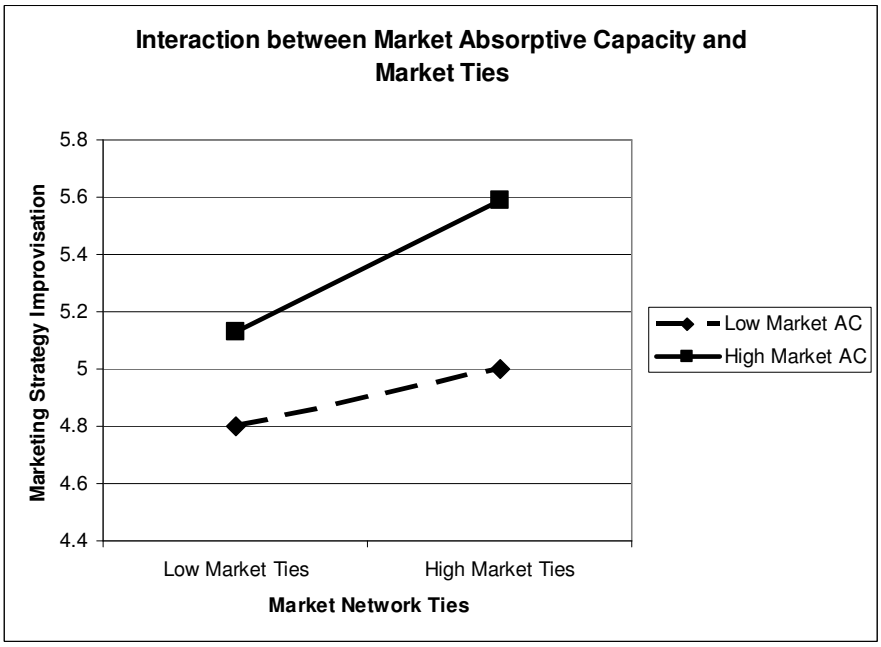

Figure 10: Interaction between Market Absorptive Capacity and Market Ties on Marketing Strategy Improvisation

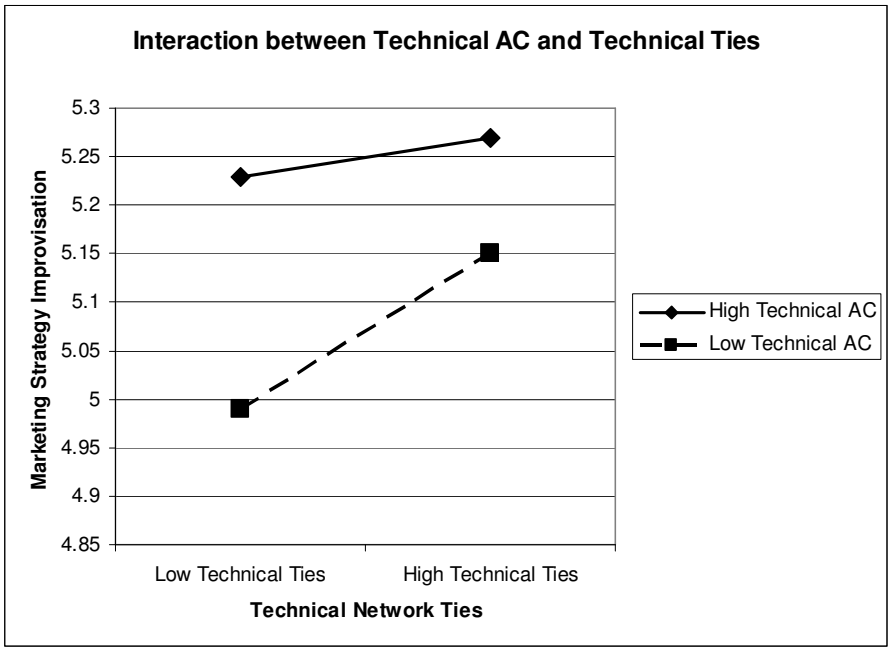

Figure 11: Interaction between Technical Absorptive Capacity and Technical Network Ties on Marketing Strategy Improvisation

marketing strategy performance, but in the opposite direction hypothesized. Therefore, teams that use market ties early tend to have less effective marketing strategy formation efforts. It could be the case that because the technology is so new and novel that it may be too early to engage in market efforts. Another alternate explanation is that teams that use ties early in the process may be less diligent about securing new market information as it progresses throughout the commercialization process. Results suggest that the timing of market information does have a substantial impact on marketing strategy formulation.

As a follow-up to this analysis, I wanted to understand how the use of market ties evolves over time. Figure 12 provides a summary of the usage of market and technical ties by phase of commercialization. Across all phases of commercialization it appears

that the prestart-up teams on average use more market ties than technical ties. However as teams progress from the first phase into technical development and design, the use of network ties (both market and technical) decreases substantially. As teams are developing prototypes and are focusing on the end product, the need for information through network ties increases. On average, the highest level of market network ties occurs in the third phase whereas the highest usage of technical ties occurs in phase 1, or concept generation. This simple graph illustrates the dynamic nature of network tie usage for teams as they progress through the commercialization phases.

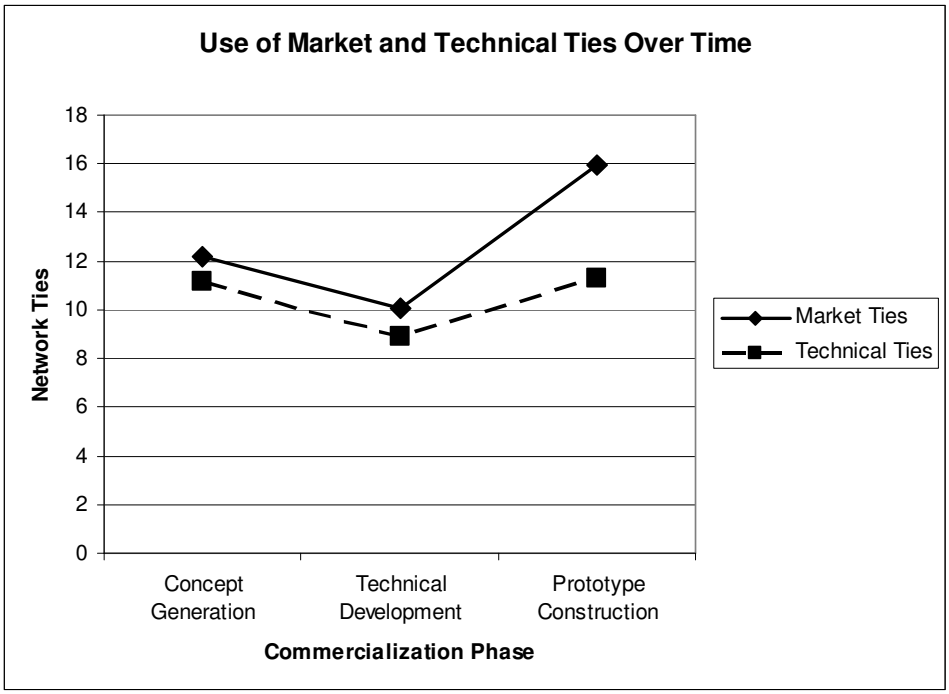

Figure 12: Use of Market and Technical Ties over Time

9.5 Relationships among Outcome Variables

Hypotheses 8 through 10 examine the relationships between the outcome variables. Hypothesis 8 predicts a significant positive relationship between improvisation and creativity. Model 5 in Tables 18 and 20 show that marketing strategy improvisation significantly enhances marketing strategy creativity. Thus, Hypothesis 8 is supported. Hypothesis 9 predicts a positive relationship between marketing strategy creativity and performance. Once again this hypothesis is supported by the results (Model 5 in Tables 14 and 16). Finally, our results also support Hypothesis 10 and demonstrate that improvisation positively impacts marketing strategy performance (Model 5 in Table 14). Therefore results support the role of marketing strategy creativity and improvisation as intermediate outcomes in predicting marketing strategy performance.

The results of these analyses are summarized in Table 25.

Table 14: Panel Fixed Effects Regression – Individual Level Data

	Dependent Variable: External Performance				
	Model1	Model2	Model3	Model4	Model5
Constant	4.913***	4.826***	5.059***	5.205***	4.806***
Market AC	-0.016	-0.016	-0.026	0.007	-0.019
Technical AC	0.041	0.055	-0.004	-0.027	-0.056
Market Ties	0.020	0.013	0.019	0.019	0.016
Technical Ties	0.040**	0.036**	0.045**	0.046*	0.038*
Market Tie Strength	-0.025**	-0.027**	-0.031**	-0.032**	-0.027**
Technical Tie Strength	0.007	0.011	0.008	0.010	0.017
Market Ties^2	--	0.001	0.001	0.001	0.001
Technical Ties^2	--	-0.001	-0.001	-0.001	-0.001
Market AC * Technical AC	--	--	-0.103	-0.114	-0.067
Market AC * Market Tie Strength	--	--	0.004	0.002	0.003
Technical AC * Technical Tie Strength	--	--	0.003	0.005	0.001
Controls:					
Task-focused Interaction	--	--	--	-0.008	-0.125*
Uncertainty	--	--	--	-0.060	-0.181*
Task Complexity	--	--	--	0.026	-0.226*
Strategy Creativity	--	--	--	--	0.121*
Strategy Improvisation	--	--	--	--	0.387**
Sigma-u	0.589	0.591	0.596	0.605	0.644
Sigma-e	0.425	0.437	0.443	0.466	0.422
F statistic	1.67*	1.21*	1.05	0.77	1.79*
R^2	0.07	0.08	0.13	0.14	0.15
N	116	116	116	116	116
K	20	20	20	20	20
ΔR^2		0.01	0.05	0.01	0.01
ΔF		-0.46	-0.16	-0.28	1.02
Hausman χ^2	19.82***	21.56***	17.45**	15.56*	20.24*

where AC: Absorptive Capacity; n=individual sample size; k=team sample size;
*p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 15: Panel Fixed Effects Regression: Team Level Data

	Dependent Variable: External Performance				
	Model1	Model2	Model3	Model4	Model5
Constant	4.679***	4.638***	4.727***	4.695***	4.176***
Market AC	-0.034	-0.031	-0.031	-0.021	-0.036
Technical AC	0.022	0.021	0.053	0.038	0.037
Market Ties	0.019**	0.018*	0.023**	0.026**	0.025**
Technical Ties	0.031***	0.026**	0.026**	0.030**	0.027**
Market Tie Strength	-0.013**	-0.014***	-0.017***	-0.018***	-0.019***
Technical Tie Strength	0.001	0.005	0.005	0.005	0.007*
Market Ties^2	--	0.001	0.001	0.001	0.001
Technical Ties^2	--	-0.002	-0.001	-0.001	-0.002
Market AC * Technical AC	--	--	-0.037	-0.045*	-0.041*
Market AC * Market Tie Strength	--	--	0.003	0.001	0.002
Technical AC * Technical Tie Strength	--	--	0.006	0.005	0.002
Controls:					
Task-focused Interaction	--	--	--	-0.022	-0.055
Uncertainty	--	--	--	-0.028	-0.030
Task Complexity	--	--	--	0.061*	0.046
Strategy Creativity	--	--	--	--	0.115**
Strategy Improvisation	--	--	--	--	0.052
Sigma-u	0.504	0.502	0.499	0.519	0.504
Sigma-e	0.310	0.312	0.313	0.312	0.304
F statistic	1.51*	1.21	1.12	1.10	1.42*
R^2	0.05	0.08	0.11	0.12	0.16
K	20	20	20	20	20
ΔR^2		0.03	0.03	0.01	0.04
ΔF		-0.30	-0.09	-0.02	0.32
Hausman χ^2	13.57**	52.65***	8.48	15.22	16.91

where AC: Absorptive Capacity; k=team sample size;
*p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 16: Panel Random Effects Regression: Team Level Data

	Dependent Variable: External Performance				
	Model1	Model2	Model3	Model4	Model5
Constant	4.537***	4.511***	4.582***	4.633***	4.107***
Market AC	-0.041	-0.037	-0.041	-0.035	-0.050
Technical AC	0.010	0.010	0.038	0.032	0.032
Market Ties	0.012	0.012	0.016*	0.018*	0.019*
Technical Ties	0.024**	0.019*	0.019*	0.021*	0.021*
Market Tie Strength	-0.007**	-0.011**	-0.014**	-0.015**	-0.016***
Technical Tie Strength	0.001	0.005	0.005	0.005	0.007*
Market Ties^2	--	0.001	0.001	0.001	0.001
Technical Ties^2	--	-0.002	-0.002	-0.002	-0.003
Market AC * Technical AC	--	--	-0.032	-0.040*	-0.030*
Market AC * Market Tie Strength	--	--	0.004*	0.003	0.002
Technical AC * Technical Tie Strength	--	--	0.005	0.025	0.002
Controls:					
Task-focused Interaction	--	--	--	0.018	-0.060*
Uncertainty	--	--	--	-0.025	-0.023
Task Complexity	--	--	--	0.038	0.027
Strategy Creativity	--	--	--	--	0.124**
Strategy Improvisation	--	--	--	--	0.051
Sigma-u	0.432	0.456	0.430	0.418	0.437
Sigma-e	0.310	0.312	0.313	0.312	0.304
χ^2	6.02	7.10	9.72	10.94	25.46*
d.f.	6	8	11	14	16
R^2	0.04	0.06	0.11	0.13	0.16
K	20	20	20	20	20
ΔR^2		0.02	0.05	0.02	0.03
$\Delta\chi^2$		1.08	2.62	1.22	14.52**

where AC: Absorptive Capacity; k=team sample size;
*p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 17: Panel Fixed Effects Regression: Individual Level Data

	Dependent Variable: External Creativity				
	Model1	Model2	Model3	Model4	Model5
Constant	4.812***	5.717***	6.230***	0.750	0.323
Market AC	0.216	0.174	0.155	0.014	-0.020
Technical AC	-0.156	-0.242	-0.256	0.019	-0.017
Market Ties	0.052	0.093*	0.113**	0.073	0.081
Technical Ties	0.064	0.123**	0.140**	0.070	0.070
Market Tie Strength	-0.016	-0.004	-0.012	-0.009	-0.003
Technical Tie Strength	-0.011	-0.055**	-0.063**	-0.043	-0.039
Market Ties^2	--	-0.002*	-0.002	-0.001	-0.002
Technical Ties^2	--	0.002**	0.003**	0.002	0.002
Market AC * Technical AC	--	--	-0.252	-0.137	-0.095
Market AC * Market Tie Strength	--	--	0.002	0.007	0.009
Technical AC * Technical Tie Strength	--	--	0.022	0.041	0.056
Controls:					
Task-focused Interaction	--	--	--	0.329*	0.221
Uncertainty	--	--	--	0.216	0.085
Task Complexity	--	--	--	0.412*	0.131
Strategy Improvisation	--	--	--	--	0.535
Sigma-u	0.682	0.827	0.903	0.887	0.866
Sigma-e	0.985	0.969	0.986	0.973	0.963
F statistic	0.40	0.70	0.67	0.81	0.88
R^2	0.01	0.03	0.03	0.07	0.04
N	116	116	116	116	116
K	20	20	20	20	20
ΔR^2		0.02	0.01	0.04	-0.03
ΔF		0.30	-0.03	0.14	0.07
Hausman χ^2	4.40	8.60	9.76	10.07	10.86

where AC: Absorptive Capacity; n=individual sample size; k=team sample size;
*p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 18: Panel Random Effects Regression – Individual Level Data

	Dependent Variable: External Creativity				
	Model1	Model2	Model3	Model4	Model5
Constant	3.658***	3.614***	3.857***	2.176***	1.519**
Market AC	0.243**	0.243**	0.208**	0.152**	0.143*
Technical AC	0.031	0.034	-0.022	-0.088	-0.124
Market Ties	-0.033**	-0.036*	-0.026	-0.032*	-0.036*
Technical Ties	-0.017	-0.021	-0.016	-0.224*	-0.025*
Market Tie Strength	0.013*	0.011	0.003	0.004	0.001
Technical Tie Strength	-0.004	-0.001	-0.001	-0.002	0.004
Market Ties^2	--	0.001	0.001	0.001	0.001*
Technical Ties^2	--	-0.001	-0.001	-0.001	-0.001
Market AC * Technical AC	--	--	-0.066	-0.048	-0.037
Market AC * Market Tie Strength	--	--	-0.011**	-0.013**	-0.015**
Technical AC * Technical Tie Strength	--	--	0.014	0.008	0.015
Controls:					
Task-focused Interaction	--	--	--	0.221***	0.196***
Uncertainty	--	--	--	0.114**	0.113*
Task Complexity	--	--	--	0.003	-0.015
Strategy Improvisation	--	--	--	--	0.159*
Sigma-u	0.000	0.000	0.000	0.000	0.00
Sigma-e	0.985	0.969	0.986	0.973	0.963
χ^2	16.63***	16.46**	22.72***	34.25***	36.62***
d.f.	6	8	11	14	16
R^2	0.14	0.14	0.18	0.27	0.28
N	96	96	96	96	96
K	20	20	20	20	20
ΔR^2		0.00	0.04	0.09	0.01
$\Delta\chi^2$		-0.17	6.26	11.53**	2.37

where AC: Absorptive Capacity; k=team sample size;
*p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 19: Panel Fixed Effects Regression – Team Level Data

	Dependent Variable: External Creativity				
	Model1	Model2	Model3	Model4	Model5
Constant	4.250***	4.355***	4.540***	2.944***	2.309**
Market AC	0.019	0.009	0.008	0.059	0.025
Technical AC	-0.002	0.001	0.028	-0.072	-0.103
Market Ties	0.014	0.015	0.022	0.005	0.005
Technical Ties	0.026	0.040*	0.043*	0.030	0.034
Market Tie Strength	-0.003	0.002	0.001	0.003	0.001
Technical Tie Strength	-0.006	-0.017*	-0.020**	-0.017*	-0.015*
Market Ties^2	--	-0.001	-0.001	-0.001	-0.001
Technical Ties^2	--	0.001*	0.001*	0.001*	0.001*
Market AC * Technical AC	--	--	-0.104	-0.080	-0.059
Market AC * Market Tie Strength	--	--	0.001	0.004	0.006
Technical AC * Technical Tie Strength	--	--	0.006	0.001	0.007
Controls:					
Task-focused Interaction	--	--	--	0.233***	0.209**
Uncertainty	--	--	--	-0.006	-0.015
Task Complexity	--	--	--	0.048	0.013
Strategy Improvisation	--	--	--	--	0.184**
Sigma-u	0.531	0.553	0.552	0.541	0.553
Sigma-e	0.659	0.661	0.664	0.650	0.643
F statistic	0.36	0.47	0.54	0.89	1.04
R^2	0.02	0.03	0.06	0.10	0.09
K	20	20	20	20	20
ΔR^2		0.01	0.03	0.04	-0.01
ΔF		0.11	0.07	0.35	0.15
Hausman χ^2	34.15	27.33	11.20	14.89	16.77

where AC: Absorptive Capacity; k=team sample size;
*p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 20: Panel Random Effects Regression – Team Level Data

	Dependent Variable: External Creativity				
	Model1	Model2	Model3	Model4	Model5
Constant	3.858***	3.877***	3.989***	2.176***	1.519**
Market AC	0.153**	0.144*	0.153*	0.152*	0.143*
Technical AC	0.013	0.013	-0.010	-0.088	-0.125
Market Ties	-0.017	-0.018	-0.017	-0.033*	-0.035*
Technical Ties	0.001	0.005	0.001	-0.024	-0.025
Market Tie Strength	0.008	0.010	0.005	0.004	0.001
Technical Tie Strength	-0.005	-0.009	-0.007	-0.001	0.004
Market Ties^2	--	-0.001	0.001	0.001	0.001*
Technical Ties^2	--	0.001	0.001	-0.001	-0.001
Market AC * Technical AC	--	--	-0.077*	-0.048	-0.037
Market AC * Market Tie Strength	--	--	-0.008*	-0.014**	-0.015***
Technical AC * Technical Tie Strength	--	--	0.008	0.008	0.015
Controls:					
Task-focused Interaction	--	--	--	0.221***	0.196***
Uncertainty	--	--	--	0.114**	0.113**
Task Complexity	--	--	--	0.003	-0.014
Strategy Improvisation	--	--	--	--	0.159*
Sigma-u	0.293	0.317	0.233	0.000	0.000
Sigma-e	0.659	0.661	0.664	0.650	0.643
χ^2	6.03	5.66	12.30	34.25***	36.62***
d.f.	6	8	11	14	16
R^2	.13	.12	.18	.26	.28
N	116	116	116	116	116
K	20	20	20	20	20
ΔR^2		-0.01	0.06	0.08	0.02
$\Delta\chi^2$		-0.47	6.64	21.95**	2.37

where AC: Absorptive Capacity; k=team sample size;
*p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 21: Panel Fixed Effects Regression – Individual Level Data

	Dependent Variable: Improvisation			
	Model1	Model2	Model3	Model4
Constant	5.854***	5.926***	5.902***	4.883***
Market AC	0.131	0.126	0.171*	0.166
Technical AC	0.054	0.047	-0.032	-0.039
Market Ties	0.054***	0.058**	0.054**	0.034
Technical Ties	0.040*	0.044*	0.047*	-0.016
Market Tie Strength	-0.018*	-0.017*	-0.019*	0.004
Technical Tie Strength	-0.002	-0.005	-0.002	0.004
Market Ties^2	--	-0.001	0.001	0.002
Technical Ties^2	--	0.001	-0.001	-0.001
Market AC * Technical AC	--	--	-0.045	0.010
Market AC * Market Tie Strength	--	--	0.009	0.007
Technical AC * Technical Tie Strength	--	--	0.012	-0.015
Controls:				
Task-focused Interaction	--	--	--	0.165*
Uncertainty	--	--	--	-0.118
Task Complexity	--	--	--	0.072
Sigma-u	0.665	0.662	0.695	0.699
Sigma-e	0.643	0.651	0.660	0.656
F statistic	2.28**	1.69*	1.26*	1.30
R^2	0.10	0.10	0.09	0.13
N	144	144	144	144
K	20	20	20	20
ΔR^2		0.00	-0.01	0.04
ΔF		-0.59	-0.43	0.04
Hausman χ^2	8.56*	9.13	19.13**	19.27

where AC: Absorptive Capacity; n=individual sample size; k=team sample size; *p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 22: Panel Random Effects Regression – Individual Level Data

	Dependent Variable: Improvisation			
	Model1	Model2	Model3	Model4
Constant	5.534***	5.681***	5.642**	4.411***
Market AC	0.117*	0.111*	0.121*	0.110*
Technical AC	0.067	0.058	0.212*	0.148
Market Ties	0.031**	0.044**	0.045**	0.041**
Technical Ties	0.021	0.031*	0.026	0.017
Market Tie Strength	0.001	-0.004	0.007	0.007
Technical Tie Strength	-0.014***	-0.019**	-0.020**	-0.020**
Market Ties^2	--	-0.004*	-0.001*	-0.001*
Technical Ties^2	--	0.001	0.002	0.001
Market AC * Technical AC	--	--	-0.022	-0.020
Market AC * Market Tie Strength	--	--	0.003	0.003
Technical AC * Technical Tie Strength	--	--	0.033	0.035
Controls:				
Task-focused Interaction	--	--	--	0.144**
Uncertainty	--	--	--	-0.026
Task Complexity	--	--	--	0.110**
Sigma-u	0.413	0.398	0.364	0.340
Sigma-e	0.643	0.651	0.660	0.656
χ^2	27.83***	29.86**	32.06***	42.56***
d.f.	6	8	11	14
R^2	0.17	0.18	0.20	0.31
N	144	144	144	144
K	20	20	20	20
ΔR^2		0.01	0.02	0.11
$\Delta\chi^2$		2.03	2.20	10.50**

where AC: Absorptive Capacity; n=individual sample size; k=team sample size; *p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 23: Panel Fixed Effects Regression – Team Level Data

	Dependent Variable: Improvisation			
	Model1	Model2	Model3	Model4
Constant	5.555***	5.713***	5.802***	4.614***
Market AC	0.152*	0.134*	0.156*	0.173*
Technical AC	0.046	0.041	0.243*	0.182
Market Ties	0.024*	0.039*	0.045**	0.043**
Technical Ties	0.020	0.032	0.026	0.021
Market Tie Strength	-0.003	-0.001	0.002	0.001
Technical Tie Strength	-0.010**	-0.014*	-0.018**	-0.015*
Market Ties^2	--	-0.001	-0.001**	-0.001*
Technical Ties^2	--	-0.001	0.001	0.001
Market AC * Technical AC	--	--	-0.122**	-0.098*
Market AC * Market Tie Strength	--	--	0.008*	0.012**
Technical AC * Technical Tie Strength	--	--	0.047*	0.046*
Controls:				
Task-focused Interaction	--	--	--	0.071
Uncertainty	--	--	--	-0.031
Task Complexity	--	--	--	0.172***
Sigma-u	0.392	0.377	0.412	0.407
Sigma-e	0.758	0.759	0.745	0.732
F statistic	2.06**	1.75**	2.04**	2.22***
R^2	0.15	0.17	0.16	0.20
N	144	144	144	144
K	20	20	20	20
ΔR^2		0.02	-0.01	0.04
ΔF		-0.31	0.29	0.18
Hausman χ^2	9.05*	7.38	222.35***	60.21***

where AC: Absorptive Capacity; n=individual sample size; k=team sample size; *p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 24: Panel Regression – Impact of Early Market Ties on Performance

	Dependent Variable: External Performance		
	Individual	Team	
	Model 1 - FE	Model 1 - FE	Model 2 - RE
Constant	3.009***	3.718***	3.730***
Market Tie Strength	-0.020**	-0.002	-0.003
Technical Ties	0.008	0.012*	0.009
Market AC*Market Ties	0.006	0.002	0.003
Strategy Creativity	0.089*	0.100**	0.100**
Strategy Improvisation	0.195*	0.048	0.050*
Use of Market Ties Early	-0.220*	-0.134*	-0.135**
Sigma u	0.544	0.462	0.435
Sigma e	0.410	0.306	0.306
F statistic	2.25**	1.88**	
χ^2			11.48**
R^2	0.28	0.20	0.25
N	116		
K	20	20	20
Hausman χ^2	13.73**	7.61	

where FE: fixed effects; RE: random effects; AC: Absorptive Capacity; n=individual sample size; k=team sample size;
*p<0.10; **p<0.05, ***p<0.01. (one-tailed).

Table 25 – Summary of Results

	Performance		***Creativity***		***Improvisation***	
	Ho	Result	Ho	Result	Ho	Result
Technical Ties	**+**	**+**	**+**	**+**	**+**	**n.s.**
Market Ties	**+**	**+**	**+**	**-**	**+**	**+**
Technical Tie Strength	**+**	**+**	**+**	**n.s.**	**+**	**-**
Market Tie Strength	**+**	**-**	**-**	**n.s.**	**-**	**n.s.**
Technical AC	**+**	**n.s.**	**+**	**n.s.**	**+**	**n.s.**
Market AC	**+**	**n.s.**	**+**	**+**	**+**	**+**
Market* Technical AC	**+**	**-**	**+**	**n.s.**	**+**	**-**
Market AC* Market Ties	**+**	**n.s.**	**+**	**+**	**+**	**+**
Technical AC * Technical Ties	**+**	**n.s.**	**+**	**n.s.**	**+**	**+**
Early Ties	**+**	**-**				
Improvisation	**+**	**+**	**+**	**+**		
Creativity	**+**	**+**				

CHAPTER 10

DISCUSSION

This research highlighted the impact of internal and external capabilities in the formation of marketing strategies for new technologies. As stated earlier in this Part, there is a real need to understand the commercialization of high technology products that are generated outside of traditional organizational boundaries. The key driver of the U.S. economy comes not from well-established organizations, but rather from small companies and start-ups. The commercialization of new technology will be a major driving force behind the global economy (National Innovation Institute Report 2004). Furthermore, the nature of innovation is changing. Innovation is now multi-disciplinary and technologically complex. It requires collaboration and communication among scientists, engineers, business and legal experts. Therefore, the implications of this research are relevant not only to university spin-offs but also to any individual engaged in trying to commercialize new technology in this dynamic time.

The first insight garnered from this research is that it is necessary to have both internal and external resources in technology commercialization. Individuals and teams trying to make a go of a new technology without the support of a well-established organization (resources, processes, etc) must use those internal and external information resources to their utmost potential. This research explored two of these resources (network ties and absorptive capacity) in detail and highlighted the need for both in formulating a go-to-market strategy. Results supported the synergistic impact of having

both network ties and the capability to absorb the information gleaned from these ties on marketing strategy formulation efforts.

Furthermore, this research examines two different types of ties that are necessary in technology commercialization: market and technical. This is the first study to create such a dichotomy. Market ties are those interpersonal relationships in which individuals or teams rely upon to collect information relating to the market. Technical ties are different from market ties in that the content of the information exchanged through these ties relate directly to the technology. By isolating out the ties as distinct, it was possible to investigate the unique role they play in formulating marketing strategies for high tech products. This discrimination between the two types of network ties contributes and extends not only to the literature on social networks, but results also clearly demonstrate that not all ties behave the same way, and entrepreneurs need to be cognizant of this when commercializing new technologies. In this research, technical network ties were found to be important in predicting marketing strategy performance. When commercializing a technology, it is imperative that you gather information about the technology. However, there may be a caveat to this notion. Technical network ties, while enhancing one's ability to develop comprehensive marketing strategies, detracted from the creativity of the strategy. Because marketing strategy creativity was found to enhance marketing strategy performance, it is imperative that the focus not be solely on gathering information related to the technology. Therefore the more information gathered relating to the technology (i.e. the more ties you have) may not always translate into superior performance. Scientists and engineers cannot simply talk to other scientists

and engineers about the technology and expect to succeed in the marketplace. It is also crucial to use market ties to collect information as well.

Perhaps one of the most interesting insights garnered from this research related to the use of market ties. It was hypothesized that the use of market ties should positively impact the effectiveness of marketing strategy formulation efforts. However, in reality results found that market ties have an inverted-U relationship with marketing strategy creativity and improvisation, thus suggesting that there is an optimal level of information that should be gathered from these ties. Therefore, too few market ties are problematic and yet too many market ties are not good either. The key to gathering information about the market from interpersonal relationships is to make sure that you have enough information to aid in the formulation of a marketing strategy but not so much information that you are unable to absorb the information and use it in formulating a strategy.

Not only does this research address the use of network ties, but also demonstrates that the type of tie matters. As evidenced by this research, teams that used strong ties to gather market information have lower levels of marketing strategy effectiveness. Therefore, when gathering information relating to the market it is advisable to get out and talk to casual acquaintances or even strangers. This result was somewhat surprising considering that the transfer of knowledge is greater through weak ties. However, the information transferred is oftentimes redundant in nature. The results of this study suggest that perhaps when collecting information related to the market, having access to nonredundant information is a better predictor of effective marketing strategy formation than having increased knowledge transfer of redundant information. The strength of technical network ties had exactly the opposite effect on marketing strategy performance.

Strong technical ties enhanced a team's ability to develop comprehensive marketing strategies. However, results do point out that teams that relied on strong technical ties seemed to improvise less in their marketing strategy efforts. This is a very interesting result and further supports the importance of distinguishing among ties that are used to gather market information and ties that are used for gathering information relating to the technology. Moreover, this result extends the current literature in social networks by empirically demonstrating that not all ties behave the same way. For example, there are situations in which it is advisable to cultivate and maintain strong interpersonal ties and enhance performance outcomes. However, weak ties can be significant drivers of performance in other situations. One explanation for the difference in the performance implications of strong versus weak ties is based upon the complexity of the information being transferred (Perry-Smith and Shalley 2003). New technologies may be so complex that a strong tie is required to have any meaningful exchange of information, while the same may not be true of information relating to the market.

In addition to network ties, it is also imperative that teams have an internal learning capability to absorb and process information relating to the market and the technology. Interestingly, the role of the internal capability, or absorptive capacity, by itself is not enough to directly impact marketing strategy formation. This research built upon the absorptive capacity construct by discriminating among two types of absorptive capacity: market and technical. Absorptive capacity has traditionally been measured as R&D divided by sales, which is only a proxy for learning capabilities present within organizations. This research extends the notion of absorptive capacity to encompass teams of individuals outside the traditional organizational context. Furthermore, the

measures of absorptive capacity used provide a richer description of the team's ability to value, assimilate, and apply knowledge. Furthermore, this is the first paper that empirically distinguishes between different types of absorptive capacity thus providing a deeper understanding of the nature of absorptive capacity. One result of particular interest is that of the interaction between the two types of absorptive capacity in predicting marketing strategy performance. It was hypothesized that teams with high levels of both market and technical absorptive capacity would have higher levels of marketing strategy performance. However, results indicated that marketing strategy performance was maximized when market absorptive capacity was high and technical absorptive capacity is low. Therefore, it is imperative that teams focused on new technology commercialization have a learning capability relating to the market.

Building upon this, when teams have both internal and external capabilities in place, the interaction between the two can significantly impact marketing strategy development. Having both access to market information through market ties and the ability to process this information can directly enhance marketing strategy creativity and improvisation. Furthermore, this interaction was indirectly related to marketing strategy performance via marketing strategy creativity and improvisation.

This research was also able to address questions regarding the timing of market information. Does it always pay off to gather information relating to the market application of the technology early on? Results found that early does not always mean better. Perhaps one explanation for this unexpected result is the context of the study. The technologies considered here are very early stage and radical in nature. Past research has demonstrated that innovations developed based on customer needs and wants tend to

more incremental in nature. Because these technologies are novel and early stage, seeking information about the market early on may not have any payoff in terms of developing marketing strategies. Perhaps, individuals seeking to commercialize new technologies should have a good handle on the technology itself before investing value time and resources talking to others about potential market applications. Teams that gathered market information later in the commercialization process were more effective in their strategy formulation efforts.

Finally, this research examined the interrelationships between the three marketing strategy effectiveness variables. Both marketing strategy creativity and marketing strategy improvisation are significant predictors of marketing strategy performance. Therefore, when seeking to commercialize new technology, individuals should not fear novel market strategies that question the status quo. Additionally, strategies evolve over time and individuals must be aware of their environment and update or improvise to account for any unforeseen changes either relating to the environment or the technology itself. Results also suggest that in addition to the direct relationship between of marketing strategy creativity and marketing strategy improvisation with marketing strategy performance, they also serves as mediators in the relationship of market absorptive capacity and performance, the interaction between market ties and market absorptive capacity on performance, and in the relationship between technical absorptive capacity and technical ties on marketing strategy performance. These interactions provide empirical support for the dynamic capabilities framework and confirm that in order to address a rapidly changing environment, it is necessary to have both internal and external capabilities working together.

10.1 Limitations

One potential limitation is that the data for this research is collected through surveys. However, the use of a panel of teams alleviates many of the concerns usually associated with survey research. Panel data can overcome questions regarding a surveys ability to demonstrate causality and can effectively handle problems associated with heterogeneity and endogeneity. Furthermore, the independent variables are collected from team members while the dependent variables are collected from external experts judging the teams' marketing strategies, thus alleviating the common source bias. In addition, a robustness check of our results regarding marketing strategy improvisation was conducted. An additional analysis was run using lagged independent variables to ensure that the results were not due to the common source bias because team members provided their perceptions of both the independent variables and that of improvisation in their marketing strategy. The results from this post hoc analysis were consistent with the original results obtained thus providing evidence to suggest that the common source bias was not the cause of the original results.

One potential limitation is that the sample is comprised of student teams. One of the difficulties in studying prestart-up teams is that they are difficult to identify. There are so few prestart-up teams that actually develop a product that makes it to the market, thus having access to the entire spectrum of prestart-up teams becomes a challenge (censoring problem). The TI:GER program provided a unique data collection opportunity in that the prestart-up teams are followed over a two-year period in which both the technology and the marketing strategy for that technology are evolving. These technologies are real and have the potential to be commercialized. Teams are comprised

of motivated individuals pursuing careers in either science, engineering, business management, or technology or patent law. In addition, the context for this research is very important. Increasingly, universities are viewed more and more as innovation centers that will continue to drive technological progress forward. Businesses are turning to universities to carry out both basic research and applied research and the key technological breakthroughs are coming out of university labs. Therefore, universities have a key role to play in advancing not only science and engineering, but also provide the impetus necessary to fuel our economy.

Perhaps the most obvious limitation is the small sample on which this research has been conducted. In order to address this issue, the analyses were estimated at both the individual and team level so as to provide robustness checks for the estimates. There were sufficient degrees of freedom to analyze the data.

10.2 Future Research Directions

An obvious extension of this research is to examine the role of network ties and absorptive capacity at later stages of the commercialization process. The focus of this study has been on marketing strategy formulation for university technologies. University technologies have two separate paths to market: license or venture. Future research should explore the role of early marketing strategy formation on the path of commercialization chosen for these technologies.

While the formulation of a marketing strategy is key milestone that should be met in the process of commercialization, it does ensure successful commercialization. Therefore, future research should address marketing strategy implementation issues in

this arena. In addition to market and technical ties, other types of ties make become more important in these later stages of commercialization.

The insights gained from this research can also extend into the strategy formation process for new products developed inside existing organizations. The role of these different types of network ties and absorptive capacity should be explored further in NPD inside well established organizations. Considering the large resource base available within organizations, what role do market and technical ties play in developing new products?

10.3 Conclusion

This research approaches the formation of marketing strategies for new technologies from a dynamic capability perspective and focuses on the impact of network ties and absorptive capacity on marketing strategy effectiveness. The objectives of this paper are to address two important questions in the marketing strategy literature. The first is the role of market and technical network ties and absorptive capacity in the formulation of marketing strategies for new technologies. The second question examined is the timing of market information on a team's ability to effectively formulate marketing strategies. Up to this point, there has been very little empirical research examining the formation of strategies at the team level and in addition, even less research examining the formation of strategies for technologies that are developed outside traditional organizational boundaries and without a predefined market application. This study is the first to distinguish between market and technical network ties and market and technical absorptive capacity and examine their differential impact in marketing strategy development. In addition to the direct impact of these internal and external capabilities

on effectiveness, this paper also strives to understand the interaction between the two capabilities and how it evolves over time, thus providing an empirical examination of the dynamic capability framework. This research helps push the marketing strategy literature forward to understand the unique nature of strategy formation for new technologies at the team level and extend the field of marketing entrepreneurship.

APPENDIX A

APPENDIX A: DEFINITION OF INNOVATION ANTECEDENTS

Variable	*Definition*
Age	The number of years the organization has been in business (Kimberly and Evanisko 1981; Kahn and Manopichetwattana 1989; Baker and Cullen 1993; Li and Atuahene-Gima 2002).
Centralization	Refers to the locus of decision-making authority within an organization (Kimberly and Evanisko 1981; Collins, Hage and Hull 1988; Kahn and Manopichetwattana 1989; Pelham and Wilson 1996).
Champion	Extent of CEO's support for adoption coupled with decision-making influence (Kimberly and Evanisko 1981; Meyer and Goes 1988; Kahn and Manopichetwattana 1989).
Change	Management's openness to change (Hage and Dewar 1973; Zmud 1984).
Clan Culture	An orientation of the firm that stresses participation, teamwork, and cohesiveness (Moorman 1995).
Communication	The information flow present within an organization (Ettlie and Rubenstein 1987; Kahn and Manopichetwattana 1989; Ibarra 1993; Hurley and Hult 1998).
Competition	Intensity and relative strength of competition present in environment (Zajac, Golden and Shortell 1991; Tsai 2001).
Complexity	Degree to which the labor was divided on the basis of specialized knowledge, indicated by the percentage of professional and technical employees (Collins, Hage and Hull 1988).
Diversification	Refers to product diversification; measured using a weighted product count measure (Geiger and Cashen 2002).
Education	Years of education and degrees awarded to managers (Meyer and Goes 1988; Ibarra 1993; Scott and Bruce 1994).
Turbulence	The level of change and uncertainty present in an organization's environment (Kahn and Manopichetwattana 1989).
Formalization	The extent to which activities were predescribed in an organization (Hage and Dewar 1973; Blau and McKinley 1979; Collins, Hage and Hull 1988; Kahn and Manopichetwattana 1989).
Market Orientation	The extent to which organizations collect and use market information, the organizational development of market-oriented strategies, and the implementation of a market-oriented response to customer needs (includes competitor orientation, customer orientation and interfunctional coordination) (Atuahene-Gima 1995).
Network	Measure of intraorganizational network position, based on in-degree centrality for each SBU. (Tsai 2001).
Professionalism	Manager's contact with their field (industry) through reading and attendance at professional meetings (Hage and Dewar 1973; Zmud 1984; Ibarra 1993).

Variable	*Definition*
Public Ownership	Indicates whether an organization is publicly owned (Goes and Park 1997).
Resources	Relative level of the resources available to certain organizations compared to similar others (Kahn and Manopichetwattana 1989; Nohria and Gulati 1996).
Size	Size was measured as the total number of hospital beds (Kimberly and Evanisko 1981; Meyer and Goes 1988; Goes and Park 1997); The number of employees present within an organization (Blau and McKinley 1979; Fennell 1984; Dewar and Dutton 1986; Graves and Langowitz 1993; Shan, Walker and Kogut 1994; Chandy and Tellis 1998; Nagarajan and Mitchell 1998; Chandy and Tellis 2000; Tsai 2001; Geiger and Lee 2002; Li and Atuahene-Gima 2002; Sherer and Lee 2002).
Specialization	The concentration of employees within an organization (Blau and McKinley 1979; Sherer and Lee 2002).
Tenure	Number of years service with organization (Kimberly and Evanisko 1981; Kahn and .Manopichetwattana 1989; Ibarra 1993).
Union	Union pressures facing the organization (Fennell 1984).
Urbanization	Percentage of a county's population residing in urbanized areas (Baldridge and Burnham 1975; Goes and Park 1997).
Team	Team level interaction among members and managers (Moorman 1995; Sethi, Smith and Park 2001).

APPENDIX B

APPENDIX B

THEORETICAL RATIONALE OF INNOVATION RELATIONSHIPS

Variable	*Rationale and Relevant Cites*
ANTECEDENTS	
Competition (+)	Rationale: It is a generally held view that competition fosters innovation (Utterback 1974; Kimberly and Evanisko 1981). Competition can influence innovation by providing companies with exposure to new ideas. Additionally, a highly competitive environment pressures managers to scan their environment to search for superior alternatives to their current methods as well as making the environment such that innovation is necessary for survival. Relevant Cites: Becker and Dietz (2004); Bidault, Despres and Butler (1998); Boeker (1997); Gatignon and Xuereb (1997); Goes and Park (1997); Greve and Taylor (2000); Joshi and Sharma (2004); Kelm, Narayanan and Pinches (1995); Li and Atuahene-Gima (2001); Li and Calantone (1998); Majumdar and Venkataraman (1998); Pelham and Wilson (1996); Powell, Koput and Smith-Doerr (1996); Roberts and Amit (2004); Soultaris (2002); Tsai (2001); Zajac, Golden and Shortell (1991)
Turbulence (+/-)	Rationale: Environmental turbulence creates an environment characterized by uncertainty and provides a stimulus for organizations to innovate in order to guard against uncertainty. Turbulence forces organization to search for and process information from the environment and search for potential opportunities. Relevant Cites: Atuahene-Gima (2004); Calantone, Garcia and Droge (2003); Davila (2003); Ettlie (1983); Gatignon and Xuereb (1997); Geiger and Cashen (2002); Im and Workman, Jr. (2004); Joshi and Sharma (2004); Kahn and Manopichetwattana (1989); Li and Atuahene-Gima (2001); Li and Atuahene-Gima (2002); Meyer and Goes (1988); Mishina, Pollock and Porac (2004); Moorman (1995); Moorman and Miner (1997); Nohria and Gulati (1996); Pelham and Wilson (1996); Sethi, Smith and Park (2001); Souder, Sherman and Davies-Cooper (1998); Soultaris (2002)
Age (+/-)	Rationale: Older organizations have established formal and informal relationships both internal and external to the organization and are a creature of norms and habits. Older organizations have been found to be more rigid and less open to change (Rao and Drazin 2000). On the other hand, some scholars

Variable	*Rationale and Relevant Cites*
	posit that younger firms are less willing to make changes that might disrupt their current means of conducting business. In addition, past research has found support for a positive relationship between age and innovation. Older organizations have a well-defined resource base and have demonstrated high potential for survival, which allows organizations the ability to pursue innovation (Kimberly and Evanisko 1981). Relevant Cites: Atuahene-Gima (2004); Baker and Cullen (1993); Boeker (1997); Bonner and Walker (2004); Day (1994); DeCarolis (2003); Freel (2003); Frost (2001); Galende and de la Fuente (2003); Graves and Langowitz (1993); Hall and Ziedonis (2001); Ibarra (1993); Kahn and Manopichetwattana (1989); Keister (2002); Li and Atuahene-Gima (2001); Mishina, Pollock and Porac (2004); Powell, Koput and Smith-Doerr (1996); Rothaermel and Deeds (2004); Sorenson and Stuart (2000)
Champion (+)	Rationale: Champions use power and influence to gain the necessary resources and support in order for the innovation to occur. Champions help nurture the innovation from conceptualization to implementation and therefore foster innovation within an organization. Relevant Cites: Chandy and Tellis (1998); Day (1994); Ibarra (1993); Joshi and Sharma (2004); Kahn and Manopichetwattana (1989); Markham and Griffin (1998); Meyer and Goes (1988); Sivadas and Dwyer (2000); Souder and Jenssen (1999); Soultaris (2002); Stevens, Burley and Divine (1999)
Diversification (+/-)	Rationale: Organizations that have very diversified product offerings have to split their R&D resources among several different product lines that can have a detrimental impact on innovation. On the other hand, diversification creates a greater knowledge base within the firm to build upon as well as promoting the dissemination of diverse ideas. Relevant Cites: Ahuja (2000); Ahuja and Lampert (2001); Ancona and Caldwell (1992); Becker and Dietz (2004); Bidault, Despres and Butler (1998); Boeker (1997); Cardinal (2001); Day (1994); Galende and de la Fuente (2003); Geiger and Cashen (2002); Hitt, Hoskisson, Johnson and Moesel (1996); Hitt, Hoskisson and Kim (1997); Hoskisson, Hitt, Johnson and Grossman (2002); Kahn and Manopichetwattana (1989); Nohria and Gulati (1996); Pelham and Wilson (1996); Powell, Koput and Smith-Doerr (1996); Rothaermel and Deeds (2004); Shan, Walker and Kogut (1994); Thomas (1990); Wong-Martinez (1995); Wuyts, Dutta and Stremersch (2004)

Variable	*Rationale and Relevant Cites*
Education (+)	Rationale: Individuals with higher education levels tend to be more open minded about organizational change. Education level is also thought to aid in the understanding and interpretation of diverse information that in turn enables innovation. Relevant Cites: Atuahene-Gima (2003); Blind and Grupp (1999); Campbell (1993); Faber and Hesen (2004); Ibarra (1993); Kahn and Manopichetwattana (1989); Keister (2002); Kimberly and Evanisko (1981); Meyer and Goes (1988); Romijn and Albaladejo (2002); Scott and Bruce (1994); Soultaris (2002); Zajac, Golden and Shortell (1991)
Network (+)	Rationale: Networks provide organizations access to knowledge and information about trends present in the environment. An organization's network increases boundary-spanning activities within an organization as well the potential for providing resources required in order for organizations to innovate. Relevant Cites: Ahuja (2000); Atuahene-Gima (2003); Bonner and Walker (2004); Faber and Hesen (2004); Goes and Park (1997); Li and Atuahene-Gima (2001); Love and Roper (2001); Powell, Koput and Smith-Doerr (1996); Rao and Drazin (2002); Romijn and Albaladejo (2002); Saez, Marco and Arribas (2002); Shan, Walker and Kogut (1994); Sivadas and Dwyer (2000); Srinivasan, Lilien and Rangaswamy (2002); Soultaris (2002); Stuart (2000); Tsai (2001)
Past Innovation (+)	Rationale: Organizations that have been successful at innovation in the past are more likely to innovate in the future. They have demonstrated the skills necessary for innovation. Relevant Cites: Ahuja and Lampert (2001); Chandy and Tellis (1998); Jones (2003); Rothaermel and Deeds (2004); Tsai (2000); Wuyts, Dutta and Stremersch (2004)
Professionalism (+)	Rationale: Managers are involved in organizations that increase their boundary-spanning activities and serve as a means for gathering information. These activities provide managers with a diverse set of ideas to carry into their own organizations. Damanpour (1991) found that professionalism of management accounted for 40 percent of the variance in innovation. Relevant Cites: Campbell (1993); Cardinal (2001); Goes and Park (1997); Hage and Dewar (1973); Ibarra (1993); Kahn and Manopichetwattana (1989); van Riel, Lemmink and Ouwersloot (2004); Wong-Martinez (1995); Zmud (1984)
Public Ownership (+)	Rationale: Public organizations may be more open to change then private organizations. Public firms have greater access to

Variable	*Rationale and Relevant Cites*
	resources that are necessary for innovation to occur, as well as market pressures to engage in innovation. Relevant Cites: Baker and Cullen (1993); Boeker (1997); Goes and Park (1997); Powell, Koput and Smith-Doerr (1996); Rothaermel and Deeds (2004); Shan, Walker and Kogut (1994)
Resources (+/-)	Rationale: Resources provide organizations with the flexibility to pursue new products (Meyer 1982). Not only do available resources provide the necessary inputs to innovation, but also reduce barriers and risks to the organization when implementing new innovations by enabling an organization to absorb the cost of the innovation and the possibility of failure (Rosner 1968; Burns 1989). On the other hand, too many resources may be an indication of management incompetence and organizational waste, which can detract from innovation. Relevant Cites: Ahuja (2000); Ahuja and Lampert (2001); Bharadwaj and Menon (2000); Boeker (1997); Bonner and Walker (2004); Campbell (1993); Chandy and Tellis (1998); Collins, Hage and Hull (1988); Day (1994); DeCarolis (2003); Ettlie (1983); Ettlie and Rubenstein (1987); Faber and Hesen (2004); Gatignon and Xuereb (1997); Geiger and Cashen (2002); Goes and Park (1997); Graves and Langowitz (1993); Greve (2003); Hall and Ziedonis (2001); Ibarra (1993); Hitt, Hoskisson and Kim (1997); Joshi and Sharma (2004); Kahn and Manopichetwattana (1989); Keister (2002); Kelm, Narayanan and Pinches (1995); Laursen and Salter (2004); Lim (2004); Love and Roper (2001); Majumdar and Venkataraman (1998); Meyer and Goes (1988); Mishina, Pollock and Porac (2004); Nohria and Gulati (1996); O'Brien (2003); Powell, Koput and Smith-Doerr (1996); Romijn and Albaladejo (2002); Sakakibara and Branstetter (2001); Scott and Bruce (1994); Sorenson and Stuart (2000); Souder, Sherman and Davies-Cooper (1998); Souder and Jenssen (1999); Soultaris (2002); Srinivasan, Lilien and Rangaswamy (2002); Tsai (2001); Wong-Martinez (1995); Wuyts, Dutta and Stremersch (2004); Yam, Guan, Pun and Tang (2004); Zajac, Golden and Shortell (1991)
Size (+/-)	Rationale: Large organizations tend to have more resources available to them than smaller organizations. There is also more diversity in the organization, which can lead to a greater number of innovative ideas. However, size can also be associated with organizational inertia and a failure to adapt to changing resource conditions. Organizations that are large are also very complex and may have more difficulty processing information.

Variable	*Rationale and Relevant Cites*
	Relevant Cites: Ahuja (2000); Ahuja and Lampert (2001); Ancona and Caldwell (1992); Atuahene-Gima (2003); Atuahene-Gima (2004); Baker and Cullen (1993); Becker and Dietz (2004); Belderbos, Carree, and Lokshin (2004); Bharadwaj and Menon (2000); Blau and McKinley (1979); Boeker (1997); Campbell (1993); Cardinal (2001); Chandy and Tellis (1998); Chandy and Tellis (2000); Collins, Hage and Hull (1988); Day (1994); Davila (2003); Ettlie (1983); Ettlie and Rubenstein (1987); Freel (2003); Galende and de la Fuente (2003); Geiger and Cashen (2002); Goes and Park (1997); Graves and Langowitz (1993); Greve and Taylor (2000); Greve (2003); Hall and Ziedonis (2001); Hitt, Hoskisson, Johnson and Moesel (1996); Hoskisson, Hitt, Johnson and Grossman (2002); Ibarra (1993); Im and Workman, Jr. (2004); Kahn and Manopichetwattana (1989); Kaufmann and Todtling (2001); Keister (2002); Kelm, Narayanan and Pinches (1995); Kotabe (1990); Laursen and Salter (2004); Li and Atuahene-Gima (2001); Love and Roper (2001); Majumdar and Venkataraman (1998); Malerba and Orsenigo (1999); Marinova (2004); Meyer and Goes (1988); Nohria and Gulati (1996); O'Brien (2003); Pelham and Wilson (1996); Powell, Koput and Smith-Doerr (1996); Rao and Drazin (2002); Rothaermel and Deeds (2004); Saez, Marco and Arribas (2002); Scott and Bruce (1994); Shan, Walker and Kogut (1994); Sorenson and Stuart (2000); Souder, Sherman and Davies-Cooper (1998); Souder and Jenssen (1999); Srinivasan, Lilien and Rangaswamy (2002); Thomas (1990); Tsai (2001); Wong-Martinez (1995); Wuyts, Dutta and Stremersch (2004); Zajac, Golden and Shortell (1991); Zmud (1984)
Specialization (+)	Rationale: Provides a focused knowledge base for the generation of ideas within an organization. It provides the organization with higher levels of technical knowledge that can be incorporated into innovations. Relevant Cites: Blau and McKinley (1979); Kahn and Manopichetwattana (1989); Kimberly and Evanisko (1981); Nohria and Gulati (1996); Scott and Bruce (1994); Sethi, Smith and Park (2001); Sherer and Lee (2002)
Tenure (+/-)	Rationale: Mangers with longer tenure provide legitimacy and knowledge of how to accomplish goals, manage office politics, and ultimately reach organizational goals. On the other hand, managers with higher levels of tenure are less likely to be open to new ideas or radical changes for fear that it may disrupt the status quo. Relevant Cites: Ancona and Caldwell (1992); Bharadwaj and

Variable	*Rationale and Relevant Cites*
Urbanization (+)	Menon (2000); Boeker (1997); Campbell (1993); Davila (2003); Ibarra (1993); Kahn and Manopichetwattana (1989); Kimberly and Evanisko (1981); Meyer and Goes (1988); Rao and Drazin (2002); Scott and Bruce (1994); van Riel, Lemmink and Ouwersloot (2004) Rationale: Urban environments provide organizations with increased diversity, larger resource base, and greater accessibility to information that enable innovation. Relevant Cites: Baldridge and Burnham (1975); Goes and Park (1997); Majumdar and Venkataraman (1998); Meyer and Goes (1988); Wong-Martinez (1995)
Clan Culture (+)	Rationale: Clan cultures are open to change and provide an environment that fosters innovation. Therefore the orientation of the organization with a clan culture is characterized as one supportive and open to innovation. A clan culture stresses employee participation, teamwork and cohesiveness. Relevant Cites: Moorman (1995); Sivadas and Dwyer (2000)
Competitor Orientation (+/-)	Rationale: Organizations that are focused on their competitors are less likely to come up with radical ideas but are likely to innovate in "me-too" products. Relevant Cites: Gatignon and Xuereb (1997); Im and Workman, Jr. (2004); Lukas and Ferrell (2000); Romijn and Albaladejo (2002); Saez, Marco and Arribas (2002); Soultaris (2002); van Riel, Lemmink and Ouwersloot (2004)
Customer Orientation (+)	Rationale: Organizations that are customer oriented are more likely to gain ideas and information from consumers that can stimulate innovation. Relevant Cites: Callahan and Lasry (2004); Gatignon and Xuereb (1997); Im and Workman, Jr. (2004); Li and Calantone (1998); Lukas and Ferrell (2000); Romijn and Albaladejo (2002); Saez, Marco and Arribas (2002); Sethi (2000); Soultaris (2002); van Riel, Lemmink and Ouwersloot (2004)
Openness to Change (+)	Rationale: A favorable attitude towards change provides organizations with a culture open to innovation. Managerial support of innovation also leads to increased resources provided for innovation. Upper management can provide a very powerful force within an organization, especially if decision-making is concentrated at the top of the organization. Relevant Cites: Calantone, Garcia and Droge (2003); Campbell (1993); Chandy and Tellis (1998); Day (1994); Ettlie (1983);

Variable	*Rationale and Relevant Cites*
	Hage and Dewar (1973); Kahn and Manopichetwattana (1989); Kotabe (1990); Meyer and Goes (1988); Soultaris (2002); Zmud (1984)
Centralization(+/-)	Rationale: Centralization is thought to discourage innovation by decreasing employee's awareness, commitment and involvement. Centralization does not allow for lower level individuals to participate in decision-making and therefore they do not feel involved with the innovation or the outcomes associated with the innovation. Centralization does not foster information transfer within the organization/free exchange of ideas that fosters innovation (Khan and Manopichetwattana 1989). On the other hand, other scholars have found the opposite relationship to be true. The concentration of power within the organization is often necessary to overcome organizational opposition to change (Dewar and Dutton 1986). Relevant Cites: Atuahene-Gima (2003); Blau and McKinley (1979); Cardinal (2001); Collins, Hage and Hull (1998); Ettlie and Rubenstein (1987); Hage and Dewar (1973); Kahn and Manopichetwattana (1989); Nohria and Gulati (1996); Pelham and Wilson (1996); Powell, Koput and Smith-Doerr (1996); Shan, Walker and Kogut (1994); Sivadas and Dwyer (2000)
Communication Generation (+)	Rationale: Promotes environmental scanning and the gathering of market relevant information, which promotes new ideas within an organization. Relevant Cites: Kahn and Manopichetwattana (1989); Lukas and Ferrell (2000); Moorman (1995); Soultaris (2002)
Communication Responsiveness (+)	Rationale: Communication responsiveness facilitates the dissemination of information throughout the organization, which in turn increases information exchange as well as the diversity of ideas generated within an organization (Utterback 1971). Past research has shown that communication is extremely important in both innovation creation and implementation (Becker and Whisler 1967). Relevant Cites: Ahuja (2000); Ancona and Caldwell (1992); Atuahene-Gima (2003); Ettlie and Rubenstein (1987); Hurley and Hult (1998); Ibarra (1993); Kahn and Manopichetwattana (1989); Lukas and Ferrell (2000); Moorman (1995); Sethi (2000); Sethi, Smith and Park (2001); Sivadas and Dwyer (2000); Srinivasan, Lilien and Rangaswamy (2002); Tjosvold and McNeely (1988); van Riel, Lemmink and Ouwersloot (2004)
Complexity (+)	Rationale: Complexity increases an organization's awareness of a need for change, improves the dissemination of diverse ideas, and

Variable	*Rationale and Relevant Cites*
	encourages debate among organizational members. Relevant Cites: Bidault, Despres and Butler (1998); Blau and McKinley (1979); Collins, Hage and Hull (1988); Ettlie and Rubenstein (1987); Galende and de la Fuente (2003); Geiger and Cashen (2002); Hage and Dewar (1973); Meyer and Goes (1988); Tjosvold and McNeely (1988); Zmud (1984)
Formalization (-)	Rationale: Formalization limits organizational flexibility and stifles the creativity of employees because of the focus on rules and procedures within the organization. Formalization results in standardized behavior from employees (Robbins 1990), thereby inhibiting innovation. Relevant Cites: Blau and McKinley (1979); Cardinal (2001); Collins, Hage and Dewar (1973); Hage and Hull (1988); Kahn and Manopichetwattana (1989); Moorman and Miner (1997); Nohria and Gulati (1996); Pelham and Wilson (1996); Sivadas and Dwyer (2000); Wong-Martinez (1995); Zajac, Golden and Shortell (1991)
Interfunctional Coordination (+)	Rationale: Promotes the diversity of information and the cross-fertilization of ideas within the organization that can stimulate innovation. Relevant Cites: Gatignon and Xuereb (1997); Im and Workman, Jr. (2004); Lukas and Ferrell (2000)
Team Communication (+)	Rationale: Communication within the team, which increases the diversity of ideas as well as the knowledge base of the team. It also allows for the cross-fertilization of ideas within an organization. Relevant Cites: Ancona and Caldwell (1992); Golden and Shortell (1991); Hurley and Hult (1998); Sethi, Smith and Park (2001); Soultaris (2002); Tjosvold and McNeely (1988); Zajac, Pelham and Wilson (1996)
OUTCOMES Financial Performance (+/-)	Rationale: Innovation provides organizations with a new method of conducting business ahead of competition. This gives organizations an edge in the marketplace. On the other hand, innovation takes up substantial resources and the organization can lose money on the innovation. Relevant Cites: Ahuja (2000); Atuahene-Gima (2004); Basile (2001); Bayus, Erickson and Jacobson (2003); Belderbos, Carree, and Lokshin (2004); Boeker (1997); DeCarolis (2003); Ettlie and Rubenstein (1987); Faber and Hesen (2004); Geroski, Machin and

Variable	*Rationale and Relevant Cites*
Efficiency (+/-)	VanReenen (1993); Greve (2003); Hitt, Hoskisson and Kim (1997); Kotabe (1990); Marinova (2004); Markham and Griffin (1998); Meeus and Oerlemaus (2000); Mishina, Pollock and Porac (2004); Moorman (1995); Moorman and Miner (1997); Negassi (2004); O'Brien (2003); Pelham and Wilson (1996); Roberts and Amit (2004); Robinson (1990); Sivadas and Dwyer (2000); Souder, Sherman and Davies-Cooper (1998); Tsai (2001); Stuart (2000) Rationale: Innovation is often linked with organizational efficiency, especially process innovation. Companies are able to develop more efficient means of conducting business through innovation. However, innovations often require substantial startup costs and investment by the organization that can lead to inefficiency. Relevant Cites: Ali, Krapfel and LaBahn (1995); Damanpour and Evan (1984); Majumdar and Venkataraman (1998); Markham and Griffin (1998); Moorman (1995); Rosner (1968); Souder, Sherman and Davies-Cooper (1998); Souder and Jenssen (1999); Tjosvold and McNeely (1988)
Subjective Performance (+)	Rationale: Most organizations perceive that innovation is directly linked to an organization's performance. Therefore firms that are successful in innovation will rate their performance higher than firms that have failed at innovation. Relevant Cites: Atuahene-Gima (2004); Bharadwaj and Menon (2000); Bougrain and Haudeville (2002); Calantone, Garcia and Droge (2003); Damanpour and Evan (1984); Davila (2003); Gatignon and Xuereb (1997); Im and Workman, Jr. (2004); Li and Atuahene-Gima (2001); Li and Calantone (1998); Markham and Griffin (1998); Pelham and Wilson (1996); Souder, Sherman and Davies-Cooper (1998); Tjosvold and McNeely (1988); van Riel, Lemmink and Ouwersloot (2004)

APPENDIX C

APPENDIX C: PART II MEASURES

Network Ties (adapted from Smeltzer, Van Hook and Hutt 1991; Reagans and McEvily 2003)

Source of Information	Did you use this source?	Frequency of Use? [24] (1=Little or none, 5=Very high)	Relat Source?	Quality of Information? (1=Poor, 5=Excellent)	Amount of Information? (1=Little or none, 5=Very high)
1. Advisor of PhD student	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
2. TI:GER Faculty	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
3. TI:GER PhD Student 1 (not on your team)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
4. TI:GER PhD Student 2(not on your team)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
5. TI:GER PhD Student 3 (not on your team)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5

[24]Frequency of use: Where 1=Less than once every 6 months, 2=2-4 times every 6 months, 3= Once a month, 4=2-4 times a month, 5=Greater than 4 times a month

6. TI:GER MBA Student 1 (not on your team)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
7. TI:GER MBA Student 2 (not on your team)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
8. TI:GER MBA Student 3 (not on your team)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
9. TI:GER JD Students 1 (not on your team)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
10. TI:GER JD Students 2 (not on your team)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
11. TI:GER JD Students 3 (not on your team)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
12. Peers outside TI:GER Program 1	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5

13. Peers outside TI:GER Program 2	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
14. Peers outside TI:GER Program	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
15. Science and Engineering Faculty (other than advisor) 1	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
16. Science and Engineering Faculty (other than advisor 2)	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
17. Business School Faculty (other than TI:GER Faculty) 1	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
18. Business School Faculty (other than TI:GER Faculty) 2	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
19. Law School Faculty (other than TI:GER Faculty) 1	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5

20. Law School Faculty (other than TI:GER Faculty) 2	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
21. Industry Sponsor for Research	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
22. Office of Technology Transfer	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
23. Outside Accountant	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
24. Outside Attorney	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
25. Friend/Relative 1	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
26. Friend/Relative 2	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5

27. Friend/Relative 3	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
28. Potential Customer	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
29. Potential Supplier	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
30. Small Business Administration	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
31. Venture Capitalist	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
32. Business Executive 1	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5
33. Business Executive 2	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5

34. Other:	❑ Yes ❑ No	1 2 3 4 5	❑ Close acquaintance ❑ Casual acquaintance ❑ Person not previously known	1 2 3 4 5	Technical 1 2 3 4 5 Market 1 2 3 4 5 Other 1 2 3 4 5

Market Absorptive Capacity (adapted from Szulanski 1996)

(Seven point scale, where 7=strongly agree and 1=strongly disagree)

Team members:

- Have a common language to interpret market information.
- Have a common vision of what it is trying to achieve through the marketing strategy.
- Have the necessary skills to respond to market information.
- Have the competency to absorb market information.
- Have the ability to understand market information.
- Have the overall capacity to absorb market information.

Technical Absorptive Capacity (adapted from Szulanski 1996)

(Seven point scale, where 7=strongly agree and 1=strongly disagree)

Team members:

- Have information on the state-of-the-art developments related to the technology.
- Have the competency to absorb information relating to the technology.
- Have the ability to understand technical information.
- Have the overall capacity to absorb technical information.
- Have a common language to interpret the technology.
- Have a common vision of what it is trying to achieve in regards to the technology.

Marketing Strategy Performance (created for this study)
Supervisor ratings of performance: (Seven point scale where 7=strongly agree and 1=strongly disagree)

- Overall, the marketing strategy developed by this team is likely to be successful.
- This team's marketing strategy will require a great deal of modification before it can be used to commercialize this technology.
- This team has developed a comprehensive plan for commercializing their technology.
- This team is well positioned to capitalize upon protectable intellectual property rights.

Marketing Strategy Creativity (adapted from Menon, Bharadwaj, Adidam and Edison 1999; Andrews and Smith 1996)
(Seven point scale, where 7=strongly agree and 1=strongly disagree)

- This team's chosen strategy to market is different from others developed in the past in this industry.
- Compared to other technologies in this industry, at least some parts of this team's marketing strategy are bold.
- Compared with other technologies in this industry, this team's marketing strategy is original.
- The technology's value proposition is novel.
- The selection of the technology's served market is unique.
- The strategy proposed to reach this served market is original.

Marketing Strategy Improvisation (adapted from Moorman and Miner 1998)
(Seven-point scale, where 7=strongly agree and 1=strongly disagree)
Rate the development of the strategy:

- Our team figured out the marketing strategy for this technology as we went along.
- Our team updated the strategy as information came to light.
- Our team improvised in carrying out this strategy development.
- The marketing strategy developed for this technology was ad-libbed.
- We are making/made changes to our strategy as we go along.
- Our team was willing to make changes to the strategy as information came along.

APPENDIX D

APPENDIX D: MARKET AND TECHNCIAL ABSORPTIVE CAPACITY CFA BY TIME PERIOD

Item	*Time 1* SL(t)	SMC	*Time 2* SL(t)	SMC	*Time 3* SL(t)	SMC
Market AC						
mktac1	0.22 (1.97)	0.05	0.49 (4.92)	0.24	0.63 (6.60)	0.40
mktac3	0.72 (7.15)	0.47	0.65 (6.81)	0.42	0.47 (4.65)	0.22
mktac4	0.83 (8.71)	0.62	0.99 (12.91)	0.97	0.96 (12.33)	0.93
mktac5	0.92 (10.19)	0.77	0.97 (12.37)	0.93	0.90 (10.95)	0.81
mktac6	0.98 (11.65)	0.90	0.97 (12.51)	0.94	0.98 (12.61)	0.95
Cronbach α	0.76		0.90		0.89	
Composite Reliability	0.87		0.92		0.9	
Variance Extracted	0.83		0.89		0.87	
Technical AC						
techac1	0.78 (7.70)	0.55	0.41 (4.00)	0.18	0.40 (3.87)	0.17
techac2	0.76 (7.44)	0.53	0.82 (9.36)	0.67	0.76 (8.37)	0.57
techac3	0.75 (7.35)	0.52	0.96 (12.20)	0.93	0.91 (11.13)	0.83
techac4	0.83 (8.43)	0.63	0.95 (11.91)	0.90	0.98 (13.12)	0.99
techac5	0.79 (7.86)	0.57	0.85 (9.86)	0.72	0.80 (9.10)	0.64
Cronbach α	0.88		0.89		0.89	
Composite Reliability	0.89		0.91		0.89	
Variance Extracted	0.83		0.88		0.85	

Item	*Time 4* SL(t)	SMC	*Time 5* SL(t)	SMC	*Time 6* SL(t)	SMC
Market AC						
mktac1	0.11 (1.01)	0.01	0.69 (7.33)	0.48	0.49 (4.90)	0.27
mktac3	0.71 (7.68)	0.50	0.88 (10.46)	0.77	0.45 (4.56)	0.24
mktac4	0.95 (12.06)	0.91	0.93 (11.54)	0.87	0.98 (13.25)	0.98
mktac5	0.96 (12.11)	0.91	0.96 (12.25)	0.93	0.98 (13.25)	0.98
mktac6	0.98 (13.09)	0.99	0.93 (11.54)	0.87	0.94 (11.79)	0.88
Cronbach α	0.82		0.94		0.84	
Composite Reliability	0.89		0.95		0.89	
Variance Extracted	0.87		0.93		0.65	
Technical AC						
techac1	0.38 (4.51)	0.15	0.42 (4.10)	0.20	0.48 (4.81)	0.24
techac2	0.65 (6.71)	0.41	0.31 (2.91)	0.10	0.88 (10.52)	0.78
techac3	0.97 (12.19)	0.92	0.82 (9.42)	0.68	0.89 (10.59)	0.79
techac4	0.87 (10.41)	0.98	0.99 (12.85)	0.99	0.96 (12.19)	0.92
techac5	0.71 (7.88)	0.51	0.84 (9.71)	0.71	0.72 (7.71)	0.51
Cronbach α	0.77		0.81		0.90	
Composite Reliability	0.85		0.83		0.90	
Variance Extracted	0.77		0.74		0.65	

APPENDIX E

APPENDIX E – CONTROL VARIABLES

Task Focused Interaction (Menon and Bharadwaj 1996)
(Five point scale, where 5=strongly agree and 1=strongly disagree)

- In our team meetings, we often get sidetracked discussing peripheral issues.*
- After an issue is raised, we quickly decide what to do about it.
- Team meetings are well organized and productive.
- The team was focused throughout the project to get it done.

Functional Conflict (Menon and Bharadwaj 1996)
(Five point scale, where 5=strongly agree and 1=strongly disagree)

- There is consultative interaction and useful give-and-take.
- Disagreements between team members impaired discussions of issues.*
- There was constructive challenge of ideas, beliefs, and assumptions.
- Members were comfortable about raising dissenting viewpoints.
- Different opinions or views focused on issues rather than on individuals.
- Even people who disagree respected each other's viewpoints.

Team Citizenship Behaviors (Menon and Bharadwaj 1996)(Five point scale, where 5=strongly agree and 1=strongly disagree)

- Some team members do not pull their fair share of the workload.*
- The team members care about the team and work to make it one of the best.
- Team members give the team's work the highest priority.
- The team members ask "what can I do for the team," rather than "what can the team do for me."
- The team members are willing to help others above and beyond the call of duty.

Task Complexity - degree of uncertainty and skill associated with performing the task (Gladstein 1984). (Seven-point semantic differential scale)
The task:

- Is a challenge/No challenge at all
- Requires high effort/Almost no effort
- Requires a high degree of skill/Very little skill
- Needed a high degree of information processing/Needed very little information processing
- Is complex/Is Simple

Environmental Uncertainty -uncertainty present within the market. (Gatignon and Xuereb 1997)(Five point scale, where 5=strongly agree and 1=strongly disagree)

- Competition in our technology's industry is cutthroat.
- The intensity of competition in this industry is very high.
- There is no real competitive threat facing us in our industry.

- Customer tastes can be assessed relatively accurately for our technology's category.
- Demand is fairly easy to forecast in this category.
- The evolution of customer preference is difficult to predict in this category.

Phase of Commercialization

- Semester of participation in TI:GER Program
- Which of the following best describes the phase of your team's technology?
  - ❑ Concept Generation and Exploration
  - ❑ Technical Development and Design
  - ❑ Prototype Construction

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