Endogenous Network Formation and Resource Interactions:
Implications for Organizational Governance and Corporate
Strategy

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy
in the Graduate School of The Ohio State University

By
Sungho Kim, M.S.
Graduate Program in Business Administration
The Ohio State University
2011

Dissertation Committee:
Professor Jay Barney, Advisor
Professor Jaideep (Jay) Anand, Co-advisor
Professor Michael Leiblein
Professor Ashton Hawk
Abstract

This dissertation consists of three essays that study the implications of the reciprocity between interfirm networks and governance choice and the interactions between resource stocks for organizational governance, interfirm network evolution, and corporate strategy. The first essay examines the impact of organizational governance choice on interfirm networks. Interfirm networks literature in strategy has exerted significant influence on organizational governance literature, by finding the roles of social mechanisms, which are embedded in the networks of interfirm relations, in economic exchanges. However, according to the findings of this study, apparently significant impact of networks on governance is in fact a manifestation of the impact of governance on networks, under certain conditions. Using transaction cost economic, resource based theory, and network theory, this study identifies such boundary conditions by linking exchange conditions, which determine organizational governance choice, with network constructs such as tie strength, network centrality, and clustering. The second essay looks at the determinants of the value of combined resource stocks, primarily from resource attribute level and from dyad and industry structure levels of analysis. In addition, this study examines the implications of sub-additivity in resource combination for M&A and the resource based view. Previous research has generally assumed additivity or super-additivity in resource combinations. This study argues that the value of the firm can diminish substantially due to irrecoverable overlaps between the combining firms’ resources. This research identifies intra- and inter-firm transferability (i.e., fungibility and tradability) of firm resources as key conditions under which value can be
destroyed in resource combinations. The counter-intuitive implications of our study help re-interpret the previous mixed empirical findings in the M&A literature. The third essay examines heterogeneity in governance choice, from a network based view. Whereas previous studies on network embeddedness found the existence of social mechanisms in economic exchanges, those are silent about the heterogeneity in governance choices shaped by network conditions. Once a causal link from governance to networks is considered, governance heterogeneity becomes an important issue. This research provides empirical findings that network attributes, such as network centrality similarity and network cluster co-location, determine the choice between alliance and M&A governance. Furthermore, this study finds evidence that indicates that only when resource based and network based perspectives are deployed together, non-biased analyses of governance choice are ensured. From methodology standpoint, the first essay develops a formal model of endogenous network formation and governance choice and the second essay a formal model of resource combinations. The first and second essays deploy agent based simulation methodology, and the third essay uses statistical analyses with field data.
Dedicated to My Parents and Jesus Christ
Acknowledgments

This dissertation would not have been possible without professional and personal supports from many people.

I wish to thank my co-advisers Jay Barney and Jaideep (Jay) Anand and my committee members Michael Leiblein and Ashton Hawk. Throughout the whole intellectual journey, Jay Barney was my lighthouse in the great ocean of knowledge and truth. His guidance always helped me to sail into the big pictures. Conversations with him further fueled my passion for the field of business policy and strategy. Even when my progress was not good, he never discouraged me. His unchanging trust gave me the strength to carry on. He taught me what it means to be a scholar. Jay Anand provided me not only very valuable and insightful feedbacks but also continuous encouragements. Those encouragements have been an important source of intellectual and mental energies that enabled me to overcome turbulences in my life as a PhD student. Without his supports, my intellectual journey would have not been possible. Michael Leiblein taught me the importance of rigorous theorizing. Ashton Hawk helped enhance methodological rigor of my research. Many thanks again for their intellectual contributions and encouragements!

I am grateful to my parents for their unchanging trust in and love for me. They are the teacher of life. They always respected my decisions and encouraged me to follow my passion. I am also indebted to Pastor Miran Lee and Pastor Ken Lee for their great hospitality, spirituality, and prayers. I truly appreciate their pure passion for nurturing young men’s visions and
leaderships.

I also wish to thank to Sharon James, Jeho Lee, SeungHyun Lee, and June-Young Kim for their advices on my academic career. I wish to thank to my close friend Claire. With her friendship, my life was brighter and more meaningful. I also owe many thanks to my friends and cohorts, Chris Welter, Suresh Singh, Anup Nandialath, Susan Young, Yeolan Lee, Jieun Park, Yejin Chang, Shaohua Lu, Ting Xiao, Bijuan Zhong, Nilesh Khare, Sangcheol Song, Charles Stevens, Anastasia Bailey, William Stromeyer, Yongsub Nam, Kihyun Park, Jaeyong Lim, GeHoon Chung, Changwoo Suh, Jiwoong Chung, Hangjoon Kim, Donghun Lee, John Cho, Sanghak Lee, SeKyung Moon, and Insul Kim. More than anything else, I appreciate their friendships.

In addition, I wish to thank to department chair David Greenberger. I appreciate the financial supports from the Department of Management and Human Resources. Finally, I am grateful to Kathleen Zwanziger and Heidi Dugger for their administrative supports.
Vita

December, 6, 1977 ........................................... Born – Incheon, South Korea

1995 ................................................................. Daejon Science High School, South Korea

2000 ................................................................. B.S. Physics, Korea Advanced Institute of Science & Technology, South Korea

2002 ................................................................. M.S. Business Administration, Korea Advanced Institute of Science & Technology, South Korea

2006 to 2008 ......................................................... Graduate Teaching and Research Associate, Department of Management and Human Resources, The Ohio State University

2008 to 2011 ......................................................... Instructor, Department of Management and Human Resources, The Ohio State University

2011 to present ................................................... Assistant Professor, Southern Illinois University

Fields of Study

Major Field: Business Administration

Minor Field: Micro Economics
TABLE OF CONTENTS

Page

ABSTRACT .......................................................................................................................... ii
DEDICATION ....................................................................................................................... iv
ACKNOWLEDGEMENT ..................................................................................................... v
VITA ...................................................................................................................................... vii
LIST OF FIGURES .............................................................................................................. xi
LIST OF TABLES ................................................................................................................ xiii

CHAPTERS:

1. INTRODUCTION ........................................................................................................... 1

2. NETWORK ENDOGENEITY: IMPACT OF GOVERNANCE ON NETWORKS ............... 5
   2.1 INTRODUCTION ......................................................................................................... 5
   2.2 BACKGROUND: NETWORK AND GOVERNANCE .................................................... 6
       2.2.1 Link From Network To Governance ................................................................... 7
       2.2.2 Link from Governance to Network ....................................................................... 9
   2.3 PROPOSITIONS ........................................................................................................... 11
       2.3.1 Conceptual Model of Evolution of Governance Form ........................................... 12
       2.3.2 Impact of Governance on Network Structures .................................................... 13
       2.3.3 Extent of and Conditions for Network Endogeneity ............................................ 20
   2.4 MODEL AND METHODOLOGY ............................................................................... 22
       2.4.1 Baseline Model .................................................................................................. 22
   2.5 RESULTS .................................................................................................................... 30
       2.5.1 Impact of Transaction Attributes on Network Structures .................................... 30
       2.5.2 Impact of Network Structures on Governance Choice ......................................... 32
       2.5.3 Impact of Resource Distribution on Network Structure ....................................... 32
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6</td>
<td>DISCUSSION</td>
<td>34</td>
</tr>
<tr>
<td>2.6.1</td>
<td>Implications for Governance Literature</td>
<td>34</td>
</tr>
<tr>
<td>2.6.2</td>
<td>Implications for Network Literature</td>
<td>37</td>
</tr>
<tr>
<td>2.6.3</td>
<td>Evolution of Network and Governance Form</td>
<td>39</td>
</tr>
<tr>
<td>2.6.4</td>
<td>Future Research</td>
<td>41</td>
</tr>
<tr>
<td>3.1</td>
<td>INTRODUCTION</td>
<td>52</td>
</tr>
<tr>
<td>3.2</td>
<td>BACKGROUND</td>
<td>54</td>
</tr>
<tr>
<td>3.2.1</td>
<td>Interactions between Resource Stocks</td>
<td>55</td>
</tr>
<tr>
<td>3.2.2</td>
<td>M&amp;A Performance and Typical Explanations</td>
<td>58</td>
</tr>
<tr>
<td>3.3</td>
<td>METHODOLOGY</td>
<td>61</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Model</td>
<td>62</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Simulation</td>
<td>69</td>
</tr>
<tr>
<td>3.4</td>
<td>PROPOSITIONS &amp; SIMULATION RESULTS</td>
<td>70</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Irrecoverable Resource Redundancy due to Resource Fungibility and Non-</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>tradability</td>
<td></td>
</tr>
<tr>
<td>3.4.2</td>
<td>Symmetry in Resource Profiles</td>
<td>74</td>
</tr>
<tr>
<td>3.4.3</td>
<td>Interaction between Resource Stocks of Different Resource Attributes</td>
<td>74</td>
</tr>
<tr>
<td>3.4.4</td>
<td>Competitive Advantage and Disadvantage of Merging Firms</td>
<td>76</td>
</tr>
<tr>
<td>3.4.5</td>
<td>Information Asymmetry between Supply and Demand sides</td>
<td>77</td>
</tr>
<tr>
<td>3.4.6</td>
<td>Small Market Size and High Degree of Rivalry</td>
<td>77</td>
</tr>
<tr>
<td>3.4.7</td>
<td>Synergy Versus Sub-additivity</td>
<td>78</td>
</tr>
<tr>
<td>3.5</td>
<td>DISCUSSION</td>
<td>80</td>
</tr>
<tr>
<td>3.6</td>
<td>CONCLUSION</td>
<td>88</td>
</tr>
<tr>
<td>4.1</td>
<td>INTRODUCTION</td>
<td>100</td>
</tr>
<tr>
<td>4.2</td>
<td>THEORY AND HYPOTHESES</td>
<td>101</td>
</tr>
<tr>
<td>4.2.1</td>
<td>Integration</td>
<td>101</td>
</tr>
<tr>
<td>4.2.2</td>
<td>Resource &amp; Network Centrality Similarities and Governance Choice</td>
<td>103</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Network Clusters, Resource Similarity, and Governance Choice</td>
<td>106</td>
</tr>
<tr>
<td>4.2.4</td>
<td>Expected Positional Advantage and Governance Choice</td>
<td>109</td>
</tr>
<tr>
<td>4.3</td>
<td>METHODOLOGY</td>
<td>111</td>
</tr>
<tr>
<td>4.3.1</td>
<td>Data</td>
<td>111</td>
</tr>
<tr>
<td>4.3.2</td>
<td>Dependent and Independent Variables</td>
<td>113</td>
</tr>
<tr>
<td>4.3.3</td>
<td>Controls</td>
<td>116</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 2.1 A Model of Endogeneity in Governance and Network</td>
<td>45</td>
</tr>
<tr>
<td>Figure 2.2 A Fully Specified Model of Governance &amp; Network Evolution</td>
<td>46</td>
</tr>
<tr>
<td>Figure 2.3 Asset Specificity and Governance Choices</td>
<td>47</td>
</tr>
<tr>
<td>Figure 2.4 Asset Specificity and the Distribution of Degree Centrality</td>
<td>47</td>
</tr>
<tr>
<td>Figure 2.5 Asset Specificity and the Distribution of Clustering Coefficient</td>
<td>48</td>
</tr>
<tr>
<td>Figure 2.6 Asset Specificity and the Distribution of Tie Strength</td>
<td>48</td>
</tr>
<tr>
<td>Figure 2.7 Initial Network Structures and Governance Choices</td>
<td>49</td>
</tr>
<tr>
<td>Figure 2.8 Variances in Resource Strength and the Distribution of Degree Centrality</td>
<td>49</td>
</tr>
<tr>
<td>Figure 2.9 Variances in Resource Strength and the Distribution of Clustering Coefficient</td>
<td>50</td>
</tr>
<tr>
<td>Figure 2.10 Variances in Resource Strength and the Distribution of Tie Strength</td>
<td>50</td>
</tr>
<tr>
<td>Figure 3.1 Irrecoverable Resource Redundancy Due to Resource Fungibility</td>
<td>89</td>
</tr>
<tr>
<td>Figure 3.2 Non Tradability of Redundant Resources</td>
<td>90</td>
</tr>
<tr>
<td>Figure 3.3 Symmetry in Resource Profiles</td>
<td>90</td>
</tr>
<tr>
<td>Figure 3.4 Interaction Between Resource Stocks of Different Resource Attributes</td>
<td>91</td>
</tr>
<tr>
<td>Figure 3.5 Resource Profile of Merging Firms Relative to the Market Distribution of Resources</td>
<td>91</td>
</tr>
<tr>
<td>Figure 3.6 Information Asymmetry Between Supply and Demand Sides</td>
<td>92</td>
</tr>
<tr>
<td>Figure 3.7 Market Size and the Likelihood of Sub-Additivity</td>
<td>92</td>
</tr>
<tr>
<td>Figure 3.8 Degree of Rivalry and the Likelihood of Sub-Additivity</td>
<td>93</td>
</tr>
<tr>
<td>Figure 3.9 Scale Economies and the Likelihood of Sub-Additivity</td>
<td>93</td>
</tr>
</tbody>
</table>
Figure 3.10 Scale economies and the likelihood of sub-additivity ...........................................94

Figure 3.11 Previous empirical findings on the relationship between relatedness and value creation .........................................................................................................................94
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2.1 Parameterization of Governance Forms</td>
<td>51</td>
</tr>
<tr>
<td>Table 3.1 Determinants of Resource Fungibility and Tradability</td>
<td>95</td>
</tr>
<tr>
<td>Table 3.2 Two dimensions of resource attributes associated with value destruction</td>
<td>96</td>
</tr>
<tr>
<td>Table 3.3 Examples of drivers of M&amp;A performance</td>
<td>97</td>
</tr>
<tr>
<td>Table 3.4 Relatedness, resource attributes, and M&amp;A performances</td>
<td>98</td>
</tr>
<tr>
<td>Table 3.5 Summary of the parameters of the model</td>
<td>99</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

This dissertation examines the implications of the evolution of inter-firm networks and the interactions among resources for organizational governance and corporate strategy. This research is motivated by the following observations: i) the impact of governance on interfirm networks does not receive attention it deserves from literature on interfirm networks and governance choice; ii) a value destroying property of fungible resources in resource combinations is overlooked in studies that apply the logic of resource combinations (e.g., M&A literature); and iii) extant interfirm networks literature does not explain heterogeneity in governance choices. Given these observations, this research examines the reciprocity between network and governance constructs, determines the value of combined resource stocks by means of resource attributes. In turn, developed theory and findings are applied to organizational governance and corporate strategy. In so doing, this study applies both agent-based simulation methods and statistical analyses of field data to explore those issues.

The first essay, in the second chapter, tackles the reciprocal relationship between inter-firm networks and governance choice. With the governance choice as a primary motor of the evolution of interfirm networks, this study establishes a link between interfirm networks evolution and conditions that govern firms’ organizational governance choices. The choices a firm makes about governance have an important impact on the network to which firms are likely to belong. In this
sense, governance choice is both the cause and the effect of network structure. Therefore, failure to control for this endogeneity may exaggerate the causal link from network to governance, while understating the causal link from governance to network. While the former causal chain has been extensively addressed in the extant literature, the latter causal chain has been rarely addressed. Given this observation, the second chapter seeks to answer to the following research questions:

Research Question 1. How does each different governance mode affect network structures?

Research Question 2. What are the implications of network endogeneity for the previous approaches to governance choice in the extant literature?

This study contributes to the corporate governance literature and network literature. It adds to the governance literature by addressing longitudinal aspect of governance choice and by examining the implications of network endogeneity in governance choice and network evolution. Furthermore, this study provides more complete and coherent answer on how preexisting network structure affects governance choice. It contributes to the network literature by examining endogeneity in network formation. There has been a call for studies on the antecedents of network formation, and my study incorporates governance choice as a mechanism of network formation. In particular, through network analysis, this research delves into the interactions between organizational economic parameters, which are exogenous, and network formation and evolution, which is endogenous.

The second essay, in the third chapter, examines the implications of resource interactions and resource combinations for M&A and the resource based view. In studies on M&A, similarity or relatedness has been argued to be a beneficial element and a source of value creation. The focal logic is that focal merging firms can realize synergy by exploiting related and complementary
resources. Also, the merging firms can enhance efficiency by selling off overlapping resources in the secondary factor market. In particular, this efficiency gain increases when the merging firms are of higher similarity, because similar firms tend to share more overlapping resources in comparison with less similar firms do.

However, this study argues that relatedness can be a source of value destruction rather than a source of value creation and that we need to carefully consider the attributes of resources involved in resource combinations or M&A. Indeed, previous studies employ a critical presumption: overlapping resources are tradable. This is the case for the resources such as excessive capacity, redundant manufacturing plants. On the other hand, resources such as brand cannot be sold off through any market means. This study suggests that if redundancy is non-tradable, then it leads to value destruction, rather than value creation. Given this theoretical concern, the third chapter aims to provide an answer to the following research question:

**Research Question 3. What are the conditions for value destruction in resource combinations?**

This research explores the research question at multiple levels of analysis: resource level, dyadic level, & industry level. It builds a formal model of interfirm resource combinations and conduct agent based simulations, in order to conduct more fine grained analyses on the conditions of value-destruction in resource combinations.

This study offers the counter-intuitive finding that the fungibility of resource and relatedness between two firms can destroy value in resource combination or M&A, contrary to previous studies that draw on logics such as relatedness, similarity, synergy, and the Penrosian model of the firm growth. In addition, some incompletely explained empirical findings in domestic and cross-border M&A studies can be interpreted with our theoretical lens of sub-additivity in resource combinations.
This research provides an alternative explanation to agency or hubris for high premium or for poor M&A performances. An implication of this study is that in estimating premium for acquisition of a target firm, managers of an acquiring firm should take into account the potential value loss from sub-additivity in resource combination, in addition to factors related to potential synergies. This in turn implies that managers in charge of acquisitions should carefully examine the resource profiles of their own and that of the target firm and consider the extent of resource overlap, the level of tradability of the overlap, and the other factors we identify in the propositions as drivers of sub-additivity.

The third essay, in the fourth chapter, seeks to explain heterogeneity in governance choices, from a network perspective. While previous studies provide empirical evidences on “presence” of the impact of network embeddedness on one form of economic actions – alliance formation, those are silent about network conditions under which firms opt for different types of economics actions. For a more complete answer to the question on the association between network embeddedness and economic actions, heterogeneity in the forms of economic actions – governance choices – should be explained.

*Research Question 4. Which conditions of network embeddedness lead to which kind of economic actions?*

This research provides empirical findings that network attributes, such as network centrality similarity and network cluster co-location, determine the choice between alliance and M&A governance. Furthermore, this study finds evidence that indicates that only when resource based and network based perspectives are deployed together, non-biased analyses of governance choice are ensured. This study’s finding as to the effects of network centrality similarity on governance choice contradicts a previous study’s finding.
CHAPTER 2

Network Endogeneity: Impact of Governance on Networks

2.1 INTRODUCTION

There is growing appreciation of the impact of a firm's network of relations on its governance choices. For example, building on transactions cost theory, Gulati (1995) has shown that social networks tend to mitigate the threat of opportunism in forming a strategic alliance (Zaheer & Venkatraman, 1995; Jones, Hesterly, & Borgatti, 1997). Building on resource-based theory, Baum, Calabrese, & Silverman (2000) have shown that potential exchange partners and the complementary capabilities these exchange partners bring to an alliance are influenced by a firm's network (Zaheer & Bell, 2005).

However, the emphasis on networks to governance fails to address the reciprocal relationship from governance to networks. In fact, the choices a firm makes about governance - should an exchange be managed through hierarchy, intermediate forms of governance, or markets - determine the networks to which firms are likely to belong. In this sense, governance choice is both the cause and effect of network structure. Therefore, failure to control for this endogeneity may exaggerate the causal link between network and governance, while understating the causal link between governance and network.
This is complicated by the fact that what previous research raised on network to governance question generates contradictory predictions and results. This problem is mainly caused by the fact that most of previous studies on alliances and interfirm networks deal with a limited set of governance functionalities at a time, despite the existence of the tradeoff across a full set of governance functionalities – safeguard, coordination, and adaptation.

The purpose of this paper is to endogenize the impact of the governance on network relationship on the network to governance relationship, i.e., to address the endogeneity issue raised above. In the process of dealing with the endogeneity problem, this paper resolves prior conflicts in the studies on the impact of network to governance.

In the rest of the paper, social network, network governance and strategic alliance literature are reviewed, in regard to the causal link from network structure to governance choice. Subsequently, this research develops a theory on the network endogeneity in governance choices, by linking the interorganizational network constructs and governance forms. This study presents a conceptual model of endogenous network formation and a network approach to governance choice. Next, this study constructs a formal model for an agent based simulation, in order to examine the conditions under which the extent of network endogeneity becomes significant. Finally, simulation results are presented, and implications for network and governance literature are discussed.

2.2 BACKGROUND: NETWORK AND GOVERNANCE

The influence of inter-firm network on governance choices has been addressed in several studies in social networks and strategic alliance. By reviewing related studies in these fields, this study indicates i) that networks affect a complete array of governance functionalities – safeguard, coordination, and adaptation; ii) and that the link from governance to networks has been
overlooked in governance and network literatures.

### 2.2.1 Link From Network To Governance

The network structure of inter-firm relationships shapes the complete set of governance functions – safeguard, coordination, and adaptation\(^1\). Studies based on sociological theories (Granovetter, 1973; Granovetter, 1985; Coleman, 1990; Gulati, 1995; Zaheer & Venkatraman, 1995) have traditionally shown the link between a firm’s network and one of the governance functions, safeguard of economic exchanges. This link has been argued by means of two different levels of analysis: dyadic level and structural level.

In the case of studies focusing on dyadic level of analysis (Granovetter, 1985), repeated interactions endogenously result in trust between parties to an exchange, and thus reducing the formal governance cost. Trust developed through a network of relations substitutes or complements the formal governance mechanisms to safeguard economic exchanges (Poppo & Zenger, 2002). In this sense, frequency of exchange bridges transaction cost economics and sociological theories, as far as governance choice is concerned (Jones, Hesterly, & Borgati, 1997).

Furthermore, structural aspect of network also affects the safeguard function of governance. For instance, a high density of links leads to informal governance through triangulation of information and rapid dissemination of reputation (e.g., Coleman, 1990).

\(^1\) Appendix A clarifies definition and boundaries of governance, governance forms, interorganizational networks, and network terminologies. Section A.1 defines governance forms and interorganizational networks. Since different streams of research use the term of each governance function in somewhat different meanings, for purposes of this study, boundary of each governance function is defined at section A.2.

Appendix B delineates network based solutions for problems in the governance of economic exchanges. The association between network structure and the safeguard functionality is described in section B.1; network structure and adaptation in section B.2; and network structure and coordination in section B.3.
The structure of interactions amongst firms, which is represented by network structure, affects the coordination function of governance as well. An underlying mechanism is that interfirm network structure dictates information flow and power distribution (Gulati & Singh 1998). Information on interdependencies and task environment affects the alignment of actions (Thompson 1967; Galbraith, 1977). Dense or redundant network structure facilitates coordination, by means of shared identity, reciprocity norms, information sharing, and interorganizational routines (e.g., Coleman, 1990).

Social network literature and evolutionary economics jointly imply that the composition of a firm’s egocentric network ties and its structure affect the adaptibility of the firm. Whereas the balance between exploration and exploitation affects firm-level adaptibility (March, 1991), networks affect that balance between exploration and exploitation (e.g., Lavie & Rosenkopf, 2006). At the dyadic embeddedness level, frequent interactions leads to similarities in information and resources across firms connected through strong ties (Granovetter, 1973). Novel information is more likely to be obtained through weak ties, and increased diversity in resources and information will further promote exploration and innovation through recombination of heterogeneous resources and routines (e.g., Nahapiet & Ghoshal, 1998). In this regard, presence of weak ties tends to shift the balance more toward exploration and strong ties more toward exploitation. At the structural embeddedness level, firms embedded within a dense network are likely to gain access to redundant information and similar resources through its network (Burt 2002; McEvily & Zaheer, 1999). Hence, sparse networks tend to facilitate exploration, whereas
dense network tend to have a propensity for exploitation (Burt, 1992, 2004; Kogut, 2000; Afuah, 2000).2

2.2.2 Link from Governance to Network

Whereas the causal link from network to governance has been examined actively in social network and strategic alliance literatures, the other link from governance to network didn’t receive enough attention it deserves. While few studies recognize the reciprocity (e.g. Gulati, 1995; Gulati & Gargiulo, 1998), they either do not actually examine the reciprocity or partially address the issue at best. Although pointing out the reciprocity between networks and economic actions3, Gulati (1995) examines the one side of the interrelatedness, the impact of social structure, which is represented by alliance networks, on economics actions, which is represented by alliance formation. Even though Gulati & Gargiulo (1999) explicitly claims that they examine the reciprocity between economics actions and networks, it has two critical shortcomings: i) it actually does not measure the impact of alliance transactions on network structures; and ii) although each governance form exerts different type of impact on network structures, it considers only alliance governance.

2 A competing mechanism states that dense network or closures may lead to emphasis on exploration. Repeated interactions, similarity, and share identity leads to trust, reciprocity norms, ultimately resulting in knowledge sharing and cooperation (Coleman, 1988; Ahuja, 2000; Schilling & Phelps, 2007). Depending on the type of task (Hansen, 1999) or type of ties (Ahuja, 2000), knowledge sharing & cooperation may lead to explorative outcomes (Phelps, 2010)

3 "The feedback loop from action to social structure in Figure 2 indicates the dynamic and iterative relationship of these two factors over time in the current context: new alliances alter the social structure that influenced their creation. This feedback makes the ontological status of the emergent alliance network quite ambiguous and precludes its clear conceptualization as either strategy or structure. More likely, it involves both: "Networks of interorganizational relations are maps both of and for strategic action" (Barley, Freeman, & Hybels, 1992)," Gulati (1995: 624)
Incomplete treatment of the reciprocity between network and governance is problematic
because of the followings. *First*, an issue of network endogeneity arises. As reviewed in the
preceding section, on the one hand, the network structure affects a complete set of governance
functions and thereby an efficient form of organizational governance. On the other hand, an
economic transaction, which is organized by a particular governance form, leads to the formation
of network ties between parties to an exchange (Baker, 1990). Governance form determines the
type of such newly formed tie and the impact of such tie on the existing structure of inter-firm
relationships. For instance, a transaction organized through market governance leads to the
formation of a weak tie between two parties to an exchange; a transaction organized through
equity based alliance leads to the formation of a strong tie over time; M&A transaction results in
the consolidation of network ties that two focal firms have before merger. In other words, the
choices a focal firm makes about governance principally determine the network in which a focal
firm will be embedded.

In this sense, inter-firm network formation is endogenous, in that a preexisting inter-firm
network structure shapes governance choice and in turn a series of governance choices construct
network structures. Implemented governance choice dictates the topology and strength of
interactions between a focal firm and the other firms to economic exchanges. Subsequently, the
structure of the interaction across firms shapes governance functions for each firm, as social
network literature (e.g., Uzzi 1997; Powell 1992; Podolny 1994; Baker 1990) and strategic
alliance literature suggest (e.g., Lin, Yang, & Demirkan, 2007; Lavie & Rosenkopf, 2006;
Gnyawali & Madhavan, 2001; Stuart, 2000; Gulati, 1999). In this sense, governance choice is
both the cause and effect of network structure. This implies that the apparently significant effect
of networks on governance may be in fact generated by the impact of governance on networks.

Furthermore, according to transaction cost economics and resource based theory, exchange
conditions, such as asset specificity, uncertainty, and resource heterogeneity, determine
governance form. Thus, from a network endogeneity standpoint, network structures are determined by those exchange conditions. Since the pattern of network formation is contingent upon exchange conditions and resource attributes, the relative impact between networks and governance will be determined by such TCE and RBT parameters. This issue has not been addressed by extant literature on interfirm networks.

Second, even though the majority of research in interfirm networks literature draw on relatedness or complementarities as a primary antecedent of network formation or alliance, it considers only alliance governance. This potentially leads to a bias, since M&A and alliance are alternative governance forms for combining resources across firm boundaries for exploitation of relatedness. Firms may opt for one governance form over the other, contingent upon inter-firm network structure, transactional environment, and resource attributes. In turn, alliance governance and hierarchical governance through M&A have differential impacts on the network structures. Whereas alliance governance will lead to either the formation of an additional market tie with a new partner or the increase in the strength of a tie between a focal firm and a previous partner, M&A transaction results in the consolidation of network ties of two merging firms.

2.3 PROPOSITIONS

For each causal link in the conceptual model of the evolution of network and governance, which is presented in the preceding section, a set of corresponding propositions is developed. The developed propositions will be a lens for the interpretation of simulation results. Comparison between the propositions and the simulation results will lead to the next phase of theorizing, finer grained theorizing informed by the feedbacks from simulation experiment results.

The organization of this section is as follows. First, a conceptual framework of network endogeneity and governance choice is presented. Second, this study provides propositions on
differential impact of each governance choice on a set of network properties. Lastly, conditions under which the extent of network endogeneity becomes significant are proposed.

2.3.1 Conceptual Model of Evolution of Governance Form

A model of endogeneity in governance choice and network evolution is shown in Figure 2.1. This conceptual model draws primarily upon the following theories: transaction cost economics, resource based theory, and network theory. A focal firm’s activity is framed as adaptive search for information on behavior of potential partners for economic exchanges and value of resources of the potential partners. Adaptive search function entails two modes of search: off-line search (intra firm search for novel combination of existing resources and/or organic development of resource) and on-line search (search for resources in the market or/and form inter-organizational arrangements).

As firms engage in adaptive on-line search, firms establish inter-firm links that represent inter-organizational arrangements for resource exchange. A set of these links that are endogenously established through adaptive search constitutes the network of relations amongst the whole firms in the population. Once the inter-firm network is formed, instituted network in turn exerts influences on the “efficiency/optimality” of governance choice that each firm just has made as well as subsequent governance choices, by affecting governance functions that the governance choice just made was supposed to serve. This endogenous causal link between governance functions and governance form dictates evolution of governance form.

Figure 2.2 shows the whole structure of causalities in the model of endogenous network formation and governance choice. Exogenous parameters deployed to the model are TCE and RBT parameters - asset specificity, the level of behavioral uncertainty, frequency of economic exchanges, and distribution of resources across firms - and evolutionary process parameters pertaining to the selection mechanism of “constrained efficient” governance form (Roberts &
Greenwood, 1997). The given exogenous parameters act as initial and boundary conditions of the model and drive the process of endogenous network formation and the evolution of governance form.

Proposition set I examines how preexisting inter-firm network structure in tandem with organizational economic parameters shapes adaptive search and governance choice of a focal firm. It also identifies the tradeoff across governance functions, which is caused by network position, and accordingly examines how network constructs affect functional levels of governance form (control/safeguard, coordination, and adaptation). Proposition set II investigates how adaptive search and governance choices shape inter-firm network structure. Causal link III is related to how firm performance is determined by the fit between supplies of governance functionalities, which are determined by an implemented governance form, and demand for governance functionalities, which are defined by environments (e.g. technological and institutional environment). Lastly, causal link IV relates to how selection mechanisms affect the evolution of governance form. Given the focus of this research, only proposition set I and II will be covered; causal links III and IV will be discussed as future research topics.

### 2.3.2 Impact of Governance on Network Structures

This study proposes that different governance choices result in network linkages with differential network attributes such as tie strength and centrality. Relational and structural embeddedness literature suggests that different kinds of ties and structures have different implications on information flow, resource sharing, and thus economic exchanges. Thus, it is suggested that governance choices will impact interorganizational network structure in different ways, and in turn that changes in network structure will affect governance choices subsequently.

In addition, it becomes an important question whether firms anticipate the consequences of the change in network structure in their governance choices. If firms do take account of the
impact of governance choice on network structure, then the next relevant question is how much rational firms are when they figure out the existing network structure and the consequences of governance choice on network structure at the next period. Some studies (e.g., Moller & Halinen, 1999; Gulati & Gargiulo, 1999; Rosenkopf & Schilling, 2007) underscore that this kind of rationality and capability such as network visioning capability (Moller & Halinen, 1999) is an important determinant of firm performances.

Given these issues, this section begins with the examination of differential impacts of governance choices on network structures. Each discussion is summarized into a proposition. Considered governance forms are market, strategic alliance, hierarchical – internal growth, and hierarchical – mergers and acquisitions governances.

First, the implementation of market governance results in formation of an interorganizational tie between two focal firms to an exchange. The type of the tie is a weak tie due to the following definition of tie strength and the specific aspects pertaining to market governance.

Whereas the first conceptualization of tie strength was made at the inter-personal level (Granovetter, 1973) ⁴, recent studies on interorganizational strategy and networks also operationalize tie strength at the inter-organizational level. For instance, Kraatz (1998) dimensionalizes interorganizational tie strength through three factors: the relationship’s overall

---

² The determinants of tie strength are amount of time, emotional intensity, mutual codification, and reciprocal services between two focal entities that are connected through a network tie (Granovetter, 1973).
duration, the frequency of collaboration, and the intensity of collaboration. In the case of a tie formed through a market transaction, overall duration of interaction is very short; frequency of collaboration is low, because market governance involves non-repetitive spot market transactions; and intensity of collaboration is also low, because market governance involves spontaneous exchanges which are coordinated through price as a sufficient aggregate statistics – no interorganizational coordination and interdependence (Williamson, 1985, 1991).

In this sense, market governance is a mechanism for new tie formation, whereas empirical research on alliance reports that repeated ties tend to be formed between firms already involved in alliance transactions (Kogut, Walker, & Shan, 1997). In other words, there exists inertia in alliance incidences.

**Proposition.** A focal firm’s implementation of market governance increases the number of weak ties of its egocentric network.

Second, a focal firm’s choice of alliance governance will lead to the development of a tie ranging from a weak to strong tie. The type of alliance, and contracts and hierarchical controls used for alliance governance determine the extent of resource commitment, the duration of relationship, and the frequency and intensity of collaboration (Kraatz, 1998; Rowley et al, 2000; Capaldo, 2007). This in turn determines the strength of interorganizational ties formed through exchange.

---

5 Capaldo (2007) operationalizes interorganizational tie strength by means of three dimensions: temporal (Kraatz, 1998), resource commitment (Rowley et al, 2000), and social dimensions (Rindfleisch & Moorman, 2001). Use of this definition leads to the same conclusion that market governance generates a weak interorganizational tie between two focal to an exchange.

6 Equity alliance, non-equity alliance, or joint venture

7 Instances of hierarchical controls used for the governance of alliances are well presented in Gulati & Singh, 1998
alliance governances. For instance, Uzzi (1997) represents a short term contract or an arm’s length transaction by means of weak tie and an inter-organizational arrangement involving equity stakes by means of a strong tie. Rowley et al. (2000) categorizes inter-organizational relationships formed through marketing agreements, licensing, and patent agreements as weak ties and those organized through equity alliances, joint ventures, and non-equity cooperative ventures as strong ties.

**Proposition.** Depending on the type of alliance, contracts, and hierarchical controls, a focal firm’s implementation of intermediate governance results in the formation of a network tie of which strength ranges from weak to strong.

By definition, the duration of relationship increases as repeated exchanges occur between a given pair of focal firms. Cumulative resource commitment increases as alliance governance reiterates. As interorganizational routines are developed, intensity of collaboration increases. Thus, according to the definition of interorganizational tie strength (Kraatz, 1998; Capaldo, 2007), as repeated exchanges occur between two focal firms through alliance governances, the tie strength between them increases accordingly.

Stronger tie strength further increases the likelihood of an additional economic exchange between the two firms, because the increase in tie strength decreases formal governance costs (Gulati, 1995; Bradach & Eccles, 1989; Jones, Hesterly, & Borgatti, 1997). Positive feedback is initiated between two constructs, tie strength and the incidence of governance between the two focal firms.

**Proposition** A focal firm’s implementation of alliance governance results in on average, higher tie strength over time.
A shared third party reduces behavioral uncertainty of, and information asymmetry in resource profiles of, two potential parties to an exchange. A shared third party can provide a focal firm information relevant to potential transactions with another firm which is linked to the shared third party also (Uzzi, 1996). Thus, the possession of a shared third party decreases the likelihood of opportunism and decrease formal governance costs\(^8\). Therefore, given the same exchange conditions, alliance transactions tend to occur between two firms that are in each firm’s intermediate local network respectively\(^9\) (Rowley & Baum, 2004). Growing network ties amongst local neighbors increase the extent of clustering amongst firms in a network, leading to higher clustering coefficient, which is a measure of the extent of cliqueness of a network.

**Proposition** A focal firm’s implementation of alliance governance results in higher extent of local network clustering

**Proposition** A focal firm’s implementation of market governance is more likely lead to the formation of a tie with non-local neighbors, compared to alliance governance.

Third, hierarchical governance – internal development does not lead to network tie formation. However, exchanges and activities organized through hierarchical governance affects firm level accumulation of resources (Argyres & Zenger, 2007) and in turn interorganizational tie

---

\(^8\) Kogut, Walker, & Shan (1997) provides the following empirical regularity: “new alliances tend to increase the density of a firm’s region in the network, suggesting that firms choose partners within the local neighborhood as opposed to outside it. Burt points out that this result indicates only that closure persists but shows nothing about the benefit closure might provide.”

\(^9\) Local network here means a set of relationships amongst the first and second order neighbors. Locality is defined by relational distance, not by physical distance. In other words, members of the first order local network are each focal firm’s partners, and those of the second order are partners’ partners.
formation indirectly (Mowery & Rosenberg, 1989; Powell, Koput, & Smith-Doer, 1996; Rowley et al., 2000). First, for the identification and evaluation of firms in regard to which firms to link with, absorptive capacity is required and this is obtained by internal accumulation of resources and capabilities through learning processes (Cohen & Levinthal, 1990). Second, the ownership and control of valuable and rare resources increase the status of a focal firm, because other firms try to link with the focal firm to get access to complementary, rare, and hard to imitate resources. Thus, if hierarchical governance of economic activities successfully leads to accumulation of such VRI resources (Barney, 1991), the degree centrality of a focal firm will increase over time.

**Proposition.** A focal firm’s implementation of hierarchical governance – internalization indirectly increases the degree centrality of its egocentric network.

Lastly, although the implementation of hierarchical governance – mergers and acquisitions does not form a new tie between focal firms, it results in the modification of network structures. M&A transaction leads to the consolidation of network links that focal merging firms controlled prior to the M&A transaction. Thus, ceteris paribus, M&A transaction leads to higher centralization of a focal firm’s egocentric network and thus a modified portfolio of network ties.

Not only the first order neighbor’s resources but also the resource bases of the second order neighbors, “alters”, affect a focal firm’s governance choice and network strategy. A focal firm may acquire a firm with a motivation to control network ties of the target firm as well as to control the resource bases of the target firm itself. Through the ‘acquired ties’ that was previously ‘owned’ by the target firm, the focal firm can gain accesses directly to the resource bases of the second order neighbors.

In addition, while M&A is a device for reconfiguring resource bases from resource based view, it is also a device to reconfigure network structure of a focal firm, from network point of view. Similarly with Villalonga & McGahan (2005)’s operationalization of governance continuum,
the divestiture can be regarded as an opposite governance mode to acquisition. A focal firm may implement divestiture, based on the rationale of reconfiguration of network ties.

**Proposition.** Ceteris paribus, M&A transaction leads to the higher centrality of a focal firm’s egocentric network.

**Proposition.** Ceteris paribus, divestiture results in the lower centrality of a focal firm’s egocentric network.

In the structural social network literature (e.g., Coleman, 1988; Burt, 1995; Burt, 1997), the reproduction of social capital and the exploitation of structural hole are two major mechanisms of network formation. Closure is the key mechanism in the Coleman’s conception of social capital. On the other hand, Burt (1995) views social capital stemming from structural holes.

Although governance choice is also a mechanism of interorganizational network formation, the relationship between governance choice and social capital and structural hole has been ignored in both governance and social network literatures. Given the same exchange conditions, firm performance will be higher if governance choice not only economizes on transactional attributes but also exploits network properties such as social capital and structural holes.

First, social capital reduces the costs of monitoring existing ties (Walker, Kogut, & Shan, 1997; Coleman, 1988). Thus, with the same level governance costs, more network ties can be formed to gain access to more information and resources. Second, the control of information flow

---

10 Bourdieu & Wacquant (1992) defines social capital as “the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition.” Coleman (1988) identifies three forms of social capital: obligations and expectations, information channels, and social norms.
and brokerage of resources through non-redundant ties are sources of value creation (Burt, 1997).

Bae & Gargiulo (2004) provided evidence that the performances of organizations increases when the organizations are in a position to expand structural holes.

The value of the structural holes and social capital is contingent on the stability of network structure and the heterogeneity of information and resources available through networks. Social capital can be more significant determinant of innovation and firm performance than the structural hole, if a network structure is stable (Walker, Kogut, & Shan, 1997). When information and resources are more diversely available in a focal firm’s network, the likelihood that additional value is generated by brokering disconnected organizations increases. This is precisely because brokerage of diverse information or resources increases the chance of valuable recombination of information or resources.

**Proposition** Ceteris paribus, a governance choice that expands structural holes will result in higher firm level and transactional level performance than one without exploiting structural holes, in particular provided that the network structure is transient and that heterogeneity across the network in resources and information is high.

**Proposition** Ceteris paribus, a governance choice that exploits social capital will result in higher firm level and transactional level performance than one without exploiting social capital, in particular provided that the network structure is stable.

### 2.3.3 Extent of and Conditions for Network Endogeneity

A key research question in this research is under which conditions network endogeneity becomes significant and thus generates a significant level of bias in the analysis of the impact of networks on governance.

In principle, the extent of network endogeneity is determined by the magnitude of impact of
governance on networks, given that of networks on governance. Suppose that interorganizational economic exchanges significantly alter the structure of interorganizational networks. This in turn impacts the causal link from networks to governance. Not considering this causal link, a researcher would conclude, after observing the association between networks and governance, that the impact of networks on governance is significant. In fact, after controlling for the causal link from governance to networks, the impact of networks on governance becomes fictitious.

Conditions for network endogeneity can be identified by examining i) network properties that directly increase the effects of governance choices on networks and ii) transactional and resource attributes that indirectly shape network structures.

Exchange conditions and resource distribution amongst firms shape governance choices, affecting interorganizational network structures. Propositions below specify the conditions under which this indirect link from transactional attributes to network structures becomes significant.

The distribution of asset specificity shapes interorganizational network structure, affecting the extent of network endogeneity. Given all other conditions equal, higher average asset specificity leads to higher propensity of firms to opt for hierarchical governance. Since this research considers two instances of hierarchical governance in internal development and M&A, further contingencies as to needs to be identified. If level of resource heterogeneity across firms is lower, firms’ propensity to opt for internal development rather than M&A becomes higher. As resource heterogeneity decreases, the potential for exploitation of relatedness and complementarity across the firm boundary diminishes, resulting in higher propensity of internal development over M&A. Since internal development does not form interorganizational ties, higher average asset specificity is associated with lower extent of network endogeneity. On the other hand, if asset specificity is lower but resource heterogeneity is higher, propensity for M&A over internal development increases. In this case, the extent of network endogeneity increases, precisely because M&A transactions alter network structures as argued in the previous section.
**Proposition.** Ceteris paribus, the higher the average of the distribution of asset specificity, the less extent of network endogeneity (when resource heterogeneity is low: internal development)

**Proposition.** Ceteris paribus, the higher the average of the distribution of asset specificity, the higher extent of network endogeneity (when resource heterogeneity is high: M&A)

When the heterogeneity in resource distribution across firms’ resource bases is higher, interfirm resource combinations will more frequently occur. This is precisely because of increased interdependence and complementarity between two focal firms’ resource bases. Higher degree of interdependence and complementarities leads to more frequent interfirm resource combinations either through alliance or M&A (Gulati 1995; Wang & Zajac, 2007). In turn, more frequent incidence of alliance or M&A is translated into higher extent of changes in network structures, as argued in the previous section. Thus, this study proposes:

**Proposition.** If the variance of the distribution of resources is larger, the extent of endogeneity will be larger.

### 2.4 MODEL AND METHODOLOGY

In order to conduct more fine grained analysis of propositions and to identify contingencies and boundary conditions of the propositions, this study develops a formal model which accounts for multiple levels of variables ranging from TCE and RBT parameters to dyadic and structural level of inter-firm network attributes.

#### 2.4.1 Baseline Model

In order to focus on the reciprocity between governance choices and network structures, a
basic model is developed such that only safeguard governance functionality is considered while coordination and adaptation governance functionalities are sidestepped. The purpose of such simplifications is to directly compare the predictions from the model to the predictions of TCE. After analyzing the behavior of the basic model, extended models in the future research will incorporate a full set of governance functionalities. Basic and extended models incorporate the following primary constructs:

i) Supply side: N heterogeneous firms constitute the supply side. Those incumbent firms compete in the same industry. Heterogeneity comes from firms’ resource profiles and dyadic transactional attributes such as asset specificity.

ii) Demand side: The demand side is simplified as much as possible so that supply side dynamics can be focused on. It consists of n homogenous consumers.

iii) Inter-firm network: The relationships amongst N firms constitute an interfirm network structure; each firm corresponds to a vertex in a network, and a relationship between two firms to an edge in a network.

**Firm:** This study builds upon and integrates two precursors of resource or routine level approaches to the modeling of the firm: Anand & Kim (2011) and Porter & Siggelkow (2008). Anand & Kim (2011) models the firm by means of a bundle of two resource stocks with the parameters of resource strength and inter-resource stock relationships (additive/multiplicative).

Porter & Siggelkow (2008) provided an extended version of typical N dimensional binary string representation of routines or activities which often is employed in NK modeling approaches (e.g., Rivkin 2000). Rather than using a simple linear payoff function which is typically used in NK model based approaches, they introduced a generalized interaction payoff function, which is rooted on the notion of activity systems and complementarity (Milgrom &
Roberts, 1990, 1995). This payoff function enables a researcher to model interaction across activities/routines such as substituting relationship or complementary relationship. In this proposed study, each dimension has value \( r_q \) ranging from 0 to \( r_{max} \) instead 0 or 1. The variable \( r_q \) denotes resource strength of \( q^{th} \) resource stock of a firm.

Each firm is conceptualized as a bundle of \( q \) resource stocks. In this study, \( q \) is 3, without loss of generality.

**Resource stocks:** Firm \( i \)'s resource bundle is represented by the following equation:

\[
\tilde{R}_i = (r_{i1}, ..., r_{iq}), \quad q \in \{1,2,3\} \text{ and } i \in \{1, ..., N\},
\]

where a vector \( \tilde{R}_i \) denotes a resource bundle of firm \( i \) and \( r_{iq} \) firm \( i \)'s \( q^{th} \) resource stock. The value creation potential or effectiveness of firm \( i \)'s \( q^{th} \) resource stock. In turn, we specify resource strength as the effectiveness of a resource stock in generating value to demand side (Capron & Hulland, 1999). Resource strength of \( q^{th} \) resource stock of a firm \( i \) is denoted by \( r_{iq} \). Resource strength of a firm \( i \) is drawn from certain probability distribution, and in this study we use normal distribution with standard deviation \( \sigma \) and mean \( \mu \):

\[
r_{iq} \sim N(\mu^{(q)}, (\sigma^{(q)})^2), \quad q \in \{1,2\} \text{ and } i \in \{1, ..., N\}
\]

**Resource value:** The value of resource bundle is determined by a value function operationalized by Porter & Siggelkow (2008). An instance of the value function with \( q=3 \) is as follows:

\[
V(R_1, R_2, R_3) = \alpha_1 r_1 + \alpha_2 r_2 + \alpha_3 r_3 + \beta_1 r_1 r_2 + \beta_2 r_2 r_3 + \beta_3 r_1 r_3 + \gamma r_1 r_2 r_3
\]

The parameters \( \alpha, \beta, \) and \( \gamma \) tune the interactive relationships between resource stocks. For
instance, if $\beta_i > 0$, resource stock $r_1$ and $r_2$ are in complementarity. On the other hand, if $\beta_i < 0$, resource stock $r_1$ and $r_2$ are in a substitutive relationship.

**Resource pooling:** Except internal hierarchical governance, strategic alliance and mergers and acquisitions involve resource pooling and recombination. In modeling resource pooling, this study makes an simplifying assumption that fungibility (internal transferability) and tradability (external transferability) of resources are perfect. With this assumption\(^{11}\), pooling of two resource bundles of firm $i$ and $j$ becomes a simple arithmetic summation of corresponding resource strengths:

$$\tilde{R}_{i+j} = \tilde{R}_i \cup \tilde{R}_j = (r_{i1} + r_{j1}, \ldots, r_{iq} + r_{jq})$$

**Value appropriation:** The magnitude of value appropriation of a focal firm is proportional to the amount of resource contribution of that firm to pooled resource bundles. Hence, if firm $i$ transact with firm $j$, the magnitude of value appropriation of firm $i$ is calculated as follows:

$$v_{ij} = V(\tilde{R}_{i+j}) \times C_{ij},$$

where $C_{ij}$ is the resource contribution ration, which in turn is defined by:

$$C_{ij} = 1/q \sum_{t=1}^{q} r_{it}/(r_{it} + r_{jt})$$

**Transaction level performance:** Transaction level performance of firm $i$ is defined as the firm $i$'s magnitude of value capture from value creation from a given transaction $\tau_{ij}$. It is equivalent to $v_{ij}$.

**Firm level performance:** Firm level performance is defined as a cumulative sum of

\(^{11}\)In the chapter 3, these assumptions are relaxed, and it will be examined the implications of varying degree of tradability and fungibility of resources for resource combinations.
claimed values.

\[ f_i = \sum_k v_{ik} \]

**Parameterization of exchange conditions:** The baseline model incorporates two TCE associated exchange conditions: asset specificity and behavioral uncertainty (likelihood of opportunism). Asset specificity is associated with the extent of value loss in case of redeployment. The extent of value loss of firm \( i \)'s investment to firm \( j \) in case redeployment is directly proportional to asset specificity between \( i \) and \( j \), \( \theta_{ij} \). \( \theta_{ij} \) is randomly drawn from a normal distribution.

\[ \theta_{ij} \sim N(\mu, \sigma^2) \]

\[ 0 \leq \theta_{ij} \leq 1 \]

**Inter-firm network structure:** Inter-firm network structure is represented in terms of \( n \) by \( n \) weighted and undirected adjacency matrix \( A \). Matrix element \( a_{ij} \) denotes the tie strength between firm \( i \) and \( j \). \( a_{ij} \) at \( t = 0 \) comprises initial condition of interdependency across the whole population of firms. Basic model sets up initial condition as a set of isolated firm, which is equivalent to the case of all firms in market governance; \( a_{ij}(0) = 0 \) for all \( i \) and \( j \). Other extended models consider various initial conditions of interdependencies.

**Adaptive search:** Each firm in this model engages in at each period adaptive search, which is an attempt to improve firm value through internal search for a novel combination of existing resources or development of valuable resource or external search for value enhancing complementary resource owned by other firms. As to external mode of adaptive search, several studies provide rationale for why adaptive search is framed in terms of search for value enhancing resources (e.g., Lin, Yang, & Arya 2009; Das & Teng 2000; Hitt et al 2000; Osborn & Hagedoorn, 2000; etc.)
Adaptive search rule can be either i) incremental (evolutionary; limited rationality) or ii) planned approach (high degree of rationality). In case incremental search, at each period a firm searches for value enhancing resource transactions. In case planned approach, given internal factors (resource configuration and firm level interdependency) and external factors (environment and resource profiles of competing and cooperating firms), a focal firm “designs” its interdependency structure and resource profile with “foresights”.

Parameterization of governance forms: Governance forms are different in terms of safeguard, coordination, and adaptation functionalities. In this study, each governance form is operationalized by parameters associated with a set of governance functionalities.

First, differential in safeguard functionality is operationalized by probability of opportunism, \( p_i \) and resource contribution ratio \( C_{ij} \). As shown above, \( p_i \) is the function of network structure and an intrinsic firm level attribute. In the case of hierarchy, \( p_i \) is zero regardless of network structures and firm level attributes. The likelihood of opportunism is a function of network structure, in case market or alliance governances. The magnitude of value appropriation is proportional to \( C_{ij} \), in the case of alliance or market governances. Value appropriation of hierarchical governance is always complete (value 1).

Second, the coordination functionality of governance is operationalized by resource interaction discount rate, \( \omega \). Each governance form is associated with different intensity of coordination of resource combination activities. As hierarchical governance as a baseline, the following equation holds:

\[
\omega_M < \omega_X < \omega_H = 1,
\]

where \( \omega_M \) denotes the resource interaction discount rate of market governance, \( \omega_X \) that of
alliance governance, and \( \omega_{HF} \) that of hierarchical governance.

Third, the types of adaptation are different across governance modes. Market governance is associated with autonomous adaptation, hierarchical governance cooperative adaptation, and alliance governance hybrid of autonomous and cooperative adaptation. Table 2.1 summarizes how governance forms are parameterized.

**Governance choices of new transactions**: The simulation model in this study involves full dyadic treatment of transactions (Zajac & Olsen, 1993). A transaction occurs only if both parties to an exchange benefit from the transaction.

Firms make their governance choices at each period, according to the following behavioral rule sets. First, each firm generates alternatives. At each period t, each firm generates a payoff table. In a payoff table, all possible combinations of exchanges are figured out based on potential parties to an exchange and governance forms. Second, each firm evaluates its alternatives generated in the previous step. Each firm selects upper \( \lambda \) best value creating transactions. Lastly, firms search for matching equilibrium. Each firm simultaneously check whether potential parties to an exchange regard the focal firm to lie within upper \( \lambda \) transactions. In the baseline model, if there are multiple matching sets, each firm implements all of them. In extended models, contingent upon a resource constraint, each firm can implement up to \( \varepsilon (R_i) \) transactions.

**Governance choices of extant transactions**: A focal firm or its partner firm may engage in opportunism. In the baseline model, opportunism considered is the termination of a contract before its contract duration, for the sake of simplicity\(^\text{12}\). The likelihood of opportunism is a function of an individual firm level attribute and a network structure.

\[
p_i = f \left( p_i^0, \bar{N}_i \right).
\]

\(^{12}\) In general, the types of opportunism are adverse selection, moral hazard, and holdup.
where $p_i^o$ denotes the intrinsic propensity of firm $i$ to engage in opportunism and $N_i$ vector network properties. In the baseline model, $p_i^o$ is homogenous across the whole population. Thus, variances in $p_i$ is generated only by the network position of each firm $i$. In extended models, there are two types with regard to the propensity of opportunism: $H$ (high type) and $L$ (low type), where $p_i^H$ is always larger than $p_i^L$.

If a transaction is active, each firm check whether it has an incentive to defect; if there is at least one firm, then an incentive to defect exists. If such an incentive exists, firm $i$ engages in opportunism with a probability of $p_i$.

**Governance cost:** For the simplicity of analysis, this study builds on Williamson (1991)’s discrete structural approach to governance costs, by adding network effects on governance costs. Whereas the determinants of governance cost in Williamson (1991) are asset specificity and governance form, an additional determinant of governance cost in this model is network effect. Such network properties as tie strength, centrality (either degree or betweenness centrality), and clustering coefficient determine governance costs as well. Thus, functional form of governance cost in this study is as follows:

$$C_g(\tau_{ij} ; \psi) = f(\theta_{ij}, a_{ij}, \bar{N}_i, \bar{N}_j ; \psi),$$

where $\tau_{ij}$ denotes a transaction between firms $i$ and $j$, $\theta_{ij}$ asset specificity between firm $i$ and $j$, $a_{ij}$ tie strength $i$ and $j$, $N$ network properties, and $\psi$ governance form. For simplicity and tractability, this study assumes a monotonic linear relationship between each independent variable and $C_g$.

**Network formation:** Market or alliance governance results in interorganizational network formation. Tie strength increases at each period by $\Delta a_M$ for a market governance and by $\Delta a_X$ for alliance governance as long as a corresponding transaction is active. In general $\Delta a_X$ is larger than $\Delta a_M$. If a transaction expires after the period of a contract, the tie strength stays at the latest level. However, if a transaction is terminated due to opportunism, the tie strength decreases by $\Delta a_O$. 

**Initial Conditions:** There are two initial conditions in this model. One is initial resource endowment and the other is initial network structure. As an extension of the baseline model, various initial conditions can be used to represent some important strategic contexts.\(^{13}\)

### 2.5 RESULTS

Agent based simulation is performed, based on a formal model described in the previous section. Simulation results are organized as follows: first, how transaction attributes affect network structures are examined; second, network structures on governance choice; and lastly, resource distributions on network structures.

#### 2.5.1 Impact of Transaction Attributes on Network Structures

In the first place, basic behaviors of the model are checked so that validity of the model can be ensured. As an external validity test, we can examine how the pattern of governance choice varies according to the variation in the distribution of asset specificity. Figure 2.3 shows the association between the average of asset specificity distribution and the probability of the occurrence of each governance form. In this figure, it is found that more hierarchical governance forms - alliance governance (X) or hierarchy (H) - are more frequently observed when asset specificity is higher (\(\mu=0.6\)). This result is consistent with the prediction of TCE. Thus, the behavior of the model is externally valid, from TCE standpoint.

The followings illustrate the link between a transaction attribute and a set of network properties - degree centrality, clustering coefficient, and tie strength.

*Asset specificity and degree centrality*

Figure 2.4 illustrates how a transaction attribute shapes interorganizational network structure.

\(^{13}\) For instance, entrepreneurial firms Vs incumbent firms; differential impacts of systemic Vs. autonomous technological change on interorganizational network structure
structure. A transaction attribute considered is asset specificity. In equilibrium, it is found that the average and variance of degree centrality increases as the average of asset specificity decreases. Ceteris paribus, when asset specificity decreases, the propensity that a less hierarchical governance - market or alliance governance - is chosen increases. In turn, this leads to more interorganizational ties, because market or alliance governance is a mechanism of network formation. As a consequence, more network ties are formed, if the average of asset specificity is lower. With a mechanism of preferential attachment, more network ties is translated into higher degree centrality.

Asset specificity and clustering coefficient

In Figure 2.5, it is found that the level of asset specificity also determines the distribution of clustering coefficient. Ceteris paribus, when the average of asset specificity distribution is lower, the average and variance of clustering coefficient distribution are higher. Higher clustering coefficient implies that network ties are more likely to be formed amongst local neighbors. Lower asset specificity generates more interorganizational ties and strategic alliances tend to be instituted between firms that are already connected each other.

Asset specificity and tie strength

Figure 2.6 shows how the distribution of tie strength is determined by the level of asset

---

14 Hierarchical governance does not lead to network formation. Instead, hierarchical governance may indirectly affect network formation. For example, if internal development is successful for certain period, resource strength will go up, resulting in higher centrality due to preferential attachments.

15 Firms are more likely to exchange with a focal firm of which resource strength is higher. As a result, the focal firm tends to have more network ties. This is an instance of preferential attachment (Barabasi & Albert, 1999).

16 This result is consistent with empirical studies that found that alliances are likely to be formed between local neighbors (e.g., Kogut, Walker, & Shan, 1997)
specificity. Ceteris paribus, when the average of asset specificity distribution is higher, tie strength tends to be larger. The same pattern applies to the maximum value of tie strength. Maximum tie strength for $\mu=0.2$ is 6, while that for $\mu=0.6$ is 11.

As exchanges repeat between two focal firms, the tie strength between them increases. Increased tie strength further increase the likelihood of an additional economic exchange between the two firms, because the increase in tie strength decreases governance costs. This forms positive feedback between tie strength and the occurrence of alliance or market governance between the two focal firms.

### 2.5.2 Impact of Network Structures on Governance Choice

Figure 2.7 shows the impact of initial network structures on governance choices. Beta represents initial conditions of network structure. If beta is low, clustering coefficient is higher (Watts, 1998). As beta increases, a network structure becomes more random with clustering coefficient decreasing. Thus, if beta is lower, less hierarchical governance forms will be more likely to be observed across the whole population.

Figure 2.7 confirms that this prediction is valid. However, it is important to note that the difference in the patterns of governance choices with different values of beta are very small. Whereas previous studies on social networks and informal governance have underscored the link from network to governance, Figure 2.7 suggests that there exist certain conditions under which the link from network to governance can be less important that the link from governance to network.

### 2.5.3 Impact of Resource Distribution on Network Structure

In addition to initial interfirm network structures and transaction attributes, the distribution of resource strength across a population of firms shapes interorganizational network structure.

*Probability distribution of degree centrality*
Figure 2.8 shows how resource distribution across a population affects the distribution of degree centrality. With a fixed average of resource strength distribution, higher variance in resource strength distribution ($\sigma = 3$) results in higher average and variance in degree centrality. Higher variance in resource strength across population implies higher degree of complementarity between resource stocks of firms. Interfirm resource combination will occur more frequently than intrafirm resource combination, as interfirm resource complementarity increases. Thus, Alliance or market governance is more likely to be chosen than hierarchical governance are.

Higher number of network ties in general increases variance in degree centrality. In addition, with preferential attachment mechanism, more network ties give rise to higher degree centrality. Firms with higher resource strength are more likely to attract more network ties. Alliance governance tends to increases the average of degree centrality, and market governance the variance of degree centrality.

*Probability distribution of clustering coefficient*

In Figure 2.9 it is found that the average of clustering coefficient also increases. On the other hand, the variance in clustering coefficient slightly decreases. With the similar logic that was applied to the association between the variance in resource strength and degree centrality, higher variance in resource strength ($\sigma = 3$) is translated into more occurrence of market or alliance governance.

*Probability distribution of tie strength*

Figure 2.10 shows that higher variance in resource strength amongst firms leads to a more right-skewed distribution of tie strength. A maximum value of tie strength is 8 when $\sigma = 1$, whereas it is 15 when $\sigma = 3$. This result clearly illustrates that the combination of preferential attachment mechanism and interfirm resource complementarity drive network formation. With higher variance in resource strength, not only more network ties tend to be attracted to some firms, but also repeated exchanges occur between firms through alliance governances.
2.6 DISCUSSION

This study offers a formal analysis on the reciprocal interaction between corporate strategy and interorganizational networks. Previous research on alliances and networks claims the importance of networks on economic actions of organizations, while not fully considering the impact of economic actions on networks.

This study finds that under certain conditions the impact of networks on governance is less important than the impact of governance on networks. This finding suggests the boundary conditions of previous studies on alliances and interorganizational networks (e.g., Gulati, 1995; Gulati & Gargiulo, 1999).

2.6.1 Implications for Governance Literature

Incorporation of networks into the analysis of governance choices invokes the importance of a dynamic approach to governance choices. The reciprocity between governance and network generates a longitudinal dynamics. From transaction cost economics standpoint, existing interorganizational network structures – tie strength, closure, and centrality - determine the formation of informal governances – trust, reciprocity norms, reputational sanctions, and interorganizational routines. Instituted informal governances in turn shape formal governances – choices amongst market, alliance, and hierarchical governance. Governance choices that are made conditional upon existing network structures modify the existing network structures. As a result, reciprocal dynamic between networks and governances continues over time.

From resource based perspective, interorganizational networks are channels of information and resource flow. Network structures shape the patterns of interorganizational resource transfer and resource combinations. Recombination, mutation, selection, and retention of resource bases embedded in a focal network reconfigure resource profiles of firms embedded in the network, influencing firms’ governance choices. This in turn changes the network structure in the next
period. Consequently, also from resource based perspective, longitudinal approach needs to be taken toward analyses of governance choices, due to network endogeneity.

Incorporation of networks into the analysis of governance choices invokes the importance of the second order uncertainty in governance choices. This study argues that finer grained identification of sources of uncertainty is necessary in network approach to governance choice than in dyadic approach to governance choice.

Uncertainty stems from factors related to dyadic relationships and macroscopic environmental factors such as technology or demand side, in studies on governance choice drawing on organizational economics. On the other hand, from a network perspective of governance choice, while macroscopic environmental factors are the same sources of uncertainty, any network level effects on governance choice are not taken into account by the approach taken by organizational economics.

The type of uncertainty can be categorized into primary uncertainty and secondary uncertainty, according to the sources of uncertainty (Koopmans, 1957; Williamson, 1985; Sutcliffe & Zaheer, 1998). Primary uncertainty refers to the uncertainty stemming from variances in states of nature and secondary uncertainty to that in behavior of other economic agents (Sutcliffe & Zaheer, 1998). Whereas a dyadic formulation of governance choice considers the secondary uncertainty only in a partner firm to an exchange (e.g., opportunism associated with behavioral uncertainty of parties to an exchange in TCE), a network approach to governance choice captures more complete secondary uncertainty. Since dyadic conception of governance choice is at best an approximation of network approach to governance choice, it accordingly ignores or overly simplify uncertainty stemming from network effects. For example, change in centrality, structural hole, or cohesiveness generates can be initiated not only by firms immediately connected through dyads of a focal firm, but also by second or higher order adjacent firms. These changes can be sources of uncertainty to a focal firm’s governance choice, precisely
because of endogeneity in the relationship between governance and network.

According to the findings of this research, exchange conditions and resource distribution, more specifically TCE and RBT parameters, determine not only short-run governance choices, but also long-run network structures, which in turn determine future governance choices. Initial exchange conditions and resource endowments, which are exogenous, shape informal governances through endogenous interaction between network and governance constructs. Under certain conditions, such as high asset specificity or high resource heterogeneity, the impact of networks on governance can be less important than the impact of governance on networks.

This result suggests that the importance of governance in the web of networks and governance is still intact. From a perspective of social network literature, social structures, of which pattern of interactions is represented by network structures, shape governance choices. However, from network endogeneity perspective of this study, not only short run network formation but also long-run network structures are collectively governed by exogenously given exchange conditions and firms’ actions that seek to optimize on their given exchange conditions – governance choices.

In addition, this study implies that the magnitudes of network endogeneity will be different across industries, since industries are heterogeneous in terms of network structures (Rosenkopf & Schilling, 2007) and types of frequently implemented corporate strategies (reference). Based on the findings regarding the impact of governance on networks, it is suggested that the heterogeneity in the following industry level properties of governances and networks leads to differential extents of network endogeneity across different industries: i) comparative frequencies of alliances versus M&A, ii) frequency of transactions between central firms – either in terms of betweenness or degree centrality, & iii) network density and the number of structural holes.

It is argued that industry level exchange conditions, such as dynamism, the rate of technological change, and industry structure shape evolution of interorganizational networks.
Environmental conditions affect each firm’s propensity to opt for a particular governance form. This in turn sets a distinct trajectory of network evolution. For example, in a mature and fragmented industry, M&A for gaining scale and market power will frequently occur. This will make a corresponding industry network more centralized. If an industry is characterized by faster technological change, alliance governance will more frequently occur (Eisenhardt & Schoonhoven, 1996; Rosenkopf & Schilling, 2007). This will lead to denser and more clustered network structures.

2.6.2 Implications for Network Literature

This study contributes to the network theory by examining endogeneity in network formation. How structures shape economic actions is a central and well established topic in social network studies. However, the question of how actions shape structures is not well addressed also in the field of social networks. This research approaches to the question from an angle of formal governance choices as economic actions. In so doing, this study is specific about the antecedents of economic actions – exchange conditions and resource distributions, with the theoretical lens of TCE and RBT.

Network literature argues that network position is an important determinant of competitive advantage. Then an important question emerges: how to shape beneficial network structures for a focal firm? Grabher & Powell (2004) pointed out that few studies on networks take a network governance approach. Network governance approach can be summarized as the following research question (Grabher & Powell, 2004): “How to design, manage, and control networks in order to reduce uncertainties and improve competitive position?” Regarding this issue, this study suggests one mechanism for network governance: organizational governance choice. From network endogeneity standpoint, governance choice is a lever that managers can control, in order to shape an interorganizational network that will confer positional advantages on the focal firm. A
focal firm has an option of selecting a particular governance form depending upon existing network structures, exchange conditions, and network resources of potential partners’ partners, since each governance form provides distinct impact on network structures.

Resource dependence theory (Pfeffer & Salancik, 1978) and the relational view (Dyer & Sing, 1998) argue that the management of interorganizational relations is a crucial determinant of competitive advantage. The unit of analysis in these streams of research is dyad. However, our study found that not only relational embeddedness (dyad) but also structural embeddedness (network) exerts significant forces on the relationships of focal firms in terms of resource heterogeneity, network centrality, and asset specificity. How can an organization control relations at the network level (structural level)? How do network level factors shape and constrain a focal organization’s management of relations? Again, one answer to the questions, which is provided by network endogeneity perspective, is that a focal firm can shape a network of interorganizational relationships through a series of adaptively optimal governance choices.

In response to a call for studies with network as a dependent variable (Madhavan, Koka, & Prescott, 1998), this study frames network structure as a function of exchange conditions and resource distribution. To the best of the authors’ knowledge, this study is the first attempt in strategy literature that directly links TCE and RBT factors with network structures. This study also responses to a call for research on the contents in network analyses (e.g., Phelps, 2010), which underscores the importance of joint analysis of structure of networks and attributes of nodes. In this research, conditions for economic exchanges such as asset specificity, resource distribution, and uncertainty corresponds to the "contents" in network analyses. This study delves into the interactions between organizational economic parameters, which are exogenous, and network formation and evolution, which is endogenous. In this sense, this study is an organizational economic analysis of network formation and evolution.

This research employed a simulation methodology in order to mitigate limitations of extant
empirical studies on interorganizational networks and strategic alliances. In the extant literature, a number of conjectures have been made, but most of them are not yet corroborated, primarily because of data limitations (Walter et al., 1997; Kogut, Walker, Shan, 1997). Compared to assertions that are purely based on verbal reasoning, well designed simulation studies are likely to provide more refined and articulated propositions for further empirical corroboration. This issue becomes significant, when emergence underpins observed phenomena. To the extent that firms make governance decisions boundedly rational, network formation and network attributes especially at the structural level are emergent properties.

There has been a call for studies on the antecedents of network evolution (e.g., Ring & Van De Ven, 1994; Doz, 1996; Nohria & Garcia-Pont, 1991; Gomes-Casseres, 1994; Madhavan, Koka, & Prescott, 1998; Gulati & Gargiulo, 1999). This research incorporates governance choice as a mechanism of network evolution. Specifically, Gulati (1998) posed the following question: "Which ex ante factors and evolutionary processes influence the development of individual alliances and networks?" With respect to that research question, this research found that transactional attributes and exchange conditions set evolutionary trajectory of the social structure. For instance, if the average of the distribution of asset specificity of transactions in a given industry or strategic groups is low, the structure of interfirm network evolve toward one with low average clustering coefficient, lower average centrality, and weaker tie strength. This social structure indirectly further necessitates more hierarchical governance due to lack of the development of social capital. In this sense, vicious cycle in the relationship between governance choice and network structure is triggered by initially high level of asset specificity.

2.6.3 Evolution of Network and Governance Form

There exist multiple mechanisms for governance and network evolution. First, governance forms may evolve as a consequence of changes in exchange conditions. As observed in the
empirical studies on strategic alliance and M&A, governance form for a given exchange may evolve over time (e.g., Kogut, 1988). For instance, an exchange that has been organized through alliance governance may evolve to be organized with hierarchical governance – M&A; or two parties to an exchange may go independent, and the exchange may be governed through hierarchy (e.g., Nickerson & Zenger, 2003).

Second, since network structure evolves as a consequence of firms’ economic actions – governance choices, the evolution of extant governance forms, which is induced by the shift in exchange conditions, leads to the evolution of network structures. In addition to the evolution of extant governance forms, additional economic transactions and thereby additional governance choices may occur, further modifying extant network structures. In this way, exchange conditions that determine governance choice will also shape and constrain network evolution.

Third, another motor of the evolution of governance forms lies at the network endogeneity in governance choices. The evolution of network structure results in the changes in the supply of governance functionalities which is provided by network. This in turn brings about the gap between the demand and supply of governance functionalities. In order to narrow this gap, rational, yet boundedly rational firm, will initiate search for more efficient governance form and modify the governance form which was efficient prior to network evolution.

When the unit of selection is the firm, the likelihood of selection is determined both by the set of fits between exchange conditions and governance forms and by the fit between exchange conditions and a focal firm’s egocentric network structure. In this sense, a focal firm’s egocentric network and a set of governance forms opted for by the focal firm are 1) buffers for each other against selective forces and 2) inertia acting as impediments to adaptation to varying exchange conditions and behaviors of firms.

Even though a few studies treated safeguard and coordination functions (e.g., Gulati & Singh, 1998) simultaneously, previous studies rarely treat a complete set of governance
functionalities\textsuperscript{17} simultaneously. One reason why adaptation functionality should be incorporated in the analysis of governance choice is that a governance form which is well coordinated and safeguarded but not adapted to changing exchange conditions is in fact a governance arrangement which is misaligned with updated exchange conditions after environmental change. In this sense, adaptation functionality mediates the causal link from the extent of safeguard and coordination functionalities to transactional performance.

2.6.4 Future Research

The followings are research topics that are identified while conducting this research. Those are closely related to the overarching theme of the interaction between interorganizational networks and governance choice.

*Deliberate Governance Choice versus Evolutionary Process in Network Formation*

Given a premise that governance choice is both the cause and effect of network structure, preexisting relationships embedded in the network pose not only opportunities but also constraints for a focal firm’s governance choice and competitive advantage. From an opportunities stand point, an established network may provide a focal firm access to valuable and rare resources (Baum, Calabrese & Silverman, 2000; Zaheer & Bell, 2005; Aldrich & Zimmer, 1986), transaction cost wise economic efficiency (Gulati, 1995), increased chance of recognizing and discovering opportunities (Arenius & Clercq, 2005; Singh, Hills, Hybels, & Lumpkin, 1999), and better adaptation to changing environment (Kraatz, 1998; Granovetter, 1973).

Generally shared assumptions across this set of studies state that exit from and entry into network can flexibly occur and that switching to the network relation that provides better resources is beneficial (Kim, Oh, & Swaminathan, 2006). Another assumption is that the extent of deliberate management of network relations is not low. If a focal firm controls certain capabilities,  

\textsuperscript{17}Safeguard, coordination, and adaptation
it can deliberately configure and manage the structure of a network which it belongs to (Aldrich et al., 1987; Anand & Khanna, 2000; Dyer & Noboeka, 2000; Hite & Hesterly, 2001). For instance, the extent of deliberate management of a network increases with increase in reputation, social status, network experience, and opportunities for network adaptation (Burton et al., 1998; Eisenhardt & Schoonhoven, 1996; Hite & Hesterly, 2001). Studies drawing on TCE, resource dependency theory, and neo-institutionalism generally at least implicitly employ this assumption (Kim, Oh, & Swaminathan, 2006).

On the other hand, another stream of research (e.g., Baum & Singh, 1994a; Burton, Sorenson, & Beckman, 1998; Larson & Starr, 1993; Hite & Hesterly, 2001; Arino & Torre, 1998; Reuer, Zollo, & Singh, 2002; Ring & Van de Ven, 1994) suggests that the extent to which network can be deliberately managed is inherently limited. There exists inertia impeding a focal firm from controlling a network of inter-firm relations, such as path dependence in network formation (Gulati & Gargiulo, 1999), relation specific routines (Gulati, 1995; Zollo, Reuer, & Singh, 2002), asset specific investment in a dyad (Levinthal & Fichman, 1988; Ebres, 1999), and other constraints in network change (Arino & Torre, 1998; Reuer, Zollo, & Singh, 2002; Ring & Van de Ven, 1994; Kim, Oh, & Swaminathan, 2006).

These two contrasting roles of network suggest that extant studies on governance choice, in particular those drawing on organizational economics, do not take into account the constraints caused by evolutionary process in network formation and thereby governance choices. In addition, this is one of the important backgrounds that explain why this study frames firm activities by means of adaptive search.

*Research Question. How does the evolutionary process in inter-firm network formation affect governance decisions?*
Research Question. To which extent can a management team deliberately change inter-firm network structure? What determines that extent?

Research Question. How do inertia in inter-firm interdependencies and emergent properties of network formation affect governance choices?

Economic Efficiency, Evolutionary Efficiency, and Discriminating Alignment

There have been criticisms on the earlier version of transaction cost economics (e.g., Coase, 1937) that this theory is subject to tautology (Robins, 1987; Perrow, 1979, 1981). As a response to the criticism, several studies (e.g., Williamson, 1975; Ouchi, 1980) applied the logic of economic efficiency borrowed from neoclassical microeconomics to further theorize transaction cost economics (Robins, 1987). The central logic of this approach is that an organization’s choices of governance form under specific environmental conditions are determined by the economic efficiency of the alignment between attributes of transaction and governance form. In the short run, inefficient firms may also survive. Hence, in the cross section, one may observe a mixture of transaction cost-wise efficient and inefficient firms. In the long run, should the market reach equilibrium(s), inefficient firms will be selected out and thus only transaction cost minimizing firms will be observed as being in an equilibrium state. In this sense, TCE presumes evolutionary efficiency (Aldrich, 1999).

However, as Robins (1987) and other related studies (e.g., Granovetter, 1985) pointed out, economic efficiency logic can be rigorously applied only when the market is perfectly competitive. Conditions for the perfect market are very stringent. In addition, TCE often deals with highly imperfect market situations; firms are heterogeneous in terms of productive inputs, differential hazard mitigating capability, etc. In this line of reasoning, evolutionary efficiency assumed in TCE is questionable. Distinction between short-term and long-term equilibrium also matters.
Discriminating alignment approach is one way of applying economic efficiency logic to governance choice theory. Discriminating alignment approach has been explicitly and implicitly applied to many studies on governance choice that draw upon organizational economics (e.g., Williamson, 1991, 1975) as well as the problem solving perspective (e.g., Nickerson & Zenger, 2004; Leiblein & Macher 2009).

Research Question. Under which conditions (such as firm level heterogeneity and market imperfections) will the discriminating alignment approach be biased? How does network endogeneity in governance choice affect evolutionary efficiency in governance choice?
Figure 2.1 A Model of Endogeneity in Governance and Network
Figure 2.2 A Fully Specified Model of Governance & Network Evolution
Figure 2.3 Asset specificity and governance choices

Figure 2.4 Asset specificity and the distribution of degree centrality
Figure 2.5 Asset specificity and the distribution of clustering coefficient

Figure 2.6 Asset specificity and the distribution of tie strength
Figure 2.7 Initial network structures and governance choices

Figure 2.8 Variances in resource strength and the distribution of degree centrality
Figure 2.9 Variances in resource strength and the distribution of clustering coefficient

Figure 2.10 Variances in resource strength and the distribution of tie strength
**TABLES**

**Table 2.1 Parameterization of Governance Forms**

<table>
<thead>
<tr>
<th>Governance Functionality</th>
<th>Parameterization</th>
<th>Governance Form</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Market (M)</td>
</tr>
<tr>
<td>Coordination</td>
<td>Resource interaction discount rate $\omega$</td>
<td>High discount</td>
</tr>
<tr>
<td>Safeguard</td>
<td>Probability of Opportunism: $p_\omega$</td>
<td>A function of network structure</td>
</tr>
<tr>
<td>Adaptation</td>
<td>Fit</td>
<td>Autonomous</td>
</tr>
<tr>
<td>Value appropriation</td>
<td>Contribution ration $C_{iy}$</td>
<td>Proportional to resource contribution</td>
</tr>
<tr>
<td>Remark: Resource</td>
<td>Contract period $r$</td>
<td>Temporary (1 period)</td>
</tr>
</tbody>
</table>
CHAPTER 3

Sub-additivity in Resource Combinations: Implications for M&A

3.1 INTRODUCTION

Super-additivity in resource combinations and its related concepts have been deployed in various streams of strategy research, in the context of diversification, mergers and acquisitions, and resource based view (e.g., Lubatkin, 1987; Jensen & Ruback, 1983; Bradley, Desai, & Kim, 1988; Seth, 1990; Palich, Cardinal, & Miller, 2000; Grant, 1988; Barney, 1988; Bruner, 2004; Itami 1987; Wernerfelt, 1984; Penrose 1959; Porter, 1985; Markides & Williamson, 1994; ; Anand & Singh, 1997; Capron, Mitchell, & Swaminathan, 2001; Lubatkin and O’Neill, 1987).

In principle, super-additivity in resource combinations is said to occur when the value of combined resource stock is larger than the sum of values of individual resource stocks. Super-additivity in resource combination has been attributed to the redeployment of fungible resources and elimination of redundant resources. More resources are seen as better and relatedness among these resources has been argued to be a source of value creation18.

18 For example, in the context of M&A, Merging firms can enhance efficiency by selling off overlapping resources in the secondary factor market (Anand & Singh, 1997; Capron, Mitchell, & Swaminathan, 2001). In particular, this efficiency gain increases when the merging firms are more related, because related firms tend to share more overlapping resources in comparison with less related firms (Jensen & Ruback, 1983; Seth, 1990; Dussauge, Garette, & Mitchell, 2000).
However, this study argues that the same conditions which previous research has attributed to super-additivity can lead to sub-additivity, in which case the value of combined resource stock is smaller than the sum of values of individual resources. In other words, sources of value creation that previous studies underscore can be sources of value destruction at the same time.

We argue that it is important to take into account the potential value destruction as a function of the intra- and inter-firm transferability of resources in addition to the value creating opportunities. Intra-firm transferability corresponds to the ‘fungibility’ property of the resource, and inter-firm transferability corresponds to the ‘tradability’ attribute of the resource.

The greater the fungibility of resources from different firms, greater the potential post-resource combination overlap among them since one firm’s resource can now be substituted by the redeployment of the other firm’s resources. Further, such potentially overlapping resources may not be tradable (Dierickx & Cool, 1989). In reality, resources have different levels of tradability. For instance, there are corporate assets, such as brand and reputation, which require significant investments over a period of time, but cannot be sold in the market.

Therefore, this study suggests that overlaps among combining resources may lead to value destruction rather than to efficiency enhancement, when redundant resources are fungible and not perfectly tradable. In other words, irrecoverable overlaps in resource combinations will lead to sub-additivity – the sum of resources after combination is smaller than the arithmetic summation of individual resources before combination.

The purpose of this study is to identify the conditions for value destruction in resource combinations. Previous models have only considered the positive aspect of synergistic potential in resource combinations by taking into account economies of scale and scope as well other gains from dynamic learning opportunities in a Penrosian model of firm growth, but have ignored the potential negative outcomes. We do not deny the positive possibilities, but our study offers the counter-intuitive possibility that the intra-firm transferability (fungibility) and lack of inter-firm
transferability (non-tradability) of related resources can destroy value in resource combination, and provides a lens to re-interpret the mixed findings in the literature.

In the rest of the paper, this study further identifies which resource attributes and mechanisms constitute the fungibility and non-tradability of resources. We provide theoretical reasoning on the conditions under which such sub-additivity in resource combinations can occur. This study explores these issues with multiple levels of analysis: resource level, dyad level, and industry level. We build a formal model of resource combinations and conduct agent based simulations, in order to perform more fine grained analyses on the conditions of value-destruction in resource combinations.

Finally, in discussion section, this research applies the theoretical lens of sub-additivity to previous research on M&A and resource based view. Sub-additivity interpretation of value destruction casts light on previous studies’ mixed empirical findings on M&A performances (Lubatkin, 1987; Seth, 1990; Palich, Cardinal, & Miller, 2000; Grant, 1988; Barney, 1988; Bruner, 2004). Some incompletely explained empirical findings in domestic and cross-border M&A studies (e.g., Arikan, 2004; Doukas, 1995; Doukas & Travlos, 1988) can be interpreted with our theoretical lens of sub-additivity in resource combinations. This research provides an alternative explanation to agency and hubris for poor M&A performance.

3.2 BACKGROUND

The concept of super-additivity and sub-additivity in resource combinations is defined. Determinants of fungibility and tradability of resources are discussed. Mergers and acquisitions (M&A) provide an opportunity to study how resource stocks from distinct origins interact with one another. Given this framework, we review M&A literature from a perspective of sub-additivity and super-additivity in resource combinations.
3.2.1 Interactions between Resource Stocks

Interaction among resource stocks is one of most frequently deployed concepts in strategy literature. For instance, the logic of synergy\(^{19}\), one type of interaction between resources, forms the basis of many studies: the Penrosian model of firm growth (Penrose 1959; Itami 1987), the leverage of core competence and shared activities in diversification (Wernerfelt, 1984; Barney, 1988; Nayyar, 1990), resource redeployment (Anand & Singh, 1997; Capron, Mitchell, & Swaminathan, 2001), and exploitation of relatedness in M&A (Lubatkin and O’Neill, 1987; Nayyar, 1992; Barney, 1997; Porter, 1985; Markides & Williamson, 1994). A logic commonly held across these sets of research is that the exploitation of complementary and related resources leads to positive gains. The other common logic deployed in the aforementioned line of research is that, by pooling related resources together, redundancy can be eliminated, and this leads to efficiency enhancement (e.g. Jensen & Ruback, 1983; Seth, 1990; Dutz, 1989; Anand & Singh, 1997; Hoskisson, Johnson, & Moesel, 1994).

However, these approaches may implicitly presume that redundant resources are tradable and thus can be sold off in the secondary factor market. In reality, resources have different levels of tradability. For example, when redundancies involve excess labor force, real estate or

\(^{19}\) Itami (1987) identifies two kinds of positive gains through exploitation of complementary resources: ‘complement effect’ and ‘synergy’. Most generally observed complement effect comes from utilizing the same physical asset over multiple lines of businesses. A second source of complement effect stems from physical assets which are not used with equal intensity over a cycle. A third type of complement effect can be realized when the level of physical resources required to operate in a given market fluctuates.

On the other hand, the essence of ‘synergy’ lies in simultaneous use of asset at no additional cost. Since invisible assets exhibit such attributes, synergy is mostly derived from invisible or intangible type assets. An implication of the differences in the source of complement effect and synergy is that synergy is multiplicative but that complement effect is additive (Itami, 1987).
manufacturing plants, they can lead to higher efficiency and thus value creation, since such assets are generally tradable and easy to dispose off in the relevant markets (Capron, Dussauge & Mitchell, 1998). On the other hand, due to its intangible nature, a brand is generally difficult to trade in the market relative to tangible resources such as warehouses or manufacturing plants.

Furthermore, contrary to conventional wisdom, the fungibility of resources can also be a source of sub-additivity in resource combination. If an activity or a resource is fungible, it can be applied to a wider scale without a commensurate increase in costs. Thus, due to this public good nature, the fungibility of resources has been regarded as a source of synergy in many studies in diversification and mergers & acquisitions (Anand & Singh, 1997; Capron, Dussauge & Mitchell, 1998). However, the extent of potential overlap between resources is the function of their fungibility. A highly fungible resource’s attribute of wider applicability at low marginal cost implies higher overlap between highly fungible resources. Thus, if resource is not perfectly tradable, resource redundancy due to the fungibility of resource results is a source of value destruction in resource combination.

The degree of resource fungibility is determined by intangibility and the position along the value chain where a focal resource is deployed. In general, intangible resources are more fungible than intangible resources (Itami, 1986). Once developed after incurring upfront fixed cost, additional deployment of intangible resources to other business lines or markets does not incur commensurate marginal cost. This kind of resource property is also referred to as public good property of resources (Caves, 1971) and excess resources (Penrose, 1959). In addition, resources deployed to upper stream of the value chain are in general are more fungible. Market and geographic specificity of downstream resources and capabilities are higher than that of upstream ones, making downstream resources less fungible (Anand & Delios, 2002).

Non-tradability stems from various reasons including indeterminacy of resource value or market failure (Akerlof, 1970), asset specificity (Williamson, 1985), path dependence (Nelson &
Winter, 1982; Dierickx & Cool. 1989), limited modularity (Simon, 1962), and indivisibility (Penrose, 1959; Mishina, Pollock, & Porac, 2004). Despite the existence of market mechanisms fail if price is indeterminable due to valuation problem and/or information asymmetry between a buyer and a seller. In the presence of co-specialization of assets, not only the second best value of a focal resource decrease to large extent, but also the modularity of the focal resource is limited. Path dependence in the process of resource accumulation increases the degree of context specificity of resources and capabilities. Table 3.1 summarizes above discussed determinants of resource fungibility and tradability.

In Table 3.2, we suggest a resource typology which is based on two key resource attributes that affect sub-additivity. First, a financial resource such as free cash flow is an example of highly fungible and highly tradable resource. Due to high level of fungibility, a focal firm can redeploy this type of resource into another business lines within the boundary of the firm, without loss of its value. Also, due to high level of tradability, this kind of resource can be traded through market means, without loss of its value. Second, distribution network is an example of resources that are tradable but not fungible. Owing to its tangibility, it is easily tradable to other firms in the market, without large value loss, but the level of fungibility of it is low precisely due to its tangibility and location-specificity. Further use of distribution network should entail commensurate increase in investment of warehouses, retail stores, trucks, etc. Third, brand assets or asset-specific technologies pertain to fungible but less tradable resources. Within the firm boundary, they can be redeployed without incurring significant additional marginal costs. However, due to intangibility and market failure, it cannot be easily traded through market means (Capron et al., 1998). In case of asset-specific technology, asset specificity further inhibits it from being traded in the market without loss in value. Lastly, one example of less fungible and less tradable resources is an asset-specific manufacturing plant. Its fungibility is low due to its tangibility, and tradability is also low due to its asset specificity, although it is a tangible resource.
Since value destroying mechanism coexists with value creating mechanism of fungibility, the overall outcome of resource combinations can be either sub-additive or super-additive, depending on the degree of tradability and fungibility of resource to be combined.

### 3.2.2 M&A Performance and Typical Explanations

M&A is a good setting for examining resource combinations, resource interactions and potential sub-additivity. The process of M&A involves taking two firms that had existed independently and then combining them into one. In this regard, when the firm is conceptualized as a bundle of resources, an M&A transaction is equivalent to a combination of resources of two firm origins. Focal firms in M&A, in reality, may remain independent going concerns even after M&A is implemented (Haspeslagh & Jemison, 1991). Indeed, if two firms are managed independently without actually being combined after M&A, the motivation for this M&A is driven by ownership or control concerns. Thus, this kind of M&A transaction is not grounded on any managerial rationale such as value creation through the exploitation of scale economies and is likely to yield simply an additive outcome in terms of resource combination, rather than a super- or sub-additive one. For the purpose of this study, we focus on managerial issues of M&A relevant to resource combinations and thus disregard such transactions driven primarily by ownership and control issues.

In M&A and diversification literature, several forms of strategic relatedness between firms as sources of value creation, have been identified (e.g. Lubatkin, 1983; Lubatkin & O’Neill, 1987; Jensen & Ruback, 1983). However, empirical research on M&A has shown consistently over several decades that acquiring firms rarely benefit financially from such transactions (Kitching, 1967; Jensen & Ruback, 1983; Singh & Montgomery, 1987; Bradley, Desai, & Kim, 1988; Anand & Singh, 1997; Capron & Pistre, 2002). Several drivers of value creation and value destruction in M&A have been identified.
Table 3.3 summarizes the mechanisms of good and bad M&A performance and their corresponding theory. Extant literature on M&A typically considers drivers of good M&A performances such as market power, risk reduction through diversification, cost reduction through scale economies, and leverage of resources. Among them, the first two drivers can be realized through either unrelated or related M&A, but the latter two factors can be realized only through related M&A.

Based on industrial organization theories, several studies (Scherer, 1980; Caves, 1981; McCutcheon, 1991; Sobel, 1984; Bolton and Scharfstein, 1990) found that increase in firm size through unrelated diversification is associated with good firm performance, because larger firm size confers higher level of market power. Meanwhile, several other studies cast doubt on this finding and found that unrelated diversification had limited effects on positive firm performance (Kreps and Wilson, 1982; Milgrom and Roberts, 1982; Saloner, 1987) or that empirical results are confounded (Geroski, 1995; McCutcheon, 1991).

Horizontal extension of resource bases through M&A may lead to economies of scale and thus cost reduction (Seth, 1990; Capron, 1999). In addition, asset divestiture following horizontal M&A enhances efficiency, because redundant resources and slack resources are disposed off (Jensen & Ruback, 1983; Anand & Singh, 1997; Dutz, 1989; Hoskisson, Johnson, & Moesel, 1994). Leverage of resources into multiple lines of businesses confers on merging firms synergistic gains through economies of scope (Barney, 1988; Nayyar, 1990; Wiersema & Liebeskind, 1995). Also, unless resources are not perfectly correlated, diversification through M&A decreases the level of risk (Seth, 1990).

On the other hand, the extant M&A literature has also identified several drivers of poor M&A performance: e.g., hubris, agency, and post merger integration. Managers frequently attribute the M&A performances far below their expectations to integration and implementation issues (Smith, 2000). Agency (Jensen, 1988) and hubris (Roll, 1986) perspectives provide
explanation that managers do not have the right incentives or beliefs to act in accordance with more objective observations.

The hubris (Roll, 1986) argument states that bidding firms do not have correct expectation about the values of target firms and thus, pay too much for targets. Also, hubris impacted bidding firms are likely to believe that they possess superior managerial capabilities than target firms’ managers. The gains to shareholders of a target firm do not necessarily stem from synergistic gains, but rather wealth of shareholders of an acquiring firm is transferred to shareholders of a target firm.

The agency perspective reveals that while the shareholders of a target firm usually benefit from M&A, the managers of the target firm may not. Managers of a target firm may lose their positions due to M&A, and managers have poor incentives to pursue their shareholders’ interests, i.e. they are likely to block takeovers. On the other hand, managers of the acquiring firm tend to enhance their positions and compensation, so they seek to make acquisitions even when they are not appropriate from a shareholder perspective (Jensen, 1986; Jensen, 1988). This perspective provides another explanation for managers’ pursuit of poorly performing M&A strategies.

Post-merger managerial challenges are another driver of poor M&A performance. Since acquiring and target firms develop and exist independently, each firm has its own organically developed routines. Due to path dependence and inertia of routines (Nelson & Winter, 1982; Dierickx & Cool, 1989), it is generally difficult to combine two sets of routines; it is often the case that one routine replaces the other. In the same vein, different corporate cultures impede post merger integration processes (Haseslagh & Jemison, 1991).

We claim that in tandem with these drivers of value creation and value destruction, subadditivity in resource combination or M&A is another important driver of value destruction. Indeed, the standard practice of determining the acquisition price to be paid for the target firm involves estimating the present values of future synergies net of implementation costs and adding
them to the existing (pre-announcement) market price (Copeland, Koller, & Murrin, 2000). This method assumes that while new value may be created through synergies, the value of the original firm stays intact. However, our lens of sub-additivity in resource combinations suggests that in estimating premium for acquisition of a target firm, managers of an acquiring firm should take into account of possible loss in original firm value due to sub-additivity in resource combination.

3.3 METHODOLOGY

For a fine grained analysis of conditions for sub-additivity in resource combination, we develop a formal model which is in turn, an input for computational analysis. In this model, a firm is represented as a bundle of resource stocks. Each resource stock is operationalized by means of one variable, resource strength, and two parameters, fungibility and tradability.

The outcome of resource combination is measured by value creation (Brandenburger & Stuart 1996) and rent created from a firm’s bundle of resources. Value creation is formalized as the difference between a consumer’s willingness to pay and a firm’s opportunity cost of offering to another consumer. A sub-additive resource combination is defined as an outcome in which the rent generated from combined resource stock is smaller than the sum of rents from each individual resource before resource combination. The probability of sub-additivity is operationalized as the ratio of the number of sub-additive resource combination outcomes to the total number of such outcomes.

This study assumes that combined resource stocks reside in a focal firm’s boundary. In other words, only M&A is considered as a case of resource combinations. Alliances for resource combinations are excluded from our model. Based on this setup we build a formal model for agent based simulation. Table 3.5 recaps the variables and parameters in the model and
3.3.1 Model

The supply side consists of \( N \) firms, characterized by resource strength, value creation, aggregate value creation, and resource rent.

*Firm:* Each firm is conceptualized as a bundle of resource stocks. The number of resource stocks of each firm is represented by \( q \). For a baseline model, \( q \) is twofold. Twofold resource stocks model can generate implications without loss of generality.

*Resource Stock:* Dierickx & Cool (1989) define two types of resource as flow and stock resource. Flow resources can be changed within a short term horizon, but stock resources cannot be altered in a short term, and a firm has to invest for a long time to develop stock resources such as technology and brand names.

In principle, two types of interactions may exist between resource stocks. The first type of interaction lies between the resource stocks within a focal firm and the second type between the resource stocks of two merging firms in the context of resource combination. For example, suppose that two focal firms which respectively consist of two resource stocks: a technology resource stock and a brand resource stock. If a focal firm is gaining competitive advantage in product markets by deploying valuable and rare technology resource stocks, this will lead to further development of brand resource stock through accumulation of resource flows stemming from positive consumer feedback. This kind of indirect interaction between resource stocks is an instance of the first type of resource interaction. On the other hand, in the context of merger of two focal firms, two technology resource stocks of the two firms may lead to a single larger resource stock if two technology resource stocks are complementary, and an inferior brand resource stock may not be deployed while superior brand resource stock is retained. This kind of direct interaction between the resource stocks of two focal firms is a case of the second type
resource interaction. For the sake of simplicity, we ignore in this study the first type of interactions between different types of resource stocks, and instead focus on interaction between the same types of resource stocks between firms: resource combination.

**Resource Strength**: We specify resource strength as the effectiveness of a resource stock in generating value to demand side (Capron & Hulland, 1999). Resource strength of \(q^{th}\) resource stock of a firm \(i\), \(r_{i}^{(q)}\), is denoted by \(\phi_{i}^{(q)}\). Resource strength of a firm \(i\) is drawn from certain probability distribution, and in this study we use normal distribution with standard deviation \(\sigma\) and mean \(\mu\):

\[
\text{(Eq. 1)} \quad \phi_{i}^{(q)} \sim N\left(\mu^{(q)}, (\sigma^{(q)})^2\right), q \in \{1,2\} \text{ and } i \in \{1,\ldots,N\},
\]

where \(N\) is the total number of firms in an industry.

This resource construct is uni-dimensional, in that resource stock is measured only in terms of resource strength. The generalized resource combination model can be extended into a multi-dimensional construct.

**Resource Attributes**: We operationalize two resource attributes: fungibility and tradability of resource stock, which correspond to the intra- and inter-firm transferability of the resource, respectively. The coefficient of fungibility, denoted by \(\varepsilon\), specifies the efficiency of resource transfer within the firm boundary. Accordingly, when a resource stock in a firm \(j\), \(r_{j}^{(q)}\), with resource strength \(\phi_{j}^{(q)}\) is redeployed to a firm \(i\) (within the firm boundary after merger), resource strength of transferred \(r_{j}^{(q)}\) becomes \(\varepsilon \cdot \phi_{j}^{(q)}\). Fungibility, \(\varepsilon\), ranges from 0 to 1, and a perfectly fungible resource corresponds to \(\varepsilon\) of 1.

Coefficient of tradability, represented by \(\tau\), relates to the extent to which a resource stock can be sold off through market means. In other words, coefficient of tradability denotes transferability of resource to another firm, outside of the firm boundary. Consequently, when a resource stock in a firm \(j\), \(r_{j}^{(q)}\), with resource strength \(\phi_{j}^{(q)}\) is sold off to a firm \(i\) outside of the firm
boundary, resource strength of transferred $r_j^{(q)}$ becomes $\tau \varphi_j^{(q)}$. $\tau$ ranges from 0 to 1, and the coefficient of tradability, $\tau$, of a perfectly tradable resource stock is 1.

**Resource Combination:** Given the concepts of tradability and fungibility of a resource stock defined above, we provide a model of resource combination as follows:

(Eq. 2) $\Phi(i_i^{(q)} \cup j_j^{(q)}) = \Phi(i_i^{(q)} + j_j^{(q)} - i_i^{(q)} \cap j_j^{(q)}) = \varphi_i^{(q)} + \varphi_j^{(q)} - \epsilon(\min[\varphi_i^{(q)}, \varphi_j^{(q)}])$

(Eq. 3) $\Phi(i_i^{(q)} \cap j_j^{(q)}) = \epsilon \cdot (\min[\varphi_i^{(q)}, \varphi_j^{(q)}])$

(Eq. 4) $T = \tau(\epsilon \min[\varphi_i^{(q)}, \varphi_j^{(q)}])$

(Eq. 5) $Z = f(T, k)$

(Eq. 6) $Z^* = \text{Max}_k[f(T, k)]$, such that $k = k^*$ maximizes $f(T, k)$,

where $i$ and $j$ respectively denotes an acquiring firm and a target firm, and $k$ another competing firm. In addition, $\epsilon$ denotes fungibility, $\tau$ tradability, $T$ tradable overlapping resource, $Z$ value recovery through selling off $T$, and $f(\cdot)$ resource trade function. $\Phi(r)$ represents resource strength of a resource stock $r$.

Equation 2 basically states that resource strength of the resource stock which results from combining firm $i$'s and $j$'s $q^{th}$ resource stocks is equivalent to the arithmetic sum of each resource stock’s strength less overlapping resource. A focal firm maximizes its value by retaining superior resource stock out of two overlapping resource stocks and selling off inferior resource stock. As equation 3 clarifies, the extent of resource overlap is proportional to the coefficient of fungibility of resources to be combined.

In equation 4, tradable part of overlapping resource is equivalent to overlapping resource multiplied by the coefficient of tradability. Equation 5 specifies salvage value of overlapping resource. When overlapping resource $T$ is sold off to a firm $k$, $Z$ is the magnitude of additional
aggregate value creation that a firm $k$ obtains. Resource trade function $f(\cdot)$ is such that the remaining $N-2$ firms except for the two focal firms that perform a resource combination bids for $T$, and an exchange of $T$ is established between the focal resource combining firms and the firm which can make the most value out of $T$, $k^*$. This maximized value of $Z$ is $Z^*$ in equation 6.

For an illustration of resource combination, we take an example of resource combination of hypothetical brand resource stocks. Brand resource stock is an example of fungible resource, and we assume, hypothetically that it is perfectly fungible ($\varepsilon = 1$) and also perfectly non-tradable ($\tau = 0$).

In the case of such a fungible and non-tradable resource (brand), the whole part of the second best fungible resource becomes obsolete (due to public good nature of fungible resources and non-tradability of the resources). Hence, the following combination rule holds for perfectly fungible resources:

$$\text{(Eq. 7) } \varphi_i^{(1)} + \varphi_j^{(1)} = \text{Max} [\varphi_i^{(1)}, \varphi_j^{(1)}]$$

Note that equation 7 immediately follows from equation 2, when $\varepsilon$ is substituted with 1. Due to perfect non-tradability, $T$ is zero according to equation 4.

**Value Creation:** This study defines the performance of resource combination as the magnitude of rent stemming from the deployment of combined resources, and rent is defined by the value creation from resources. With added-value analysis framework (Brandenburger & Stuart, 1996; Adner & Zemsky 2006), value creation from a firm’s offer is the difference between the willingness to pay of a consumer and the firm’s opportunity cost of offering to an additional consumer. Hence, value creation from a unit of offer of a firm $i$ to a consumer $p$ can be represented by the following equation where we denote value creation as $v$, willingness to pay as $w$, and opportunity cost as $c$.

$$\text{(Eq. 8) } v_i = w_p - c$$
The relationship between two resource stocks can be of two types: multiplicative and additive (Itami, 1987). In this study, we assume that the relationship between \( r_i^{(1)} \) and \( r_i^{(2)} \) is multiplicative. Hence, willingness to pay, \( w_p \), is proportional to the product of \( \varphi_i^{(1)} \) and \( \varphi_i^{(2)} \). Thus, value creation from firm \( i \)'s offer \( l \) to a consumer \( p \) is

\[
(Eq. \ 9) \ v_i = w_p - c = a \left( \varphi_i^{(q=1)} \varphi_i^{(q=2)} \right) - c,
\]

where \( a \) is a proportional constant with a positive value. Opportunity cost \( c \) is broken down into two parts: marginal cost \( c_v \) and fixed cost \( c_f \).

Whereas value creation measures the magnitude of value added to an individual consumer \( p \), we are interested in the magnitude of total value creation that a bundle of resource of a firm generates. Aggregate value creation \( V_i \) measures this quantity and is the sum of value creation made to each consumer who purchased an offer from firm \( i \):

\[
(Eq. \ 10) \ V_i = \sum_{p=1}^{n} \delta_p v_i = \sum_{p=1}^{n} \delta_p [a \left( \varphi_i^{(q=1)} \varphi_i^{(q=2)} \right) - c_v] - c_f,
\]

where \( \delta_p \) has value of 1 if consumer \( p \) purchased an offer from firm \( i \) and 0 otherwise.

**Resource Rent:** Rent created from a firm’s bundle of resources can be calculated by the amount of value which the firm adds to a market (Brandenburger & Stuart, 1996). If there is no competitor, added value is equivalent to aggregate value creation, the sum of value creations to demand side. However, when there exists rivalry in a participating market, added value is the aggregate value creations relative to next best aggregate value creation\(^{20} \). In order to compute resource rent from each firm, aggregate value creation for each firm is calculated first. Then, descending sorting is performed as to aggregate value creation, and resource rent is computed by

\^{20} According to Brandenburger & Stuart (1996), when there exists rivalry in a participating market, added value is the aggregate value creations relative to consumers’ next best alternatives. Here we use a simplified version of that approach.
the following rules:

(Eq. 11) \[ R_i = V_i - V_b, \quad j \in -i, \quad if \ V_i > 0 \]
\[ R_i = 0, \quad j \in -i, \quad if \ V_i < 0 \]

, where \( i \) represents a focal firm, \( V_b \) minimally positive value creation in the market, and \( R_i \) rent from a focal firm.

**Scale economy:** When two focal firms combine their resource stocks, the value of two focal firms may be enhanced by scale and scope economies. Value enhancement is realized by the spread of fixed cost, elimination of redundancies, risk reduction, exploitation of core competence, etc. In this model, scale and scope economies manifest in the reduction of opportunity cost, \( c \) in the equation 8. Per unit cost of an offer by a consolidated firm is inversely proportional to the summation of resource strengths of all resource stocks.

(Eq. 12) \[ c_v = c_0 \times \alpha \times \frac{1}{\sum \varphi_i^{(q)} + \sum \varphi_j^{(q)}}, \]

where \( i \) denotes a focal firm, \( j \) a target firm, and \( c_0 \) the basis value of opportunity cost. \( \alpha \) represents the extent to which the size of resource bases influences scale economies.

**Degree of Sub-additivity:** A sub-additive resource combination is defined as an outcome in which rent generated from a combined resource stock is smaller than the sum of rent from each individual resource stock before resource combination. The opposite case is defined as a super-additive outcome. Hence, we define the degree of sub-additivity as follows:

(Eq. 13) \[ S = \frac{\Delta R}{R} = \left[ R_{i+j} - (R_i + R_j) \right]/[R_i + R_j] \]

where \( i \) represents a focal firm, \( j \) a firm with target resource stocks, \( i + j \) two focal firms with consolidated resource stocks. If \( S \) is positive, resource combination outcome is super-additive. If \( S \) is negative, the result of resource combination is sub-additive. The smaller the \( S \), the more sub-additive resource combination outcome is.
The probability of sub-additivity is operationalized as the ratio of the number of sub-additive outcomes to the total number of resource combinations.

**Measurement of M&A Performance:** M&A and alliance are used to govern interfirm resource combination (Wang & Zajac, 2007). This study considers only M&A as an example of resource combination. The focus of this study in measuring M&A performance is on value creation *per se*, rather than the issue of value appropriation between an acquiring firm and a target firm. This, we are interested in M&A performance independent of premium paid in order to concentrate on the issue of sub-additivity in value creation. In fact, equation 13 already reflects this issue, and the degree of sub-additivity defined in the equation 13 is a measure of the overall M&A performance of the merged firm.

**Demand Side:** *n* homogeneous consumers comprise the demand side. The demand side is simplified as much as possible in the model so that we may focus on resource combination on the supply side. Each consumer compares the magnitude of utility of offerings of all firms. This magnitude of utility is equal to the magnitude of value creation, $v_i$, which is specified in equation 8. The likelihood that each consumer purchases an offering from a firm $i$ increases with the magnitude of $v_i$. Due to information asymmetry between supply and demand side, it does not happen deterministically that each consumer chooses the firm with the highest value creation. Each consumer purchases with probability $p_c$, from the firm that offers the highest utility. Probability $p_c$ measures the degree of information asymmetry and relates to the extent to which each consumer knows the quality of offerings, $v_i$, from the firms in the market.

**Market Structure and Competition:** The ratio of the number of firms to the number of consumers, $n/N$, partially captures the extent of rivalry in a given market, in that each firm competes for a limited number of consumers and that the likelihood of each consumer’s purchasing a firm’s offering increases with the resource strength of itself.

In addition, the resource distribution of firms represents another dimension of market
structure. As indicated in the equation 1, two parameters $\mu$ and $\sigma$ characterizes the distribution of resources across $N-2$ competitors in the market. If focal firm’s resource strength is $\phi_1^{(q)}$, the following comparative statics specifies competitive advantage of focal firms relative to the market or competitors, in terms of resource strength:

$$ (\text{Eq. 14}) \quad C = \phi_1^{(q)} - \mu^{(q)} $$

If $C$ is positive, a focal firm has competitive advantage to its competitors on average, in terms of resource strength. If $C$ is negative, focal firm possesses competitive disadvantage on average to competitors. If $C$ is zero, a focal firm is at competitive parity to competitors on average, in terms of resource strength.

### 3.3.2 Simulation

The above model is translated into agent based simulation code. Each firm is conceptualized as an agent with a set of behavioral rules and variables that represent the states of an agent. Simulation code is implemented in the C++ programming language.

The steps that a single run of simulation goes through are as follows. The steps are in large categorized into two parts. One is an ex merger stage: step 1 to 3, and the other is a post merger stage: step 4 to 6. In the first step, parameters are set and all the variables are initialized. Resource strengths of focal firms are set with given parameters, and resource strengths of other firms are randomly drawn from a well defined probability distribution. Second, given resource profiles set in the first step, the magnitudes of value creations are calculated. Next, demand side adoption occurs. Based on the magnitude of value creation, each consumer decides from which firm to purchase a unit of offer. Third, the total value creation and rent that each firm has generated are calculated. Fourth, resource combination between two focal firms is performed. Fifth, the same procedure from the second step to the fourth step is performed so that total value creation and rent after resource combination can be calculated. Finally, degree of sub-additivity is
calculated, according to equation 13. This simulation flow is repeated with a fixed set of parameters and the probability of sub-additivity is obtained.

For each set of simulation parameters, a simulation run is realized 200 times and then the probability of sub-additivity is calculated. For instance, with a fixed set of simulation parameters, if 200 trials resulted in 80 sub-additive outcomes, the probability of sub-additivity under the condition of given set of parameters is 0.4. This repetitive process is similar to standard Monte Carlo simulation method and also to other applications of agent based simulation method to strategy research (e.g. March, 1991; Levinthal, 1997; Rivkin, 2000; Ethiraj & Levinthal, 2004; Siggelkow & Rivkin, 2006; Ganco & Agarwal, 2009; Davis, Eisenhardt, & Bingham, 2009; Fang, Lee, & Schilling, 2010; Lenox, Rockart, & Lewin, 2006.).

3.4 PROPOSITIONS & SIMULATION RESULTS

Based on the above described model, we conducted simulations using agent based computational approach. Simulation results are used to derive our propositions in regards to some core conditions, under which sub-additive post-acquisition outcomes are likely. The extent of sub-additivity is determined by the differential between rents stemming from combined resources ex post and ex ante resource combination. In turn, the magnitude of rent from combined resources is determined by multiple factors such as resource attribute per se, dyadic relationships between resources, demand side attributes regarding value creation, degree of competition, etc. Thus, factors at the multiple levels - resource, dyad, and industry levels - are suggested to determine the extent of sub-additivity in resource combinations.

We organize the simulation results corresponding to separate conditions for sub-additivity as follows: first, the link between resource level attributes and sub-additivity is theorized and examined in proposition 1 and 2; second, the link between dyad level properties and sub-
additivity in proposition 3 and 4; third, the link between industry level properties and sub-additivity in proposition 5 through 7; and lastly, how the presence of synergistic gains in resource combinations affects sub-additivity, vice versa, is examined.

3.4.1 Irrecoverable Resource Redundancy due to Resource Fungibility and Non-tradability

At the heart of value loss in resource combination lies resource overlap which is not recoverable through any market means. When overlapping resource is tradable through any market means, redundancy has neutral or positive performance implications in resource combination. However, if redundant resource is not perfectly tradable, redundancy cannot be recovered, leading to value loss.

For example, consider two hypothetical firms A and B with identical products. Firm A controls brand $\alpha$ and distribution network I that is composed of retail stores, warehouses, sales forces, trucks, and etc. Likewise, firm B controls brand $\beta$ and distribution network II. Suppose that brand $\alpha$ is superior to brand $\beta$ in all of the regions that the distribution channel I and II cover. In this example, brand is an instance of highly fungible resource. In order to obtain distribution channel II, firm A acquires firm B. Since $\alpha$ is superior to $\beta$ and $\alpha$ and $\beta$ are highly fungible, $\beta$ will be replaced with $\alpha$ in the regions covered by firm B’s distribution network II. As a result, brand $\beta$ becomes obsolete. Since this value destroying irrecoverable resource overlap (obsolescence of brand $\beta$) and value enhancing synergy through leverage of the first best fungible resource (brand $\alpha$) coexist, net result can be either positive or negative, depending on the relative magnitude of each effect.

Note that in this example we are not interested in ownership issue but rather in the management issue. Hence, non-integrated separate operations of the two firms A and B after
merger in order to avoid resource overlap (in brands) is not a viable case in this example\textsuperscript{21}.

\textit{Resource overlaps due to resource fungibility}

Fungibility is an attribute of a resource that facilitates its application to different settings within the firm (Anand & Singh, 1997). If a resource is fungible, it can be redeployed to another line of business or market without commensurate costs. Thus, in terms of resource combinations, a higher degree of fungibility of resources implies larger extent of resource overlap between resources to be combined.

Due to public good property of fungible resource, a firm can deploy the best resource stock to other uses in which the second best resource stock was deployed previously. Hence, a firm can benefit by applying only the first best fungible resource stocks while replacing the second best fungible resource stock in order to maximize value\textsuperscript{22}. Our model shows that a higher level of fungibility entails higher degree of resource overlap in resource combination, which in turn implies greater probability of sub-additive outcomes.

\textit{Proposition 1:} Ceteris paribus, as the fungibility of resources involved in post-acquisition resource combination increases, the likelihood of sub-additive outcomes increases.

Intangibility is often correlated with fungibility since physical characteristics limit deploying

\textsuperscript{21} Note that Capron & Hulland (1999) found negative performance implications of consolidation of brands. Such results have an important association with our main claim of this paper: combination of fungible resources such as brands and sales forces entails sub-additivity, and this leads to value destruction in M&A incorporating such resources.

\textsuperscript{22} Capron et al. (1998) found that resources of stronger position are redeployed to a firm with weak resource position in horizontal mergers and acquisitions.
a resource at lower than commensurate costs (Itami, 1987). Fungibility of resource has been addressed in many different forms such as public good property (Caves, 1971), intangibility (Itami, 1987), and excess resource (Penrose, 1959).

Non-tradability of redundant resources

Tradability refers to the extent to which the value of resource can be evaluated, and thus the resource can be traded through market means. Consequently, it represents the value a firm can obtain by transferring it across firm boundaries. The less tradable is a resource, the greater is the value destroyed precisely because any redundancy may not be recovered. Non-tradability of a resource may stem from an indeterminacy of its value as well as its limited modularity even if value of the resource is determinable.

When the second best resource is no longer deployed by the firm, this resource redundancy per se does not lead to sub-additivity. If the second best fungible resource stock is tradable in the secondary strategic factor markets, then fungibility of resource has neutral or even positive performance implications in resource combination due to potential synergies. However, if fungible resource is at the same time non-tradable, as is often the case since fungible resources tend to be intangible and subject to market failure (Itami, 1987), then a firm loses the value which could be gained from deploying the second best resource.

Proposition 2: Ceteris paribus, as tradability of resources involved in post-acquisition resource combination increases, the likelihood of sub-additive outcome increases.

Proposition 1 and 2 state the relationship between the likelihood of sub-additive outcomes and the key resource attributes: fungibility and tradability, i.e., intra- and inter-firm resource transferability.
3.4.2 Symmetry in Resource Profiles

The degree of resource asymmetry between an acquiring firm and a target firm is defined by the relative difference between the resource strengths of the two firms. The greater the symmetry in their respective resource profiles, greater will be the potential for redundancy, \textit{ceteris paribus}, and hence, greater the likelihood of sub-additivity.

\textit{Proposition 3: Ceteris paribus, as symmetry between the resources of the acquiring and acquired firms increases, the likelihood of sub-additive outcome increases.}

The concept of resource symmetry is closely related to strategic relatedness. Relatedness can be defined at multiple levels and units of analysis, such as similarities in products, markets, technologies, resource attributes, and managerial perceptions (Montgomery, 1982; Koh & Venkatraman, 1991; Wang & Zajac, 2007). Relatedness implies overlap in resources (Wernerfelt, 1984; Dussauge, Garrette, & Mitchell, 2000; Wang & Zajac, 2007). Furthermore, if resources are related as well as fungible and non-perfectly tradable, sub-additivity will be more pronounced. For instance, if two merging firms are related in terms of human resources, efficiency gain can be realized by headcount reduction. Meanwhile, if the two firms are related from the standpoint of marketing assets and target markets, the resource combinations will result in sub-additivity precisely because brand asset is fungible yet hardly tradable.

3.4.3 Interaction between Resource Stocks of Different Resource Attributes

In propositions 1 and 2, the sources of sub-additivity are the irrecoverable overlap between each merging firm’s resource stock of the same kind (e.g. between brands of merging firms or between distribution networks of merging firms); in other words, non-tradable overlap between resource stocks of $q=1$ or $q=2$. Sub-additivity can further arise from sub-additive interactions between resource stocks of different kinds (e.g. interaction between combined brand and
combined distribution network); in other words, interaction between the combined resource stocks of \( q=1 \) and that of \( q=2 \).

Regardless of the nature of the interaction between resource stock of \( q=1 \) and \( q=2 \) (such as multiplicative or additive relationships), the magnitude of value creation from given bundle of resources decreases as redundancy in resource stocks of \( q=2 \) increases, even though the extent of redundancy in resource stocks of \( q=1 \) remains the same. This mechanism of sub-additivity is distinct from that discussed in the proposition 1 and 2, in that proposition 1 and 2 do not relate to interaction between resource stock of \( q=1 \) and \( q=2 \) at all. Those two mechanisms of sub-additivity can co-exist.

Proposition 4: Ceteris paribus, given the level of fungibility and tradability for a focal resource stock (\( q=1 \)), as fungibility is higher and tradability is lower for the other resource stocks (\( q=2 \)), the likelihood of sub-additive outcome increases.

Figure 3.4 illustrates interaction effect that lies between resource stocks of different \( q \). For the solid line in the figure, fungibility of resource stocks of \( q=2 \) are at medium level. Meanwhile, for the dotted line, fungibility of resource stocks of \( q=2 \) are at low level. A variable on the x-axis is the level of fungibility of resource stocks of \( q=1 \). In this simulation, value loss due to factors associated with proposition 1 and 2 is controlled for.

Consistent with the Proposition 1 and 2, it is observed in the solid series of the Figure 3.4 that the likelihood of sub-additivity increases as fungibility of resource of \( q=1 \) increases. On the other hand, in the dotted series of the Figure 3.4 even when fungibility of resource stock of \( q=1 \) is large, propensity of sub-additivity is very low. Although redundant fungible resources become obsolete, superior fungible resources are deployed to the whole combined firm, leading to very low chance of sub-additivity because in this case no redundancy exists in the resource stocks of \( q=2 \). What drives the difference between the two series is the resource attributes of resource
stocks of \( q=2 \), given fungibility and tradability of resource stocks of \( q=1 \).

### 3.4.4 Competitive Advantage and Disadvantage of Merging Firms

In addition to the resource profiles of focal merging firms, the resource profiles of competing firms in the market also affect the probability of sub-additive outcomes. Since the likelihood that a firm is selected by consumers increases with the level of value creation that the firm generates, a focal firm, after merger, may generate smaller value creation if competing firms have, on average, superior resource profiles than the focal firm. When irrecoverable resource redundancy is larger, the impact of disadvantageous resource position on value creation decreases because redundancy becomes larger.

**Proposition 5:** Ceteris paribus, as the competitive advantage\(^{23}\) of merging firms relative to other firms decreases, the likelihood of sub-additive outcomes increases.

In the simulation experiment with its result represented by Figure 3.4, \( \varphi_1(1) \) and \( \varphi_2(1) \) (resource strength of each of focal firms) are set at 120. Thus, \( \mu=100 \), \( \mu=120 \), and \( \mu=250 \) respectively denotes the condition that focal firms are at an inferior resource position to the market average; that focal firms are at an equal resource position with the market average; and that focal firms are in a superior resource position to the market average, respectively. When \( \mu \) is 100, the overall extent of sub-additivity is low, and the probability of sub-additivity still increases as fungibility increases. When \( \mu \) is 120, overall extent of sub-additivity is significant, but the probability of sub-additive outcomes does not systematically vary with the level of fungibility. When \( \mu \) is 250, overall propensity of sub-additivity becomes very high, and the likelihood of sub-

\(^{23}\) As the equation 14 in section III already clarifies, competitive advantage is defined as the differential between the resource strength of focal merging firms and the average resource strength of all the other firms in an industry.
additive outcomes sharply increases as the level of fungibility increases.

3.4.5 Information Asymmetry between Supply and Demand sides

Consumers may have incomplete information on the offerings from firms, such as attributes and quality of products or services. This kind of issue becomes significant when offerings are of experience goods (Akerlof, 1970). Also, when firms are new to the market, the level of information asymmetry between supply and demand sides can be high.

With higher degree of information asymmetry, the probability that consumers purchase from firms with lower value creation increases than with lower degree of information asymmetry. This in turn implies that unless focal firm’s competitive advantage in resource strength is placed at the bottom, value creation that could be generated from the focal firm is more likely to go to the inferior competitors when the level of information asymmetry is higher. Thus, we arrive at the following proposition.

Proposition 6: Ceteris paribus, as the information asymmetry between supply and demand sides increases, the likelihood of sub-additive outcomes increases.

3.4.6 Small Market Size and High Degree of Rivalry

Intensified competition will increase the propensity of sub-additivity. In our model, a higher level of competition can arise from a small market size (number of consumers) or/and rivalry on the supply side (the number of firms).

Proposition 7a: Ceteris paribus, as market size decreases, the likelihood of sub-additive outcomes increases.

Figure 3.7 shows how fungibility and market size affect the propensity of sub-additivity. While the relationship between fungibility and the likelihood of sub-additivity is maintained as
stated in the proposition 1, the likelihood of sub-additivity decreases as market size increases. With a given size of population of firms, as resource pool becomes more limited, the degree of competition increases (Hannan & Freeman, 1977).

*Proposition 7b: Ceteris paribus, as the number of firms increases, the likelihood of sub-additive outcomes increases.*

In Figure 3.8, it is shown that as the number of firms competing in the same market increases, the likelihood of sub-additivity increases, while the relationship between fungibility and the likelihood of sub-additivity remains intact. Likewise, consistent with the logic in the preceding paragraph, given the restricted resource and consumers, a larger population leads to a higher degree of competition. In turn, higher extent of rivalry also drives sub-additive outcomes, as stated in the proposition 4. Proposition 7a and 7b are in primal and dual relationship, in that market size and the number of firms are interrelated, in terms of the extent of rivalry.

### 3.4.7 Synergy Versus Sub-additivity

Traditionally, M&A literature has argued for synergistic gains through M&A. For example, horizontal mergers and acquisitions consolidate productive assets of two focal firms, resulting in scale economies. Similarly, through the exploitation of economies of scope, related mergers and acquisitions may lead to super-additive outcomes (Lubatkin and O’Neill, 1987; Nayyar, 1992; Barney, 1997; Porter, 1985). Related mergers and acquisitions may further enhance efficiency of focal merging firms, because redundancy stemming from relatedness can be eliminated (Jensen & Ruback, 1983; Seth, 1990; Dutz, 1989). In addition, the leverage of redeployable resources to the multiple related lines of businesses can further enhance firm value (Anand & Singh, 1997).

On the other hand, one of our central claims in this study is that consolidation of fungible and non-perfectly tradable resources results in sub-additive outcomes. This value destroying
mechanism and other value enhancing mechanisms such as scale and scope economies coexist. Thus, the overall outcomes of resource combinations or mergers and acquisitions depend on the relative strengths of super-additive and sub-additive mechanisms, respectively. We now consider such a case where synergies co-exist with value destruction from overlap. As an illustration we consider the case of scale economies, though we can, in general, consider other forms of synergies.

Figure 3.9 shows the probability of sub-additive outcomes as a function of the scale of a target firm and the strength of scale economies. In the presence of stronger economies of scale ($\varepsilon = 10$), overall likelihood of sub-additive outcomes is lower compared to the case of weaker economies of scale ($\varepsilon = 10$). As the scale of a target firm increases, the magnitude of positive gains from scale economies increases, leading to lower probability of sub-additivity. This result is also consistent with the proposition 3, in that the scale of a target firm with the constant scale of a focal acquiring firm is equivalent to the degree of resource asymmetry between a focal firm and a target firm.

Figure 3.10 illustrates how the magnitude of scale economies moderates the association between the level of fungibility and the probability of sub-additivity. While consistent with the proposition 1, overall propensity of sub-additivity decreases when the strength of scale economies is strong ($\varepsilon = 1$).

These simulation results imply that the resultant likelihood of super-additive outcomes would be lower than what they would have been if fungible and non-perfectly tradable resources existed in the resource profiles of focal merging firms. Likewise, the probability of sub-additivity would appear lower, if super-additive mechanisms such as scale and scope economies coexisted with sub-additive mechanisms. Ultimately, the likelihood of sub-additive or super-additive outcomes is the function of fungibility and tradability of resources, as well as the magnitude of synergistic gains such as scale and scope economies. Related simulation results shown Figure 3.9
and Figure 3.10 provide propositions consistent with these arguments:

**Proposition 8a:** The presence of the sub-additive mechanism in resource combination decreases the overall synergistic gains in resource combinations or M&A.

**Proposition 8b:** The presence of scale economies decreases the probability of sub-additive outcomes in resource combinations or M&A.

### 3.5 DISCUSSION

In this paper we have delved into the question of how the value of a set of resources is determined by resource combination and the attributes of resources, and derived propositions on the conditions for sub-additivity.

It is found that factors across multiple levels – resource, dyad, and industry levels – determine the extent of sub-additivity. The intra- and inter-firm transferability, i.e., the fungibility and the tradability of resources were identified as core drivers of value destruction in resource combinations. We identified and analyzed dyad and industry level factors that enhance or diminish the probability of value destruction. Our analysis revealed an association between the asymmetry in the resource strengths of merging firms and the likelihood of sub-additivity. It was found that a higher degree of symmetry leads to a larger value loss, contrary to the established notion of strategic relatedness as a driver of value creation. The competitive advantage or disadvantage of focal resource combining firms, conceptualized as the resource position of these firms relative to the market average of resource strength distribution, also significantly affects the degree of sub-additivity in resource combinations. Competitive advantages in resource position diminish the chances of sub-additivity. When consumers have less information about the offerings of firms, the probability of sub-additive outcomes increases. The extent of value loss in resource combination is also affected by industry level factors – market size and rivalry. Smaller market
size and the higher degree of rivalry increase the likelihood of sub-additive outcomes in resource combinations.

As the simulation results show, factors at multiple levels – at the resource level (proposition 1, 2, 4 & 8), dyadic level (proposition 3), and industry level (proposition 5, 6, & 7) – affect the propensity of sub-additivity in resource combinations. Therefore, a sole consideration of resource redundancy falls short of understanding the consequence of resource combinations for firm value.

This study has twofold implications for strategy research. First, this research has direct implications for the M&A literature. While the poor average performance of M&A is long established, we offer a novel lens to understand this issue. Second, and less directly, this research speaks to resource based view (RBV) literature more broadly since in our model an M&A transaction is simply an experiment in combining resources. Our results may be extended to other instances of resource combination.

Quite counter-intuitively, the factors that we identify as potential drivers of sub-additive outcomes have been seen in previous literature as drivers of good performance. For instance, many of previous studies in M&A, diversification, and strategic alliances have regarded relatedness as a source of synergy and thus a driver of good M&A or diversification performance (e.g., Singh & Montgomery, 1987; Grant, 1988; Ravenscraft and Scherer, 1987; Rumelt, 1982, Williamson, 1986; Taylor and Lowe, 1995; Lubatkin and O’Neill, 1987; Nayyar, 1992; Barney, 1997; Porter, 1985; Markides & Williamson, 1994). Redeployment of related resources and elimination of redundancy that stems from relatedness enhances the value of combined firms. Strategically similar firms are in an advantageous position to exploit pooled resources, compared to dissimilar firms (Prahalad & Bettis, 1986). Furthermore, according to the cognitive perspective on absorptive capacity (Cohen & Levinthal, 1990) logic, similarity in resource profiles will increase value creation potential.

However, our research suggests that relatedness can also be a driver of poor M&A
performance. A higher degree of strategic relatedness or symmetry between two merging firms implies a higher degree of resource overlap. If the overlapping resource is not perfectly-tradable, relatedness poses value loss, and thus net effect of relatedness can be either positive or negative, contrary to studies that argue that relatedness is associated only with value creation. Table 3.3 recaps previously identified drivers of good and bad M&A performances as well as another driver of bad M&A performances, sub-additivity in resource combinations, which is identified by this study.

As several studies (Lubatkin, 1987; Palich, Cardinal, & Miller, 2000; Seth, 1990; Bruner, 2004) suggest, there is a lack of consensus on the relationship between relatedness and diversification or M&A performances. Our study identifies a factor responsible for such mixed empirical findings in this literature. Inconsistency in the extant literature is potentially explained by our finding that super- or sub-additive outcomes may both follow from strategic relatedness or similarity depending on the fundamental characteristic of the underlying resources. For instance, empirics have shown that related M&A are not always more value creating than unrelated M&A, concluding that the relationship between relatedness and value creation follows inverted –U shape curve as shown in Figure 3.11. In the case of low relatedness, the magnitude of value creation is low due to low potential for synergy. In the case of high relatedness, the amount of value creation is again low, even though potential for synergy is large.

Our lens of sub-additivity in resource combinations explains why high degree of relatedness can lead to low level of value creation. While potential for super-additivity stemming from high relatedness exists, potential for sub-additivity increases at the same time due to high relatedness.

Table 3.4 summarizes our perspective on the association between strategic relatedness and the performances of M&A. If resources involved in M&A are strategically similar, two types of M&A outcomes are possible, depending on the attributes of the resources. First, if similarity
comes from tangible or tradable resources, it has positive implication on M&A performance, since redundancy in this case is tradable and thus leads to efficiency enhancement (quadrant 1). Second, if similarity stems from intangible or less-tradable resource bases, overlapping resource is less tradable, leading to value destruction (quadrant 2).

Likewise, conditional upon the attributes of resource bases of two focal merging firms, two outcomes are possible when two firms are strategically dissimilar. Basically in this case, the extent of resource overlap is small. If dissimilarity lies in tangible or tradable resources, performance implication can be neutral because no resource redundancy exists; due to limited resource fungibility and complementarity, gains from leveraging resources are not likely. On the other hand, if dissimilarity comes from intangible or less tradable resource bases, cross-leverage of fungible and diverse resources leads to value enhancement.

In addition, some interesting but incompletely explained empirical findings in domestic and cross-border M&A studies can be explained with our theoretical lens of sub-additivity in resource combination. For instance, regarding the debate on the benefits of leveraging intangibles compared to tangibles, Arikan (2004) reported that in domestic M&A settings intangible assets do not create as much value as tangible assets despite the potential leveraging of such resources due to their public good properties. Arikan (2004)’s finding can be explained with our lens of sub-additivity: intangible resources exhibit high fungibility and low tradability and combination of this type of resources lead to value destruction.

In the context of cross-border acquisitions, Doukas (1995) found that while the first cross-border acquisition creates value for a firm possessing strong intangibles and entering a new country, the second and subsequent cross-border acquisitions of the firms in the same country do not create value. Our lens of sub-additivity in resource combination provides a novel interpretation of this finding. The first acquisition provides a value-enhancing novel resource in the host country to the acquiring. For example, such a resource may be local downstream assets
that a firm requires to compete in the local market and complementary to its global competitive advantage. Meanwhile, resources acquired through the second and subsequent M&A in the same host countries are likely to be similar to the resources acquired through the first acquisition, and hence, redundant. If such redundant and overlapping resources are less tradable, it leads to value destruction.

In a similar vein, our study speaks to internalization theory (Hymer, 1960; Buckley & Casson, 1998) and entry modes (Kogut & Singh, 1988; Hennart & Park, 1993; Zahra, Ireland, & Hitt, 2000; Agarwal & Ramaswami, 1992). An MNE exploits valuable intangibles while bypassing market failure, by internalizing transactions either through organic growth or M&A as entry modes. Our study suggests that the degree of strategic similarity between the focal MNE and potential target firms in the host country and the tradability of overlapping resources moderates the previously identified relationship between optimal entry mode and resource profiles of a focal MNE and firms in the host country.

Our study provides an alternative explanation to agency or hubris perspectives for poor M&A performances. An implication of our propositions is that in estimating premium for acquisition of a target firm, managers of an acquiring firm should take into account the potential value loss from sub-additivity in resource combination, in addition to factors related to potential synergies. This in turn implies that managers in charge of acquisitions should carefully examine the resource profiles of their own and that of the target firm and consider the extent of resource overlap, the level of tradability of the overlap, and the other factors we identify in the propositions as drivers of sub-additivity.

This study also has fundamental implications for the resource based view. An implicit assumption in arguments based on the resource based view is that more resources are always better. For example, Penrose (1959)’s logic of corporate expansion is that resources with public good property are always in excess, so that a firm can profitably leverages this resource and enter
another market or business, increasing firm value in the process. However, this rationale does not take into account all potential interactions among resources, some of which can result in negative outcomes. While the literature frequently draws upon one type of interaction across resources: synergistic gains through exploitation of complementary resources, another type of interaction, value loss due to resource overlap, has been hardly been addressed. Similarly, Barney (1991) and Peteraf (1993; 1994) have identified important attributes of strategic resources, yet value destroying interactions among them have not been considered.

The sub-additivity in option portfolios offers an insightful analogy to understand the sub-additivity in resource combinations (Vassolo, Anand & Folta, 2004). From an option perspective, the value of a resource may consist of two components: value stemming from current deployment and that from option to deploy to an alternative use in the future in case it is a fungible resource. For example, the value of the two brand names of merging firms may be determined by their current deployment plus the option to leverage the brand to new alternatives (Capron & Hulland, 1999). The high level of fungibility of brand implies high degree of correlation among underlying assets from the option perspective. Therefore, if a bundle of resources in merged firm is conceptualized as a portfolio of real options, then option portfolio research (e.g. Stulz, 1982; 24)

\[\text{Stulz (1982) found that the value of portfolio of exotic options decreases when the correlation among the options increases. In his analysis, an exotic option on the minimum or maximum of two assets is considered, and this option is based on switching option of two call options. He found that the value of this class of option becomes minimum when two call options are perfectly correlated (i.e., correlation is 1) and maximum when correlation is -1. Note that sum of options is not additive if correlation across options is not zero.}\]

Applied to the case of real option portfolios in firms, two important conditions of non-additivity have been identified (Anand, Oriani, and Vassolo, 2007): (i) correlation among real assets and (ii) existence of constraints on the exercise of different options. Note that a portfolio can be sub-additive due to redundancies and super-additive due to switching flexibility.
Vassolo et al., 2004; Anand, et al., 2007) suggests that the value of the combined resource stocks, i.e., the two brand names, will decrease due to correlation between the services that two brand names provide to the focal merged firm. The current deployment of the inferior (therefore, discarded) brand is replaced by exercising the option to leverage the superior brand, the value of the discarded brand cannot be recovered. The magnitude of value loss from the obsolescence of inferior brand is equivalent to the future cash flow that could be generated from obsolete brand.

An important limitation of this research so far is the inability to derive empirically testable hypotheses since the core variables that drive sub-additivity may also otherwise drive performance, as previous research has shown. It will be difficult to isolate the positive and negative effects of these factors with field data.

We can extend the current study to examine the relationship between strategic flexibility and resource fungibility. As implied by Anand & Singh (1997), fungibility can be a source of strategic flexibility under dynamic environments. This issue can be addressed by adding environmental uncertainty into the current model. It would be an interesting to examine how different types of uncertainties affect the degree of sub-additivity in resource combination or M&A, by applying the option logic (Anand, et al., 2007).

While the primary logic of transaction cost economics (Williamson, 1975; Coase, 1932) and internalization theory (Hymer, 1960) lies in value appropriation, this study’s logic lies in value creation. As argued by some studies (e.g. Zajac & Olsen, 1993; Wang & Zajac, 2007; Barney, 1999), value creation and appropriation are both important determinants of governance decision. In this regard, this study contributes to studies on governance choice, by examining the value creation aspect of M&A governance. Thus, a future research opportunity is to develop a full-fledged theory of governance choice that incorporates sub-additivity in resource combination. Alliance and acquisition are governance forms for exploiting synergy through relatedness and complementarity in resources of two focal firms. By developing a framework incorporating the
sub-additivity concept, we expect to resolve the following inconsistencies related to the governance choice between acquisition and strategic alliance, which lie in the extant literature.

First, previous studies on the governance choice between acquisition and alliance suggest that if two firms have similar resources, they will opt for acquisition because similar resources lead to more competition and subsequently to more conflicts (Wang & Zajac, 2007; Hannan & Freeman, 1977; Ernst & Bleeke, 1995). Hence, in order to avoid conflict, focal firms opt to govern relatedness-exploiting transactions with acquisition that is more hierarchical than alliance governance (Wang & Zajac, 2007). Second, previous studies also suggest that acquisition may be a better governance choice than alliance if the level of similarity between two firms is high (Balakrisnan & Koza, 1993) because similarity implies less information asymmetry between two focal firms, and thus less uncertainty in integration process. Therefore, under low similarity, focal firms are likely to face larger extent of integration problems if they opt for acquisition rather than alliance governance (Wang & Zajac, 2007).

However, our perspective suggests that due to the similarity between resources of two focal firms, value destruction may occur when two firms are combined via acquisition governance. Thus, from the perspective of sub-additivity in resource combinations, an alliance may be a better governance form for exploiting relatedness than an acquisition if resource similarity is extensive; alliance is an weakly-coupling governance for resource combinations whereas acquisition is a tightly-coupling governance for resource combinations, resulting in differential extent of sub-additivity. Since the multiple perspectives on the association between relatedness and governance choice yield inconsistent predictions, prediction of overall impact of relatedness on governance choices is not trivial. Therefore, future research could address the above competing predictions and develop a integrated theory on the choice between alliance and acquisition as the governance forms for exploiting relatedness.
3.6 CONCLUSION

This study provides the conditions for sub-additivity in resource combinations, primarily drawing on attributes of resources. By incorporating a formal model and computational analysis, we specified fine grained conditions under which resource combinations can lead to sub-additive outcomes. While we primarily dealt with fungibility, tradability and asymmetry of resources as determinants of sub-additivity in resource combination, we have also considered other pertinent factors that help understand the issue better. Analysis of the full array of factors that follow from our models permits a deeper understanding of the antecedents of sub-additivity.
Figure 3.1 Irrecoverable resource redundancy due to resource fungibility
Figure 3.2 Non tradability of redundant resources

Figure 3.3 Symmetry in resource profiles
Figure 3.4 Interaction between resource stocks of different resource attributes

Figure 3.5 Resource profile of merging firms relative to the market distribution of resources
Figure 3.6 Information asymmetry between supply and demand sides

Figure 3.7 Market size and the likelihood of sub-additivity
Figure 3.8 Degree of rivalry and the likelihood of sub-additivity

Figure 3.9 Scale economies and the likelihood of sub-additivity
Figure 3.10 Scale economies and the likelihood of sub-additivity

Figure 3.11 Previous empirical findings on the relationship between relatedness and value creation
Table 3.1 Determinants of Resource Fungibility and Tradability

<table>
<thead>
<tr>
<th>Fungibility</th>
<th>Theory</th>
<th>Tradability</th>
<th>Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determinant</td>
<td></td>
<td>Determinant</td>
<td></td>
</tr>
<tr>
<td>Public good property</td>
<td>Caves, 1971</td>
<td>Indeterminacy of resource value</td>
<td>Akerlof, 1970</td>
</tr>
<tr>
<td>Intangibility</td>
<td>Itami, 1986</td>
<td>Asset specificity</td>
<td>Williamson, 1985</td>
</tr>
<tr>
<td>Excess resource</td>
<td>Penrose, 1959</td>
<td>Path dependence</td>
<td>Nelson &amp; Winter, 1982</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited modularity</td>
<td>Simon, 1962</td>
</tr>
</tbody>
</table>
Table 3.2 Two dimensions of resource attributes associated with value destruction

<table>
<thead>
<tr>
<th>Tradable</th>
<th>Less-tradable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less-fungible</td>
<td></td>
</tr>
<tr>
<td>✓ Example: distribution network</td>
<td>✓ Example: asset-specific manufacturing plant</td>
</tr>
<tr>
<td>Fungible</td>
<td></td>
</tr>
<tr>
<td>✓ Example: financial resource</td>
<td>✓ Example: brand asset, asset-specific-technology</td>
</tr>
<tr>
<td>Drivers of good performances</td>
<td>Drivers of bad performances</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td><strong>Mechanism</strong></td>
<td><strong>Mechanism</strong></td>
</tr>
<tr>
<td>Market power</td>
<td>Internal market vs</td>
</tr>
<tr>
<td>Cost reduction</td>
<td>External market efficiencies</td>
</tr>
<tr>
<td>Risk reduction</td>
<td>Poor incentives for</td>
</tr>
<tr>
<td>Leverage of fungible resources</td>
<td>target selection</td>
</tr>
<tr>
<td>Exploitation of relatedness</td>
<td>Poor judgment for</td>
</tr>
<tr>
<td></td>
<td>target selection</td>
</tr>
<tr>
<td></td>
<td>Poor integration/Cognitive-</td>
</tr>
<tr>
<td></td>
<td>cultural problem</td>
</tr>
<tr>
<td></td>
<td>Incompatible routines/Inertia</td>
</tr>
<tr>
<td></td>
<td>Sub-additivity</td>
</tr>
<tr>
<td>Theory</td>
<td>Theory</td>
</tr>
<tr>
<td>IO</td>
<td>Agency</td>
</tr>
<tr>
<td>Scale/Scope economies</td>
<td>Agency</td>
</tr>
<tr>
<td>Diversification</td>
<td>Hubris</td>
</tr>
<tr>
<td>RBV</td>
<td>Evolutionary/Cognition</td>
</tr>
<tr>
<td>RBV</td>
<td>Evolutionary theory</td>
</tr>
<tr>
<td></td>
<td>Resource Combination</td>
</tr>
</tbody>
</table>
### Table 3.4 Relatedness, resource attributes, and M&A performances

<table>
<thead>
<tr>
<th>Tangible</th>
<th>Strategically Similar</th>
<th>Strategically Dissimilar</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>Neutral</td>
</tr>
<tr>
<td>(Quadrant 1)</td>
<td>(Quadrant 3)</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>(Quadrant 2)</td>
<td>(Quadrant 4)</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.5 Summary of the parameters of the model

<table>
<thead>
<tr>
<th>Category</th>
<th>Parameters</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource attributes</td>
<td>$\varphi$</td>
<td>Resource Strength</td>
</tr>
<tr>
<td></td>
<td>$\mu$</td>
<td>Average of resource strength</td>
</tr>
<tr>
<td></td>
<td>$\sigma^2$</td>
<td>Variance of resource strength</td>
</tr>
<tr>
<td></td>
<td>$\epsilon$</td>
<td>Fungibility</td>
</tr>
<tr>
<td></td>
<td>$\tau$</td>
<td>Tradability</td>
</tr>
<tr>
<td>Supply side</td>
<td>$N$</td>
<td>Number of firms</td>
</tr>
<tr>
<td></td>
<td>$c_v$</td>
<td>Marginal cost</td>
</tr>
<tr>
<td></td>
<td>$c_f$</td>
<td>Fixed cost</td>
</tr>
<tr>
<td></td>
<td>$\alpha$</td>
<td>Strength of scale economies</td>
</tr>
<tr>
<td></td>
<td>$C$</td>
<td>Resource competitive advantage</td>
</tr>
<tr>
<td>Demand side</td>
<td>$n$</td>
<td>Number of consumers</td>
</tr>
<tr>
<td></td>
<td>$p_c$</td>
<td>Degree of information asymmetry</td>
</tr>
<tr>
<td>Value creation function</td>
<td>$c$</td>
<td>Proportional constant</td>
</tr>
<tr>
<td></td>
<td>$b$</td>
<td>Returns to scale</td>
</tr>
</tbody>
</table>

99
CHAPTER 4

Network Embeddedness and Heterogeneity in Organizational Governance

4.1 INTRODUCTION

Interorganizational networks shape and constrain the flows of resources and information on the value of resource and on the behavior of potential partners, affecting firms’ resource combinations and their corresponding organizational governance choices (Baum, Calabrese, & Silverman, 2000; Zaheer & Bell, 2005; Gulati, 1999; Rowley & Baum, 2004).

From a perspective of resource combinations and information exchanges, at the dyadic level, strong ties promote intensive and in-depth information transfer and development of interorganizational routines for learning and resource sharing, leading to more extensive exploitation of relatedness and complementarities between two focal firms (e.g., Uzzi, 1996). On the other hand, a set of weak ties promote the heterogeneity of resources accessible through interfirm networks (Granovetter, 1973). At the structural level, higher centrality is associated with less information asymmetry on the value of social capital and behavior of potential partners (Gulati & Gargiulo, 1999).

While these streams of research have been influential to strategy literature by showing the impact of network embeddedness (Granovetter, 1985, 1973) on economic actions, network embeddedness has been examined only in the context of alliance formation as an instance of economic actions, with a focus on the causal link from network to governance (e.g. Gulati 1995;
Gulati & Gargiulo, 1999; Kogut, Walker, & Shan, 1997). As soon as another causal link from governance to network is taken into account, heterogeneity in economic actions becomes an important issue for network embeddedness.

An instance of the impact of governance heterogeneity on networks is the influence of expected positional advantages on governance choices. While existing networks shape information flows and resource combinations and thus governance choices – a backward looking aspect of governance choice, firms may also take into account expected positional advantages that alliance or M&A transactions provide to focal firms – a forward looking aspect of governance choice. Alliance and M&A are two alternative governance forms for inter-firm resource combinations, and they confer different types of network positional advantages on focal firms. Whereas alliance governance modifies focal firms’ local networks at the dyad level, hierarchical M&A governance does so at the structural level. Therefore, omission of alternative governance forms in analyses of the association between network and governance constructs can be problematic.

The purpose of this study is to examine how expected network positional advantages determine the governance choice between alliance and M&A, while taking account of differential impacts of alliance and M&A governances on networks. This study addresses the issue from both backward and forward aspects of network based governance choices. This research analyzes field data on strategic alliances, M&A, and inter-firm network in the computer industry.

4.2 THEORY AND HYPOTHESES

4.2.1 Integration

Alliance network and its impact on alliance formation is a most intensively studied field among interorganizational network studies (e.g. Contractor & Lorange, 1989; Nohira & Garcia-pont,
1991; Stuart, 2000; Rowley, Behrens, & Krackhardt, 2000; Gulati, 1995; Gulati & Gargiulo, 1999; Ravie & Rosenkopf, 2006; Robinson & Stuart, 2007; Koka & Prescott, 2008; Baum, Calabrese, & Silverman, 2000). Although the primary motor of alliance formation and thereby network formation in these studies is exploitation of relatedness/complementarities between resources of focal firms to alliance, this stream of research does not consider an alternative mode of resource combination – M&A. Alliance and M&A governance are two alternative modes of resource combinations (Wang & Zajac, 2007; Dyer, Kale, & Singh, 2004; Villalonga & McGahan, 2005).

Whereas governance literature on the choice between alliance and M&A is relatively well developed, literature on the association between interfirm network structures and the choice between alliance and M&A is non-existent; let alone such studies, research on the impact of interfirm networks on M&A governance is very thin.\(^{25}\)

Simultaneous incorporation of both alliance and M&A governances into the analysis of interfirm networks and governance is critical, because each governance choice exerts different type of impact on interfirm network structures. A significant difference is that alliance governance directly affects network structures at the dyadic level but M&A governance does so at the structural level.

In the case of alliance governance, alliance governance will lead to the development of a tie ranging from a weak to strong tie. The type of alliance,\(^{26}\) and contracts and hierarchical controls\(^ {27}\) used for alliance governance determine the extent of resource commitment, the duration of relationship, and the frequency and intensity of collaboration (Kraatz, 1998; Rowley et al, 2000; Capaldo, 2007). This in turn determines the strength of interorganizational ties formed through

\(^{25}\) Exceptions are Lin, Peng, Yang, & Sun (2009) and Yang, Lin, & Lin (2010). This study offers a finding which is inconsistent with Yang et al. (2010).

\(^{26}\) Equity alliance, non-equity alliance, or joint venture

\(^{27}\) Instances of hierarchical controls used for the governance of alliances are presented in Gulati & Singh, 1998
alliance governances.

The implementation of hierarchical governance – mergers and acquisitions does not form a new tie between focal firms, it results in the modification of network structures. M&A transaction leads to the consolidation of network links that focal merging firms controlled prior to the M&A transaction. Thus, ceteris paribus, M&A transaction leads to higher centralization of a focal firm’s egocentric network and thus a modified portfolio of network ties.

Not only the first order neighbor’s resources but also the resource bases of the second order neighbors, “alters”, affect a focal firm’s governance choice and network strategy. A focal firm may acquire a firm with a motivation to control network ties of the target firm as well as to control the resource bases of the target firm itself. Through the ‘acquired ties’ that was previously ‘owned’ by the target firm, the focal firm can gain accesses directly to the resource bases of the second order neighbors.

Finally, ambiguous and inconsistent treatment of M&A transactions in the construction of interfirm networks may have impact of the validity of extant literature. In particular, seminal studies on interorganizational networks, such as Contractor & Lorange (1989) and Nohira & Garcia-pont (1991), consider the impact of M&A transactions on network structure only at the dyad level. However, M&A transactions in fact affect interfirm networks at the structural level. Inaccurate treatment of differential impacts of different governance forms on network structures potentially leads to bias in the analysis of the impact of networks on governance, precisely because of the reciprocity between networks and governance\(^\text{28}\).

4.2.2 Resource & Network Centrality Similarities and Governance Choice

Resource based view suggests that the resource similarity between two focal firms is a determinant of organizational governance choice (Wang & Zajac, 2007; Tanriverdi &

---

\(^{28}\) The concept of the reciprocity between networks and governance is explained in details in Chapter 2.
First, the magnitude of synergy in resource combinations is a function of resource similarity between resource stocks. The extent of redundancies is proportional to the degree of similarity between resource stocks to be combined (Wernerfelt, 1984; Dussauge, Garrette, & Mitchell, 2000). By pooling similar resources together, redundancy can be eliminated, and this leads to efficiency enhancement (e.g. Jensen & Ruback, 1983; Seth, 1990; Dutz, 1989; Anand & Singh, 1997; Hoskisson, Johnson, & Moesel, 1994). While alliance allows at best “pooling” resources, M&A allows integration of resource bases of focal firms. Thus, M&A has a greater potential for redundancy elimination than alliance. Second, when firms are more similar in terms of resources, markets, or technologies, the extent of competition between them increases (Hannan & Freeman, 1977). Thus, an alliance between similar firms is expected to escalate competition rather than promote cooperation between them. Third, if two firms are more similar to each other, information asymmetry between them is smaller. Similarity suggests similar routines, structures, resources and capabilities. Less degree of information asymmetry between two focal firms reduces uncertainty as to M&A decisions. While less information asymmetry also reduces uncertainty regarding alliance formation, its impact on M&A is larger than that on alliance.

Note that similarity is a distinct construct from complementarity (Wang & Zajac, 2007). Complementarity rather suggests moderate dissimilarity between focal firms. Implications of complementarity for governance choice are the opposite of implications of similarity for governance choice.

**H1.** The higher the degree of resource similarity between two focal firms is, the more likely it is that M&A governance is opted for over alliance governance.

The network centrality29 or/and network status of potential alliance partners of M&A
targets affects a focal firm’s boundary expansion decisions (Gulati & Gargiulo, 1999; Podolny, 1993; Chung, Singh, & Lee, 2000; Yang, Lin, & Lin, 2010). Network centrality is a network property which gauges the width and depth of a focal node’s influence over a network in terms of information dissemination, resource flows, and signaling. Larger network centrality implies shorter path lengths from a focal firm to other firms, larger number of interfirm relationships, or/and network links with firms of central roles, in a given network.

When there is uncertainty about the attributes of a potential partner, such as uncertainty about resources or behavior, network centrality of the potential partner can be a signal for its unobserved attributes (Gulati & Gargiulo, 1999; Podolny, 1993; Chung, Singh, & Lee, 2000). High network centrality is a manifestation of cumulative preferential attachments (Barabasi & Albert, 1999; Andriani & McKelvey, 2009), and thus a focal firm may perceive it as a signal for attractiveness of a potential alliance partner or M&A target. Also, if a particular potential partner firm, which is not necessarily a central firm by itself, is connected with a central firm, it can be a signal in regard to its resources and behavior (Podolny, 1993).

Since governance decision is made on a bilateral basis (Zajac & Olsen, 1993), relative network centrality between two focal firms determines the choice between alliance and M&A. Even though a firm with low centrality has an incentive to ally with a firm with a firm with high centrality, a central firm in general has a small incentive to ally with a firm with low centrality, and thus it is not likely to accept a peripheral firm (Podolny, 1994; McPherson, Smith-Lovin, & Cook, 2001; Gulati & Gargiulo, 1999; Piskorski & Anand, 2006). In addition, firms of similar status tend to have similar expectation each other as to the level of a partner’s resource commitment to a focal firm, facilitating cooperation (Chung et al., 2000). Therefore, ceteris

several measures of centrality, eigenvector centrality (Bonacich, 1987) is often used for a measure of network status.
paribus, alliance tend to occur between firms with a similar level of network centrality.

On the other hand, when the difference in centrality of two focal firms is larger, a focal firm with a higher status is likely to opt for M&A over alliance governance in order to minimize status damage from affiliating with a firm with a lower network status.

**H2a.** The higher the degree of network centrality similarity between two focal firms is, the more likely it is that alliance governance is opted for over M&A governance.

In regards to the association between centrality similarity and governance choice, Yang et al. (2010) provides a different reasoning, leading to the opposite prediction. Their key argument is that firms engage in status exchange through alliance, and status exchanges occur between a high status firm and low status firm rather than between a low and low status firm or between a high and high status firms. Provided that status similarity is low, i.e., centrality similarity is low, M&A is not an optimal governance choice, according to Yang et al. (2010)’s reasoning; failure of M&A will result in a focal firm’s status damage, and M&A requires higher degree of commitment and resources than alliance governance. H2a and H2b are competing hypotheses and to be discussed in discussion and conclusion section.

**H2b.** The higher the degree of network centrality similarity between two focal firms is, the more likely it is that M&A governance is opted for over alliance governance.

### 4.2.3 Network Clusters, Resource Similarity, and Governance Choice

Existing network literature has acknowledged "local clustering" as one of the fundamental structural tendencies featuring the alliance network (Baum, Shipilov, & Rowley, 2003; Rowley et al., 2004; Rowley et al., 2005; Walker, Kogut, & Shan, 1997). The local clustering stems from imperfect, incomplete information on potential partners' capabilities and trustworthiness, which necessarily create partnering risk and uncertainty (Baum et al., 2005; Beckman, Haunschild, &
Phillips, 2004). In an attempt to mitigate the partnering risk and uncertainty, firms tend to rely on their local network as conduits of information and hence become biased toward embedded ties (Gulati, 1995a, 1995b; Rapoport, 1957; Uzzi, 1996, 1997); they prefer engaging in repeated ties with past partners or creating ties with partners' partners to creating new ties with strangers located outside their local network (Baum et al., 2005). Such behavioral pattern drives network to grow on a local basis and eventually engenders a number of chunks of localized networks, i.e., clusters which collectively constitute the whole network (Burt, 2005; Dorogovtsev & Mendes, 2003; Jin, Girvan, & Newman, 2001; Kilduff & Tsai, 2003; White, Boorman, & Breiger, 1976). Thus, it is argued that the network clusters in social space are at least in part a natural outgrowth of the local clustering and a universal phenomenon as well (Gulati & Gargiulo, 1999; Rowley et al., 2004; Scott, 2000; Wasserman & Faust, 1994).

Literature also suggests that network clusters demarcate boundaries of information flow (Baum, Shipilov, & Rowley, 2003; Burt, 2005; Rowley et al., 2004). Just as information on promising investment opportunities circulates within a focal industry and geographical clusters, so the information on the partners is relayed, shared, and communicated only within the network cluster (McEvily & Zaheer, 1999; Sorenson & Stuart, 2001); in effect, information in the network cluster is sealed off, so that actors outside the cluster are less able to get access to it. Then, it stands to reason that partnering risk should be small when potential partners come from the same network cluster in view of the fact that information on the potential partners' capabilities and reliability is readily available. By similar logic, the partnering risk could be substantial when the potential partners are from different network clusters because information on them is not easily accessible.

Such differing partnering risk and uncertainty contingent on the network cluster position, in turn, relates to the governance choice. Outright acquisition evidently incurs greater costs than alliance when a partner turns out to be opportunistic ex post, mainly because acquisition is
economically less reversible than alliance is (Folta, 1998; Leiblein & Miller, 2003; Leiblein, 2003; Villalonga & Mcgahan, 2005; Wang & Zajac, 2007). Accordingly, when information on a potential partners is lacking because they are located in different network clusters, firms will prefer alliance to M&A in order to reduce the partnering risk and uncertainty involved. Taken together, it is hypothesized:

**H3. If two focal firms are located in the same network cluster, M&A governance is preferred to alliance governance.**

One of the reasons why resource similarity increases the likelihood of M&A being selected over alliance choice is that when resources are similar there should be less information asymmetry, the negative consequences of which are greater for the M&A choice. However, since resources are intrinsically path dependent and socially complex and represent causal ambiguity as well (Barney, 1991; Dierickx & Cool, 1989), it should be far from easy to evaluate resource similarity with precision based solely upon publicly available information (Barney, 1986). Stated differently, the magnitude of the hypothesized correlation between resource similarity and governance choice may be smaller than expected when analyzed in isolation from other sources of (private) information. In this connection, network literature suggests the possibility that such incomplete public information could be nicely complemented by information available through network. Research evidence has suggested that embedded ties and closed network enable forums for discussion and thicker, fine-grained information transfer (Uzzi, 1996, 1997), undergirded by network governance mechanisms such as social norm, reciprocity, trust, and reputational sanction (Burt, 2005; Coleman, 1988; Jones, Hesterly, & Borgatti, 1997). Further, such rich, detailed, and accurate information is more likely to circulate within the network cluster, as discussed (Granovetter, 1985; Rowley et al., 2004). Consequently, if an M&A target is located in the same network cluster, an acquirer will be able to reduce information asymmetry to a larger extent by
tapping not only public information but the information through network. In other words, the positive effect of resource similarity on the M&A choice will be greater when network information is simultaneously factored in. Thus, this study hypothesizes:

**H4.** Network cluster co-location moderates the association between resource similarity and the governance choice between alliance and M&A such that the positive correlation between resource similarity and the likelihood of M&A being selected increases when two focal firms are located in the same network cluster.

### 4.2.4 Expected Positional Advantage and Governance Choice

Firms may make governance decisions based not only on social mechanisms and informational and resource flows shaped by existing networks, but also on expected positional advantage stemming from network structures modified through the implementation of governance choice. Arguments made so far in the previous hypotheses are based on the following question: “Given a specific set of network properties, what is an optimal governance decision?” On the other hand, the following argument is framed by another question, “Which governance form does a firm should opt for, in order to shape a specific positional advantage and thereby obtain additional network resources stemming from an alliance partner or a M&A target?” While the former question is based on a “backward looking perspective of governance and network strategy, the latter is a “forward looking perspective” of governance and network strategy.

According to the expected degree of rationality of managers as to strategic management of their interfirn networks, there are two perspectives (Rowley & Baum, 2004): partner selection and network management perspectives. According to the partner selection perspective in social network literature (e.g., Gulati, 1995; Gulati & Gargiulo, 1999), firms strategically consider in their economic actions dyadic level network properties but do not necessarily take into account positional advantages at the structural level. Thus, according to this perspective, distinguishable
patterns of network properties at the structural level are emergent at best. On the other hand, network management perspective (e.g. Moller & Halinen, 1999; Grabher & Powell, 2004; Rowley & Baum, 2004) states that a manager can recognize benefits of certain network positions and accordingly shape its network structure for its benefits, to certain extent yet limited.

This study considers two types of expected benefits conferred on a focal firm by alliance or M&A transactions: informational & resource benefit and network status (centrality) benefit. This study argues that the expected magnitude of informational and network resource benefits are different according to governance choices.

The expected magnitude of informational and network resource gains from alliance or M&A is in the following order: M&A, alliance, and no-partnering. In case of non-partnering, additional gain in network resources is nonexistent.

Additional network resources that are conferred on a focal firm by an alliance or M&A transaction can be measured by additional accessibility/channels to a given network through an alliance partner or, respectively. From the dyadic standpoint, an alliance partner’s direct ties become a focal firm’s second order indirect ties (partner’s partners). In case of M&A, a target firm’s portfolio of network ties becomes a focal acquiring firm’s direct ties; previous ties of an acquiring firm and a target firm are consolidated into a single firm boundary.

From the structural standpoint – network centrality, each focal firm gains an indirect benefit from an alliance transaction. In terms of degree centrality, each focal firm gains one additional degree. Even if a partner firm’s eigenvector centrality is large, transfer of this network status benefit to a focal firm is limited, because there is two degrees of separation between a focal firm and a central firm tied to a focal firm’s alliance partner. On the other hand, M&A transaction

---

30 Provided that actual consolidation occurs
directly transfers a target firm’s network resources to a focal acquiring firm\textsuperscript{31}.

A critical distinction between a direct tie and in indirect tie renders M&A to be a distinct vehicle from alliance in terms of network resource governance. Whereas an indirect link serves a role of information conduits, it cannot serve a direct tie’s distinct functions. A direct tie enables focal firms to intensively share knowledge and resources, exploit complementarities and scale economies, with firms linked though it (Ahuja, 2000). In this regard, M&A governance is characterized with a higher extent of control over network resources than alliance governance. Provided that firms behave strategically enough such that they consider in their governance choice not only the attributes of a partner firm but also the network resources associated with the partner firm, they will opt for a governance choice which confers on the focal firm greater additional benefits of network resources.

\textbf{H5.} The governance choice with greater expected information and network resource benefits will be preferred

\textbf{H6.} The governance choice with greater expected network status increment will be preferred.

\section*{4.3 METHODOLOGY}

\subsection*{4.3.1 Data}

Two sets of archival database are used. For the construction of interfirm networks, SDC Platinum database is utilized. Both alliance and M&A databases are included into samples for interfirm networks construction and regression analysis. For accounting and financial data, this study operationalizes such differences between alliance and M&A with further details in the methodology section.

\textsuperscript{31}This study operationalizes such differences between alliance and M&A with further details in the methodology section.
COMPUSTAT database is used. Computer industry consisting of both hardware and software firms is selected for this study. This industry is known for ample alliance and M&A activities (Yang et al., 2009). This study collects data on governance choices and financial information for each year over the period from 1990 to 2010 and 1989 to 2010, respectively.

Sample selection process is as follows. To ensure complete availability of financial information of sample firms, the selection of sample entries begins with COMPUSTAT database. Only the records that meet the following criteria are selected: i. complete information on control variables; and ii. public firms in the United States. A panel of COMPUSTAT entries in a given industry consists of total 21,055 observations and total 2,318 unique firm entries over the specified period. Next, consistently with studies involving interfirm networks (e.g. Stuart, 2000; Gulati, 1995; Rowley, Behrens, & Krackhart, 2000; Marsden & Knoke, 1994), selection of dyad observations was performed according to the following criteria: i. both parties to a transaction have membership in the computer industry; and ii. at least one strategic alliance or M&A transaction with other members in the industry. In addition, for M&A transactions, only the transactions that entail changes in control right are included into our sample. The change in control right is operationalized by two criteria: i. less than 50% ownership stakes before a M&A transaction and ii. majority ownership after the transaction. Selected dyad observations, then, are matched with the COMPUSTAT entries in the same industry.

For alliance transactions, this dyad sample selection procedure results in total 614 dyad observations and 317 unique firm entries. Likewise, for M&A transactions, this leads to total 52 observations and 88 unique firm entries.

---

32 SIC codes: 3571, 3572, 3573, 3577, 7371, 7372, 7373, 7374, and 7375 (Yang et al., 2010).
4.3.2 Dependent and Independent Variables

**Dependent variable**

*Governance choice:* Given that the governance decision between alliance and M&A is our central concern, this study operationalizes the dependent variable as a binary variable (0=alliance, 1=acquisition).

**Independent variables**

*Resource similarity:* In keeping with Wang and Zajac (2007), this study operationalizes resource similarity on the basis of Standard Industrial Classification (SIC) codes. We assign to resource similarity of two focal firms 1 when the first four digits of the two focal firms' SIC codes are equal, 0.75 when the first three digits of the two focal firms' SIC codes are equal, 0.5 when the first two digits of the two focal firms' SIC codes are equal, 0.25 when the first digit of the two focal firms' SIC codes are equal, and 0 when the first digit of the two focal firms' SIC codes are not equal.

*Network centrality similarity:* To operationalize network measures of this kind, this study first constructs adjacency matrices by adopting five year moving window (Baum et al., 2005; Gulati & Gargiulo, 1999; Kogut, 1998). This study includes all alliance and M&A activities of the selected industries for the previous five years. Two concerns arise here. First, there might be firms that have never appeared in a list of alliance and M&A transactions. These firms are not identified as nodes in the adjacency matrices, but could be significant players in the industries. If these firms are not included, the normalization of network measures that is required for longitudinal comparability can be imprecise. To address this concern, this research identifies all the firms in the selected industries in the COMPUSTAT in each focal year and includes all of them as nodes.

---

33 It is noted that Wang and Zajac (2007) employs the North American Industrial Classification System (NAICS) instead of SIC codes.
when adjacency matrices are constructed. These firms serve as nodes in the adjacency matrices but are not allowed to have edges or relations. Second, there should be a left-censoring concern. To address this concern, this research constructs the adjacency matrices five years after the beginning point of the data.

Measures of network centrality are broadly classified into two distinct categories depending on whether they take into account global or local network (Scott, 2000; Wasserman & Faust, 1994). Since our theory concerns the centrality in the global network, network centrality is operationalized as eigenvector centrality, one of the measures of global centrality (Bonacich, 1972, 1987). Conceptually, the eigenvector centrality considers not only the centralities of direct ties but those of their partners, those of their partners' partners, and so on —i.e., the overall set of successive cascading relations. Viewed through the lens of matrix algebra, this measure is indeed a solution to a system of equations through Eigendecomposition of an adjacency matrix —i.e., eigenvector of the adjacency matrix. This study calculates the eigenvector centrality using UCINET 6.359 (Borgatti, Everett, & Freeman, 2002). Then, network centrality similarity of two focal firms is operationalized as the ratio of the smaller to the larger centrality of the two focal firms (Gulati & Gargiulo, 1999). Thus, this measure is bounded between 0 and 1.

Network cluster co-location: First, network clusters in our adjacency matrices are identified by using Markov Clustering Algorithm (MCA), which was devised to partition a graph (Dongen, 2000, 2008). Based on the iterative procedures of matrix expansion and inflation, this algorithm breaks down a graph into non-overlapping clusters, the optimal number of which is determined by the graph's topological properties. To identify network clusters, this research uses UCINET 6.359 (Borgatti, Everett, & Freeman, 2002). According to results, there are 53 non-overlapping clusters during our sample period. Then, a dummy variable is created such that it is set to 1 when two focal firms are located in the same network cluster and 0 when the two focal firms are located in the different network clusters.
Expected information benefit: Prior literature conceptualizes direct ties and indirect ties as conduits of information (Ahuja, 2000; Burt, 1992). From a network perspective, alliance governance increases the number of direct and indirect ties of two focal firms. Accordingly, a firm may anticipate the information benefit derived from network expansion through alliance governance. To operationalize the expected information benefit of the alliance, for the sake of simplicity only local ties are considered, i.e., each firm's direct ties; thus, a firm's direct ties will be two-steps away indirect ties for its partner firm. Then, this study adopts Burt's (1991) frequency decay weighting scheme (refer to Ahuja, 2000 for further details), assuming that two focal firms decide to ally. This weighting scheme assigns a weight, $1-f_i/(N+1)$ to each tie, where $f_i$ is the total number of nodes that are reachable by path distance $i$, and $N$ is the total number of nodes that can be reachable independent of path distance. Since this study considers only local networks, it sets $i$ as 2 and calculates the expected information benefits for two focal firms. Then, we sum two focal firms’ expected information benefits and define that value as the expected information benefit through alliance governance.

In contrast, M&A, from a network standpoint, amalgamate two focal firms’ networks into one; in other words, M&A aggregates direct and indirect ties of two firms. Accordingly, a firm can predict ex ante the informational benefit from network consolidation through M&A governance. In M&A, the direct ties of a target firm become direct ties of its acquiring firm, a major difference from alliance governance where direct ties of a firm serves as just indirect ties of its partner firm. Recall that since this study considers each firm's direct ties only, it operationalizes the expected information benefit from M&A governance as the summation of direct ties. A corollary of this operationalization is that the expected information benefit of acquisition is always greater than that of alliance in a dyad since acquisition does not involve the decay of tie strength and concomitant information quality (Ahuja, 2000).

Expected network centrality increment: As discussed, eigenvector centrality, our measure of
network centrality, considers the overall set of successive cascading relations. To ensure the existence of a solution to a system of equations, the contribution of node centrality should decrease with a factor of a certain value as the node's path distance increases (Bonacich, 1987). As a generalization of the eigenvector centrality, Bonacich (1987) proposed beta centrality where beta represents attenuation speed per increment of one degree of separation. In most cases, the beta's limit is determined with reference to the largest eigenvalue of the adjacency matrix. Accordingly, this implies that in the case of alliance, a firm's eigenvector centrality contributes to its partner firm's eigenvector centrality by a factor of the beta, because the distance between them is one degree of separation, vice versa. Applying this logic, this study operationalizes the expected network centrality increment of a focal firm as its partner firm's network centrality multiplied by the beta. Then, those are aggregated for a given dyad.

On the other hand, M&A consolidates the two focal firms' networks into one; no attenuation arises. Thus, this study operationalizes the expected network centrality increment of acquirer/target just as the target/acquirer firm's centrality. Then, those are aggregated for a given dyad. As a natural consequence, the expected network centrality increment of M&A is always greater than that of alliance as a factor of beta in a dyad. According to the data, the beta ranges between 0.12 and 0.14 in our sample period.

4.3.3 Controls

Following prior literature of dyadic analysis, this study controls for a number of variables to exclude possible alternative explanations. Financial resources and firm performances also affect governance choices. Several financial and accounting variables are deployed into regression models, in order to control for their effects on the governance choice between alliance and M&A. Relative size is a predictor of alliance formation and M&A incidence (Gulati, 1995; Seth, Song, & Pettit, 2000; Wang & Zajac, 2007). For instance, if the sizes of the two firms are fairly different,
M&A could be preferred. On the other hand, if the sizes are similar, alliance could be preferred (Hennart & Reddy, 1997, 2000). Relative size is calculated by a ratio of larger total asset divided by smaller total asset, of two focal organizations in a dyad (Gulati & Gargiulo, 1999). Firms with ample slack resources may have higher likelihood of opting for M&A (Tan & Peng, 2003; Lin, Peng, Yang, & Sun, 1999; Jensen, 1986). Relative firm performance may affect the governance of interfirm interdependence and cooperation (Gulati, 1995). We measure firm performance by return on assets (ROA). We follow Wang & Zajac (2007) to calculate relative ROA between two organizations. Relative solvency can affect the degree of complementarity between two focal firms’ businesses and thereby the incidence of alliance or M&A (Gulati & Gargiulo, 1999).

This study controls for prior alliance experience (combined) of the two focal firm dyad (Gulati & Gargiulo, 1999). As learning theory suggests, prior experience increases the efficiency of the activity involved, based on feedback loops and iterative learning (Lavie, Stettner, & Tushman, 2010; Zollo & Winter, 2002). We compute the number of alliances the focal firm has entered in the prior five years and sum them up for a given dyad. In a similar vein, this study inserts prior M&A experience (combined) of two focal firms in a dyad, in order to control for organization-specific learning effects of M&A experience. We compute the number of M&A a focal firm has involved in the previous five years and then sum them up for the dyad. Alliance history is also inserted, to control for dyad-specific effects associated with trust, information asymmetry, and relational routines (Dyer & Singh, 1998; Gulati, 1995a, 1995b). This is measured as the number of alliances that two focal firm has entered together in the previous five years. This 5 year-moving window is consistent with the width of moving window used for the construction of interfirm adjacency matrix.
A dummy variable for each year is also included over the period from 1995 to 2010, in order to control for unobserved yearly effects of macro-economic shocks and environmental changes on governance choices. Table 4.1 summarizes control variables and their operationalization.

4.3.4 Estimation Technique

Given that our dependent variable is binary, this study uses probit regression models\(^{34}\) as follows (Greene, 2008):

\[
p(y = 1|x) = \int_{-\infty}^{x\beta} \phi(t)dt = \Phi(x'\beta)
\]

where \(\phi(\cdot)\) and \(\Phi(\cdot)\) is the standard normal density and distribution function, respectively, and \(x\) and \(\beta\) covariate matrix and parameter vector, respectively. To control for heteroscedasticity, this study reports robust standard errors. For estimations, this study uses probit command with request for Huber/White/sandwich variance estimator in STATA 11 (StataCorp., 2009).

Notably, for a test of hypothesis 5 and 6, conditional probit model is used. It is a generalization of probit models that are capable of accommodating choice-specific variables. This is because the hypotheses make use of choice-specific attributes over and above individual-specific variables. Put more specifically, hypothesis 5 and 6 rest upon a presumption that the expected benefits vary according to the choice between alliance and M&A. Thus, expected benefits are inherently choice-specific. For estimations, this study uses asmprobit command with a request for Huber/White/sandwich variance estimator in STATA 11 (StataCorp., 2009).

---

\(^{34}\) Compared to logistic distribution, the standard normal distribution is thinner in the tails. However, in most cases, logit and probit regression generate almost similar results (Greene, 2008). For robustness check, this study also conducts logit regressions and finds consistent patterns. Since some dyads appear more than once, we also conduct panel data models of probit/logit regressions and found similar pattern.
4.4 RESULTS

Table 4.2 presents the descriptive statistics and correlations for all variables used in the analysis. In order to reduce non-essential collinearity, all the variables used in the interactions were mean-centered (Cohen et al., 2003). For ease of interpretation, the non-centered variables were used to create the descriptive statistics. While most correlation coefficients are modest and below 0.4, the correlation of the interaction term with resource similarity is too high, raising a concern of multi-collinearity. Hence, this study calculates and examines variance inflation factors (VIFs) and condition numbers for all models. The largest VIF was far below 10, with mean VIF 1.75, and the condition number is also below 20; thus, there is little concern about multi-collinearity (Greene, 2008).

Table 4.3 shows the results for (conditional) probit estimates for governance choice. Model 1 presents a baseline model which includes only control variables. As expected, the differential of profitability increases the likelihood of M&A being selected. Consistent with previous literature, prior alliance experience increases the chance of alliance to be selected, whereas prior M&A experience increases the chance of M&A to be selected. Although the effect of alliance history is not significant, this makes sense in that some potential acquirers could choose alliance first to reduce the information asymmetry and risk of outright acquisition (Folta, 1998; Folta & Miller, 2002; Miller & Folta, 2002).

Model 2 inserts resource similarity. According to the result, this study finds no support for hypothesis 1. However, according to the results of the models controlling for network cluster co-location, hypothesis 1 is supported. In particular, in models 6, 7, and 8, resource similarity is significant at p<0.01. Thus, this study finds partial support for hypothesis 1 with a condition that

---

35 The choice-specific variables were not included since the correlations with individual-specific variables are not defined and calculated.
network cluster co-location is controlled for.

Model 3 introduces network centrality similarity. According to the result, hypothesis 2a is strongly supported, instead of hypothesis 2b. The coefficients are significant at p<0.001 across the models. That is, when the focal firms' network centralities are similar, alliance governance is preferred.

Model 4 introduces network cluster co-location. We find strong support for hypothesis 3. In other words, if a potential partner firm comes from the same network cluster, a focal firm chooses M&A over alliance. Model 5 inserts the interaction term between resource similarity and network cluster co-location. Hypothesis 4 is supported at p<0.1. Stated differently, if a potential partner firm is located in the same network cluster, the positive effect of resource similarity on the likelihood of M&A being chosen becomes greater.

Models 6 to 8 insert the expected information benefit and the expected network centrality increment. The results do not support hypotheses 5 and 6. Interestingly enough, the signs are opposite to our expectation and very significant. In other words, a governance choice that will yield greater network benefits is less likely to be selected even after all other individual-specific variables are controlled for. These unexpected results merit further meticulous consideration, and we will delve deeper into them in the discussion section.

According to the literature, the marginal effects of covariates vary with the values of the covariates because probit models are based upon a non-linear, normal distribution (Greene, 2008; Hoetker, 2007; Zelner, 2009). To account for this possibility, the current practice is to report the average marginal effects, if possible (Hoetker, 2007; Long & Freese, 2006; Wooldridge, 2002). The average marginal effects are calculated by first computing individual marginal effects and then averaging them out in the entire sample. To calculate average marginal effects, this study uses margins command in STATA 11 (StataCorp., 2009). Table 4.4 presents the average marginal effects of all the models. The results show that the average marginal effects are fairly consistent.
with the previous findings, raising no concern of inaccurate statistical conclusions that stem from the non-linear probability distribution of probit models.

4.5 DISCUSSION AND FUTURE STUDY

4.5.1 Discussion

This research was motivated by an observation that the intersection of network literature in strategy and governance literature is remarkably underexplored yet. Although many studies have shed light on the impact of interfirm networks on a class of firms’ strategic choices – alliance formation, extant literature does not provide answers to the association between networks and heterogeneity in governance choices. Whereas extant literature is successful at showing the importance of networks on alliance formation, it cannot predict which governance mode – alliance or M&A – will be opted for, given a network structure.

This study contributes to interfirm network literature and governance literature, by disentangling the heterogeneity in governance choices from a network based perspective. It is found that network centrality similarity and network cluster co-location determine the governance choice between alliance and M&A. More importantly, an empirical evidence of the interaction between resource and network constructs is captured. For those analyses, this research takes an approach, which is based on dyadic conceptualization of governance choice (Zajac & Olsen, 1993) and network management perspective (Doz, 1996; Madhavan, Koka, & Prescott, 1998; Rowley & Baum, 2004), to those analyses.

This research’s finding on the association between resource/business similarity and the choice between alliance and M&A confirms previous findings. As two focal firms are more similar in terms of resource/business, M&A is more preferred to alliance governance. However, on the other hand, this study finds that resource similarity’s impact on governance choice is
moderated by focal firms’ relative network cluster co-locations. A primary mechanism of moderation is that the membership in a network cluster works as a source of information on potential partners’ behavior and resources and capabilities. Without simultaneously considering network based factors, resource based factors cannot accurately explain heterogeneity in governance choices. This finding indicates an important interaction between resource base view and “network base view” of governance choices. This finding has two fold implications regarding resource based and network based views of governance choice. Since networks shape information and resource flows around focal firms, a resource based view of governance choice which considers only resource bases of focal firms per se has inherently limited explanatory power. At the same time, since network structures moderate the association between resource attributes and governance choice, an interfirm network analysis without accounting for resource attributes has its own limitation. This observation underscores the importance of joint analysis of network structures and characteristics of nodes – firm level attributes (Phelps, 2010).

This study’s finding as to the effects of network centrality similarity on governance choice contradicts Yang et al.(2010)’s finding. It is argued that Yang et al.(2010) has theoretical issues in their formulation of a hypothesis regarding the effect of network status similarity on the governance choice between alliance and M&A. Yang et al. (2010) argues that network-status-wise similar firms tend to opt for M&A over alliance, because through alliance a firm with lower status is legitimized by a firm with higher status and a firm with higher status has a higher bargaining power and thus appropriates more from an exchange with the firm with a lower network status. There are two issues here. First, they do not clearly indicate what an exchange between the focal firms involves; what does a firm with higher status receive in return for

36 Our discussion specifically relates to Yang et al. (2010), precisely because that is the only study that examines the impact of networks on the choice between alliance and M&A in the extant literature.
legitimizing a firm with a lower status? A possible scenario is that a lower status firm brings its own resources (e.g. technology complementary with resources of the higher status firm) in exchange for legitimization. Even if this scenario is the actual case\textsuperscript{37}, their model specification and analysis do not allow them to claim the validity of such reasoning. In order to claim validity, they should include into their regression models an interaction term between technology complementarity and network status similarity and get a positive coefficient with statistical significance. Furthermore, our finding related to the hypothesis 4 indirectly suggests that network-status-wise similar firms engage in alliance in order to exchange complementary resources rather than network status. This implication runs against Yang et al. (2010)’s justification of their regression result, a positive correlation between high network status similarity and firms’ preference for M&A over alliance. Second, Yang et al.(2010) does not actually specify why M&A is superior to alliance in terms of status exchange, under a condition of high network status similarity. Although status exchange is the primary logic in their argument regarding alliance governance, it is not deployed at all into their argument regarding M&A. To be a more accurate comparative governance analysis, Yang et al. (2010) had to apply the same criteria to both arguments on alliance and M&A. It is argued that contrary to their reasoning, M&A can be a governance form which enables a focal firm with a higher network status to bypass status damage stemming from an exchange with a lower network status firm, while exploiting complementarities between them.

From network based view of governance choice, on one hand, firms make governance decisions based on the opportunities and constraints imposed by existing network structures. On

\textsuperscript{37} In fact, many studies (e.g. Gulati & Gargiulo, 1999; Podolny, 1993) suggest that the likelihood that this scenario is realized is not high. Empirical evidence suggests that ceteris paribus alliance occurs between firms which are similar in terms of network centrality, a case of structural homophily (Podolny, 1994; McPherson, Smith-Lovin, & Cook, 2001; Piskorski & Anand, 2006).
the other hand, firms may make governance decisions based on expected informational & resource benefits and positional advantages conferred on themselves by shaping specific network structures through governance choice – a forward looking perspective of the network based approach to governance choice. Hypotheses 5 and 6 examined the latter perspective of a network based view of governance choice.

While expected resource benefits and positional advantages are statistically significant predictors of the governance choice between alliance and M&A, the sign of the corresponding regression coefficients are opposite to this study’s predictions. In the current analysis, the cost side of positional advantages and governance choices is not taken into account. Even if M&A can provide greater positional advantages and network resources than alliance, higher cost and risk associated M&A, such as less flexibility, more sunk investments (McGrath, 1997; Folta, 1998; Leiblein & Miller, 2003) and greater negative impact stemming from uncertainty about potential partners, may discourage firms to opt for M&A over alliance. It is further asserted that industry level factors can shape this result. Given a fact that computer industry is one of high technology industries characterized by a high level of technological and market uncertainty, alliance governance can be preferred to hierarchical M&A governance as a more flexible means to get access to network resources of partner firms. Also, given a brief qualitative observation of this study’s focal industry, computer industry, equity alliance transactions are rarely observed. This may indicate that in this industry less hierarchical controls are preferred when firms access to resources across firm boundaries. This observation may be extended into a rationale behind the governance of network resources. Although direct ties confer on a focal firm more extent of control over network resources, it’s more costly to maintain direct ties than indirect ties (Burt, 2005). Due to specific attributes of the computer industry, the cost of owning direct ties may outweigh the benefits of owning direct ties, leading to firms’ average preference for the ownership of indirect ties over direct ties. In turn, this results in firms’ preference for alliance,
relative to M&A, as a means of controlling network resources.

4.5.2 Future Study

It is hypothesized that those specific attributes of the industry, which affect relative attractiveness of M&A over alliance governance, are the level of uncertainty, the diversity of resources, in particular technology, and the degree of clustering. If the “width” of information is more important than the “depth” of information, maintaining a higher number of indirect ties though a portfolio of alliances is a better choice than owning direct ties through M&A. If the degree of global clustering of an intra-industry network is higher, it is likely that network resources brought by ties with two different firms are more redundant each other. Hence, owning indirect ties through alliance governance will entail less loss from redundancies between network resources accessed through interfir links with different firms, than owning direct ties through M&A. In order to corroborate assertions made above, this study has to test hypotheses 5 and 6 in different industry settings, where those three parameters vary.

For a complete analysis of the forward looking network perspective of governance choice, joint consideration of link and node characteristics for the analysis of expected positional advantage gains is required. This study acknowledges that for a better and more rigorous test of reasoning behind the hypothesis 4, interaction between network and resource constructs can be tested by a term network cluster co-location x resource unobservability attributes rather than by a term network cluster co-location x resource similarity. Assertions made in this discussion section merit further empirical corroboration as a future study.

Also in terms of methodology, this study acknowledges further room for improvement. First, a more refined measure of resource similarity between focal firms can be used in future study. An alternative similarity measure is Mowery, Oxley & Silverman (1998)’s measure of resource redundancy. Second, in future study, we will consider changing the unit of analysis and
dependent variable, for better controls of fixed and random effects and correlation between years. Whereas the unit of analysis in the current analyses is transaction, firm-year level will be considered as a primary unit of analysis. With this updated unit of analysis, dependent variable accordingly changes from a binary choice variable to a count variable. With a count dependent variable, which indicates the number of alliance or M&A transactions of a focal firm, a negative binomial or poisson distribution will be used for regression analysis.
### Table 4.1 Control Variables and Their Operationalization

<table>
<thead>
<tr>
<th>Measure</th>
<th>Operationalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size similarity</td>
<td>Measured by total asset (AT). Similarity measure operationalized by $\frac{Max(AT)}{Min(AT)}$.</td>
</tr>
<tr>
<td>Performance similarity (ROA</td>
<td>Measured by net income (NI) divided by total asset (AT). Similarity measure operationalized by $\frac{\exp(NI/AT_i) - \exp(NI/AT_j)}{\exp(NI/AT_i) + \exp(NI/AT_j)}$.</td>
</tr>
<tr>
<td>Slack similarity</td>
<td>Measured by current asset (AC) divided by current liability (LC). Similarity measure operationalized by $\frac{Max(AC/LC)}{Min(AC/LC)}$.</td>
</tr>
<tr>
<td>Solvency similarity</td>
<td>Measured by long term debt (DL) divided by current asset (AC). Similarity measure operationalized by $\frac{Max(AC/LC)}{Min(AC/LC)}$.</td>
</tr>
</tbody>
</table>
Table 4.2 Descriptive statistics\textsuperscript{a,b}

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Size similarity</td>
<td>0.187</td>
<td>0.258</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Relative ROA</td>
<td>-0.016</td>
<td>0.202</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Relative slack</td>
<td>1.969</td>
<td>2.699</td>
<td>-0.02</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Relative solvency</td>
<td>0.309</td>
<td>0.943</td>
<td>-0.02</td>
<td>-0.16</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Prior alliance experience (combined)</td>
<td>28.017</td>
<td>36.652</td>
<td>-0.29</td>
<td>-0.05</td>
<td>-0.10</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Prior M&amp;A experience (combined)</td>
<td>2.588</td>
<td>3.536</td>
<td>-0.07</td>
<td>0.01</td>
<td>-0.17</td>
<td>0.10</td>
<td>0.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Alliance history</td>
<td>0.08</td>
<td>0.405</td>
<td>0.00</td>
<td>0.02</td>
<td>-0.04</td>
<td>0.01</td>
<td>0.31</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Resource similarity (A)</td>
<td>0.63</td>
<td>0.401</td>
<td>0.12</td>
<td>-0.02</td>
<td>0.05</td>
<td>-0.03</td>
<td>-0.10</td>
<td>-0.10</td>
<td>-0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Network centrality similarity</td>
<td>0.077</td>
<td>0.197</td>
<td>0.22</td>
<td>-0.01</td>
<td>-0.06</td>
<td>0.02</td>
<td>0.07</td>
<td>0.18</td>
<td>0.29</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Network cluster co-location (B)</td>
<td>0.04</td>
<td>0.197</td>
<td>0.07</td>
<td>0.01</td>
<td>-0.04</td>
<td>-0.03</td>
<td>0.10</td>
<td>0.09</td>
<td>0.32</td>
<td>0.01</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>11. (A) X (B)</td>
<td>0.026</td>
<td>0.144</td>
<td>0.05</td>
<td>-0.02</td>
<td>0.04</td>
<td>-0.02</td>
<td>-0.09</td>
<td>-0.13</td>
<td>-0.07</td>
<td>0.83</td>
<td>-0.07</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

\textsuperscript{a} correlation of $|0.057|$ or greater significant at $p<0.05$

\textsuperscript{b} choice-specific variables-the expected information benefit and expected network centrality increment-are not included.
### Table 4.3 Probit estimates

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size similarity</td>
<td>-0.125</td>
<td>-0.170</td>
<td>0.072</td>
<td>0.226</td>
<td>0.194</td>
<td>0.001</td>
<td>0.082</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.185)</td>
<td>(0.192)</td>
<td>(0.276)</td>
<td>(0.288)</td>
<td>(0.288)</td>
<td>(0.427)</td>
<td>(0.418)</td>
<td>(0.428)</td>
</tr>
<tr>
<td>Relative ROA</td>
<td>0.960***</td>
<td>0.947***</td>
<td>1.234***</td>
<td>1.321***</td>
<td>1.313***</td>
<td>1.765***</td>
<td>1.857***</td>
<td>1.741***</td>
</tr>
<tr>
<td></td>
<td>(0.251)</td>
<td>(0.252)</td>
<td>(0.334)</td>
<td>(0.335)</td>
<td>(0.335)</td>
<td>(0.484)</td>
<td>(0.479)</td>
<td>(0.485)</td>
</tr>
<tr>
<td>Relative slack</td>
<td>0.070***</td>
<td>0.073***</td>
<td>-0.036</td>
<td>-0.019</td>
<td>-0.024</td>
<td>-0.039</td>
<td>-0.040</td>
<td>-0.038</td>
</tr>
<tr>
<td></td>
<td>(0.200)</td>
<td>(0.205)</td>
<td>(0.23)</td>
<td>(0.24)</td>
<td>(0.033)</td>
<td>(0.035)</td>
<td>(0.035)</td>
<td></td>
</tr>
<tr>
<td>Relative solvency</td>
<td>-0.396*</td>
<td>-0.411*</td>
<td>-0.505*</td>
<td>-0.301</td>
<td>-0.328</td>
<td>-0.273</td>
<td>-0.305</td>
<td>-0.293</td>
</tr>
<tr>
<td></td>
<td>(0.193)</td>
<td>(0.200)</td>
<td>(0.277)</td>
<td>(0.264)</td>
<td>(0.274)</td>
<td>(0.356)</td>
<td>(0.377)</td>
<td>(0.353)</td>
</tr>
<tr>
<td>Prior alliance experience (combined)</td>
<td>-0.020***</td>
<td>-0.020***</td>
<td>-0.015***</td>
<td>-0.015***</td>
<td>-0.015***</td>
<td>-0.002</td>
<td>-0.009+</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td></td>
</tr>
<tr>
<td>Prior M&amp;A experience (combined)</td>
<td>0.085***</td>
<td>0.085***</td>
<td>0.092***</td>
<td>0.116***</td>
<td>0.112***</td>
<td>0.147***</td>
<td>0.181***</td>
<td>0.133***</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.027)</td>
<td>(0.027)</td>
<td>(0.028)</td>
<td>(0.039)</td>
<td>(0.040)</td>
<td>(0.043)</td>
<td></td>
</tr>
<tr>
<td>Alliance history</td>
<td>-0.065</td>
<td>-0.065</td>
<td>0.251*</td>
<td>0.120</td>
<td>0.079</td>
<td>0.247</td>
<td>0.172</td>
<td>0.261</td>
</tr>
<tr>
<td></td>
<td>(0.162)</td>
<td>(0.122)</td>
<td>(0.134)</td>
<td>(0.143)</td>
<td>(0.238)</td>
<td>(0.205)</td>
<td>(0.245)</td>
<td></td>
</tr>
<tr>
<td>Resource similarity (A)</td>
<td>0.082</td>
<td>0.096</td>
<td>0.287+</td>
<td>0.632*</td>
<td>0.926*</td>
<td>0.946*</td>
<td>0.913*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.102)</td>
<td>(0.140)</td>
<td>(0.158)</td>
<td>(0.247)</td>
<td>(0.355)</td>
<td>(0.359)</td>
<td>(0.353)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.506)</td>
<td>(0.510)</td>
<td>(0.494)</td>
<td>(0.613)</td>
<td>(0.664)</td>
<td>(1.066)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network cluster co-location (B)</td>
<td>0.681***</td>
<td>0.763***</td>
<td>0.903***</td>
<td>1.076***</td>
<td>0.858**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.196)</td>
<td>(0.200)</td>
<td>(0.294)</td>
<td>(0.293)</td>
<td>(0.294)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) X (B)</td>
<td>1.320+</td>
<td>1.905+</td>
<td>1.954+</td>
<td>1.883+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected information benefit (combined)</td>
<td>-0.123***</td>
<td>-0.158***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.028)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected status increment (combined)</td>
<td>-0.026***</td>
<td>0.013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.013)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>858</td>
<td>858</td>
<td>537</td>
<td>537</td>
<td>537</td>
<td>537</td>
<td>537</td>
<td>537</td>
</tr>
<tr>
<td>log-likelihood</td>
<td>-468.7</td>
<td>-468.4</td>
<td>-256.7</td>
<td>-251.4</td>
<td>-249.7</td>
<td>-239.0</td>
<td>-244.0</td>
<td>-238.6</td>
</tr>
<tr>
<td>Chi-squared</td>
<td>161.5***</td>
<td>160.1***</td>
<td>199.1***</td>
<td>213.1***</td>
<td>217.3***</td>
<td>175.7***</td>
<td>190.3***</td>
<td>177.9***</td>
</tr>
</tbody>
</table>

a. robust standard errors in parentheses
b. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1
c. year dummies included, but not reported
d. probit regression estimates
e. conditional (choice-specific) probit regression estimates
Table 4.4  Average partial effects$^{a,b,c,d,e}$

<table>
<thead>
<tr>
<th></th>
<th>(1)$^d$</th>
<th>(2)$^d$</th>
<th>(3)$^d$</th>
<th>(4)$^d$</th>
<th>(5)$^d$</th>
<th>(6)$^d$</th>
<th>(7)$^d$</th>
<th>(8)$^d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size similarity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.039</td>
<td>-0.053</td>
<td>0.019</td>
<td>0.059</td>
<td>0.050</td>
<td>0.000</td>
<td>0.016</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.058)</td>
<td>(0.059)</td>
<td>(0.074)</td>
<td>(0.075)</td>
<td>(0.075)</td>
<td>(0.080)</td>
<td>(0.080)</td>
<td>(0.080)</td>
</tr>
<tr>
<td>Relative ROA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.300***</td>
<td>0.295***</td>
<td>0.331***</td>
<td>0.345***</td>
<td>0.340***</td>
<td>0.330***</td>
<td>0.358***</td>
<td>0.324***</td>
</tr>
<tr>
<td></td>
<td>(0.077)</td>
<td>(0.076)</td>
<td>(0.088)</td>
<td>(0.086)</td>
<td>(0.086)</td>
<td>(0.093)</td>
<td>(0.094)</td>
<td>(0.092)</td>
</tr>
<tr>
<td>Relative slack</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.022***</td>
<td>-0.022***</td>
<td>-0.009</td>
<td>-0.004</td>
<td>-0.006</td>
<td>-0.007</td>
<td>-0.008</td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Relative solvency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.124*</td>
<td>-0.128*</td>
<td>-0.135+</td>
<td>-0.078</td>
<td>-0.085</td>
<td>-0.051</td>
<td>-0.058</td>
<td>-0.055</td>
</tr>
<tr>
<td></td>
<td>(0.060)</td>
<td>(0.061)</td>
<td>(0.074)</td>
<td>(0.069)</td>
<td>(0.071)</td>
<td>(0.067)</td>
<td>(0.072)</td>
<td>(0.066)</td>
</tr>
<tr>
<td>Prior alliance experience (combined)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.006***</td>
<td>-0.006***</td>
<td>-0.004***</td>
<td>-0.003***</td>
<td>-0.003***</td>
<td>0.000</td>
<td>-0.002+</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Prior M&amp;A experience (combined)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.027***</td>
<td>0.026***</td>
<td>0.024***</td>
<td>0.030***</td>
<td>0.029***</td>
<td>0.027***</td>
<td>0.034***</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.007)</td>
<td>(0.006)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Alliance history</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.020</td>
<td>-0.02</td>
<td>0.067*</td>
<td>0.031</td>
<td>0.020</td>
<td>0.046</td>
<td>0.033</td>
<td>0.048</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.050)</td>
<td>(0.031)</td>
<td>(0.035)</td>
<td>(0.037)</td>
<td>(0.044)</td>
<td>(0.039)</td>
<td>(0.046)</td>
</tr>
<tr>
<td>Resource similarity (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.025</td>
<td>0.025</td>
<td>0.075+</td>
<td>0.164**</td>
<td>0.173**</td>
<td>0.182**</td>
<td>0.170**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.037)</td>
<td>(0.041)</td>
<td>(0.064)</td>
<td>(0.066)</td>
<td>(0.070)</td>
<td>(0.066)</td>
<td></td>
</tr>
<tr>
<td>Network centrality similarity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.459***</td>
<td>-0.502***</td>
<td>-0.557***</td>
<td>-0.386***</td>
<td>-0.491***</td>
<td>0.378***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.131)</td>
<td>(0.130)</td>
<td>(0.125)</td>
<td>(0.114)</td>
<td>(0.125)</td>
<td>(0.113)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network cluster co-location (B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.178***</td>
<td>0.198***</td>
<td>0.207**</td>
<td>0.258***</td>
<td>0.195**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.050)</td>
<td>(0.076)</td>
<td>(0.079)</td>
<td>(0.079)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) X (B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.342+</td>
<td>0.356+</td>
<td>0.376+</td>
<td>0.350+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.193)</td>
<td>(0.196)</td>
<td>(0.210)</td>
<td>(0.193)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected information benefit (combined)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected status increment (combined)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>858</td>
<td>858</td>
<td>537</td>
<td>537</td>
<td>537</td>
<td>537</td>
<td>537</td>
<td>537</td>
</tr>
</tbody>
</table>
a. robust standard errors in parentheses
b. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1
c. year dummies included, but not reported
d. average marginal effects
e. marginal effects at mean
APPENDIX A

DEFINITION OF GOVERNANCE, GOVERNANCE FORMS, INTERORGANIZATIONAL NETWORKS, AND NETWORK TERMINOLOGIES

A.1 Governance Forms and Interorganizational Networks

The scope of the term, governance, in this study is within organizational governance – a firm’s choice between market, hierarchy, and hybrid governance to organize an economic exchange (Williamson, 1985, 1991). It also involves features of governing interorganizational relationships for economic exchanges such as contracts, administrative controls, equity ownership, and behavioral norms such as trust.

In market governance, the mechanism of governance is autonomous coordination through price as a sufficient statistic. In the case of hierarchy, authority or managerial fiat is a governing mechanism (Coase, 1937; Williamson, 1991). Hierarchical controls involve ownership and administrative structures such as command structure & authority systems, incentive systems, standard operating procedures, dispute resolution procedures, and non-market pricing systems (Stinchcomb, 1985; Gulati & Singh, 1998). Differing mechanisms of governance forms lead to the differentials in safeguard, coordination, and adaptation of economics exchanges due to differing capacities of incentive intensity, monitoring, and dispute resolution (Nickerson & Zenger, 2004; Leiblein & Macher, 2009; Williamson, 1991; Poppo & Zenger, 1998).

Coase (1937) first introduced discrete and dichotomous categorization of governance forms: market and hierarchy. Williamson (1975; 1979) conceptualized governance forms in terms of
continuous spectrum, with market and hierarchy at each end of the spectrum. Williamson (1991) later added one more discrete form of governance, “hybrid governance form”, in order to explain frequent mixed governance forms observed in the real world. Meanwhile, Powell (1990) argued that certain governance forms such as network organizations and alliances cannot be properly represented by “hybrid governance form”, because they are not equivalent to a simple interpolation of market and hierarchy in many aspects: (elaborate & cite from Powell, 1990).

Network is a representation of a set of relationships, links, amongst entities, nodes. The structure of a network specifies the patterns of interactions amongst entities in the network. In this study, the focus of analyses is at the interorganizational level where each firm corresponds to a node and an inter-firm relationship to a link.

There are multiple domains and levels of interorganizational linkages. From the value chain standpoint, there can be links within and across suppliers, focal firms, and buyers. With respect to the levels of interorganizational network, micro links and/or macro links between organizations can exist. Micro links denote interpersonal linkages between individual boundary spanners of two focal organizations connected through the network link (Zaheer, McEvily, & Perrone, 1998; Katz & Kahn, 1978). Boundary spanners engage more actively in the interorganizational relationships than other individuals in a focal organization and act on behalf of their own organizations (Zaheer, McEvily, & Perrone, 1998; Friedman & Podolny, 1992). Macro links are associated with the organizational structures and routines that are institutionalized, between organizations, through repeated interactions between boundary spanners (Zucker 1977; Zaheer, McEvily, & Perrone, 1998). In spite of turnovers of individual boundary spanners, macro links can be steady under certain conditions (Ring & Van de Ven, 1994). This study focuses on networks of horizontal formal interorganizational market ties. Market ties are established between organizations when
the focal organizations exchange goods, services, and/or money (Baker, 1990). This study claims that the strengths of links differ, depending on the governance form used to organize those kinds of economic exchanges. Thus, this study takes a weighted network approach to interorganizational linkages, where network structures are specified not only by the topologies of the networks but also by the distribution of strength of interactions amongst organizations.

A.2. Definition and boundary of governance functions

This study takes a functionality approach to governance. From a functional aspect of governance, governance mechanism contends with such functions of governance as safeguarding, coordinating economic exchanges, and maximizing value creation through the exploiting complementary resources, while adapting the firm itself to changing environment. While this kind of governance dimensionalization approach has been adopted by a few recent studies (e.g., Zenger, Lazzarini, & Poppo, 2002; Agarwal, Siggelkow, & Singh, forthcoming; Nickerson & Zenger, 2004), none of these comprehensively address the complete set of governance functions.

Since each stream of research tends to mean safeguard, coordination, and adaptation functions of governance in somewhat different ways, for the purpose of this study, the boundary of each governance function is defined here. The meaning and boundary of safeguard function in this study is precisely consistent with TCE’s conception of safeguard function of governance. An efficiently aligned governance form minimizes expected governance costs stemming from ex post

---

38 The domains of interorganizational linkages are categorized by Baker & Faulkner (2002) as follows: i) market exchange (Baker, 1990), ii) strategic alliance (Gulati, 1995), iii) joint participation in an underwriting syndicate (Podolny, 1993), iv) director interlocks (Mizruchi, 1996), v) Political action (Neustadl & Clawson, 1988), vi) Family ties (Ze’’itlin et al., 1974), vii) Illegal activities, such as price-fixing conspiracies (Baker & Faulkner, 1993).
opportunistic behavior of parties to an exchange or those stemming from *ex post* holdup.

Whereas TCE’s notion of adaptation is rather focused on the need for realignment of cooperation between parties to an exchange under exogenous disturbances (Williamson, 1991; Gulati, Lawrence, & Puranam, 2005), this study distinguishes coordination function from adaptation function. Consistent with Organization Theory (e.g., Lawrence & Lorsch, 1967; Thompson, 1967), the knowledge based view of the firm (e.g., Kogut & Zander, 1996) and the problem solving perspective (e.g., Nickerson & Zenger, 2004; Leiblein & Macher, 2009), even without exogenous disturbances, the coordination of interdependent activities is a necessary function of governance.

Coordination is the alignment of actions (Gulati et al., 2005) or an endeavor to achieve the unity of efforts (Lawrence & Lorsch, 1967), in the presence of interdependency within firm or across firm boundaries. With this perspective, “coordination” referred to by TCE is in fact “cooperation” that relates to the alignment of incentives (Gulati et al., 2005). Since the unit of analysis in this study is an inter-organizational linkage at the dyadic and network levels, the focus of this study is the coordination across firm boundaries.

Adaptation is the dimension of governance functions that are most diversely interpreted. In general, adaptation is the firm’s deliberate change of strategy and structure in response to environmental change. (Levinthal, 1994). TCE refers to two types of adaptation: autonomous and coordinative adaptation. (insert briefly each definition). Adaptation is the adjustment of contract in response to changing transactional environment. The level of analysis is dyad, in that adaptation in TCE is concerned with coordination between two parties to a contract. Coordination here is the alignment of incentives, which is different from the alignment of actions.

Organizational learning literature argues that the organization has the natural tendency toward exploitation, leading to organizational inertia and learning myopia. Whereas exploitation increases the likelihood of short term survival, it ultimately renders a firm vulnerable to
environmental change. Exploration breaks organizational inertia and increases the long term adaptibility. Thus, the balance between exploration and exploitation increases the adaptibility at the firm level. From the institutional perspective, social learning, imitation, and legitimacy adds to the adaptibility of a firm; strong ties are beneficial to adaptibility in this regard.

A.3. Glossary: Network terminologies

The following table explains major network terminologies used in this study:

<table>
<thead>
<tr>
<th>Terminology</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network</td>
<td>Network is a representation of a set of relationships, links, amongst entities, nodes. The structure of a network specifies the patterns of interactions amongst entities in the network.</td>
</tr>
<tr>
<td>Tie strength</td>
<td>At the interpersonal level, the determinants of tie strength are amount of time, emotional intensity, mutual codification, and reciprocal services between two focal entities that are connected through a network tie (Granovetter, 1973). At the interfirm level, Capaldo (2007) operationalizes interorganizational tie strength by means of three dimensions: temporal (Kraatz, 1998), resource commitment (Rowley et al, 2000), and social dimensions (Rindfleisch &amp; Moorman, 2001).</td>
</tr>
<tr>
<td>Network density</td>
<td>“The degree a respondent's ties know one another/ proportion of ties among an individual's nominees. Network or global-level density is the proportion of ties in a network relative to the total number possible (sparse versus dense networks).”</td>
</tr>
<tr>
<td>Degree centrality</td>
<td>“The number of links that a node has. Basically, centrality captures the impact of a given node to other nodes. Centrality measure in general gives a rough indication of the social power of a node based on how well they &quot;connect&quot; the network.”</td>
</tr>
</tbody>
</table>
| Betweenness centrality | “Betweenness centrality of a node \( v \) is the ratio of the number of shortest paths from all vertices to all others that pass through the node \( v \) to the number of shortest paths from all vertices except \( v \) to all others except \( v \). \[
g(v) = \sum_{s \neq v \neq t} \sigma_{st}(v)/\sigma_{st}
\]
where \( \sigma_{st} \) total number of shortest paths from node \( s \) to node \( t \) and \( \sigma_{st}(v) \) is the number of those paths that pass through \( v \)."
<table>
<thead>
<tr>
<th>Characteristic Path Length</th>
<th>Betweeness Centrality is a more useful measure of the load placed on the given node in the network as well as the node's importance to the network than just connectivity.</th>
</tr>
</thead>
</table>
| Clustering coefficient      | “For any connected graph G, the average distance between pairs of vertices is referred to as the graph's "characteristic path length."
More precisely, for any two vertices \(v\) and \(v'\) in \(V(G)\), let \(L(v,v')\) denote the shortest path length connecting \(v\) to \(v'\). Let \(L(v)\) denote the average of \(L(v,v')\) across all vertices \(v'\) in \(V(G)\) with \(v'\) not equal to \(v\). Finally, define the characteristic path length \(L(G)\) of \(G\) to be the average of \(L(v)\) across all vertices \(v\) in \(V(G)\), Watts (1999:26-33),” Excerpted from Tesfatsion (2008). |
| Structural hole             | “Static holes that can be strategically filled by connecting one or more links to link together other points. Linked to ideas of social capital: if you link to two people who are not linked you can control their communication.” |
APPENDIX B

NETWORK BASED SOLUTIONS FOR PROBLEMS IN THE
GOVERNANCE OF ECONOMIC EXCHANGES

This section stipulates the mechanisms that underlie the links from network structure to governance functionality. Each governance function - safeguard, coordination, and adaptation is considered in order.

B.1 Safeguard functionality of governance

Safeguard (A)

Figure A2.1 depicts a causal link from the strength of ties to the safeguard function of governance. Strong ties promote the development of social norms such as reciprocity, shared identity, shared language, and social attachment, further leading to institutionalization of trust between two organizations linked through a strong tie (Granovetter, 1973; Gulati, 1995). Trust may substitute or complement formal governance, lowering dependence on formal governance mechanisms (Dyer & Chu, 2003; Podolny, 1994; Walker, Kogut, & Shan, 1997).

Safeguard (B)

There is another mechanism for strong ties to lead to higher level of safeguard governance function. As several studies have shown (Jones et al, 1997; Kraatz, 1998; Uzzi, 1996), strong ties established through frequent exchange facilitate the transfer of fine grained information and tacit knowledge. This decrease information asymmetry between the parties linked through a strong tie.
Lower degree of information asymmetry, in turn, facilitates monitoring and control, also leading to better safeguard of economic exchange. Figure A2.2 depicts this causal link from the strength of tie to the governance functions of safeguard and control.

Safeguard (C)

Whereas the two preceding mechanisms of safeguard functionality operate at the dyadic level, there is another mechanism of safeguard that works at the structural level. High network density and thus a high level of redundancy facilitates triangulation of information and rapid dissemination of reputation (Coleman, 1990; Rowley, 2000; Dyer & Singh, 1998). In such network structures, information acquired from multiple channels can be compared each other, and common organizations within redundant ties may act as referral agents (Ahuja, 2000; Gulati, 19995), result. In turn, these informational mechanisms promote monitoring and coordination (Coleman, 1990), acting as a safeguard functionality. Thus, two focal firms to an exchange are embedded in a dense network are exposed to less risk from opportunism when exchanges are governed by market or alliance governances. Figure A2.3 describes this causal link from network clustering to safeguard/control function of governance.

Given this, high level of network density and strength of ties can substitute each other, in terms of the governance functions of safeguard.

B.2 Adaptation functionality of governance

Adaptation (a)

The mix of strong and weak ties in a focal firm’s network influences short run concerns and long run viability of organizations. As argued by Granovetter (1973) and other subsequent studies (e.g., Zaheer & Zaheer, 1997), a focal firm tends to acquire novel information through weak ties rather than strong ties. Reciprocal exchanges and frequent interactions that characterize a strong
tie lead to a high degree of similarity in the information of two organizations connected through a strong tie (Granovetter, 1973). A set of wide-ranging weak-ties enable a focal firm to be cognizant of information and opportunities (Zaheer & Zaheer, 1997). Given that network ties of a focal firm are conduits for information and resources, weak ties increases the width of search and strong ties the depth of search.

Exploration and exploitation (Koza & Lewin, 1999?) are two genetic strategies for adaptation. Exploration, maintenance of a good level of diversity in information and resources through experimentation, is necessary for the generation of diverse alternatives and thus for the long run viability of organizations (March, 1991). At the same time, exploitation, refinement of existing routines and selected alternatives, is required to ensure the survival of organizations. As argued above, strong ties promote exploitation and weak ties exploration. In all, the composition of strong and weak ties of a focal firm determines the balance between exploration and exploitation and thus adaptability of the organization (e.g., Lavie & Rosenkopf, 2006). Figure A2.4 summarizes such an association between a dyadic level network property and the adaptation functionality.

On the other hand, some studies found (e.g., Kraatz 1998) that strong ties are critical for the adaptability of organizations under significant uncertainty, in contrast to the studies that argue that as degree of uncertainty increases more weak ties are required (e.g., Rowley et al 2000). It is argued that the latter holds in the case of moderate uncertainty level whereas the former holds in the case of high uncertainty level to the extent of Knightian uncertainty.

When uncertainty level is low to medium, maintaining a good level of diversity is valuable for adaptation. In combination with diverse information garnered through weak ties, such variation mechanisms as recombination and mutation increase the number of alternatives, leading to a sufficient level of differentiation that may match contingencies generated by uncertainty.

When uncertainty level is very high, while diverse information gleaned through a set of
weak ties is still helpful for adaptation, the quality of information and trustworthiness become critical. When it is hard for a firm to anticipate consequences and implications of environmental change, fine grained information from trustworthy organizations through strong ties can be more valuable for adaptive decision making than diverse information gathered through a number of transient weak ties (Rogers, 1995; Kraatz, 1998). Strong ties promote adaptation by means of intense information sharing and communication (Uzzi, 1996; Kraatz, 1999).

*Adaptation*(b)

Whereas the preceding section deals with how network property at the dyad level affects the balance between exploitation and exploration, this section looks at the association between the network property at structural level and adaptation function of governance. Two structural variables are considered: local network density and degree of clustering.

Higher degree of clustering implies higher extent of redundant links amongst interconnected firms. Redundant network structure can hamper exploration which otherwise can be facilitated in sparse network. Granovetter (1973) claimed that information that firms in a dense cluster have tends to be homogenous. Sparse network facilitates exploration through structural holes (Burt, 1992; Ahuja, 2000). Network composed of redundant ties restrict exploratory search and decrease the level of diversity (Walker et al., 1997). Kogut (2000) argued that firms situated in dense network develop similar resource bases through mimicry. Afuah (2000) proposed that economic agents embedded in dense network tends to focus on exploitation and thus dense network is good at diffusing existing knowledge but not at generating novelty in a dynamic environment.

Thus, the degree of clustering determines the balance between exploration and exploitation, ultimately influencing the governance function of adaptation, at the structural level. Figure A2.5 summarizes this relationship.

*Adaptation*(c)
Another structural level variable, centrality, conditions the governance function of adaptation as well. Network centrality is correlated with the extent to which a focal firm can access to information and resources through network linkages (Freeman, 1979; Wasserman & Faust, 1994). Often time, network and resource dependence literatures argue that power is proportional to network centrality. A focal firm with high network centrality can get access to and control information and resources of other organizations that are linked with the focal firm. In this regard, network centrality may increase adaptability, owing to commensurate power and informational advantages.

However, on the other hand, high network centrality may decrease adaptibility. Presence of a hub dramatically curtails average path length of a network, decreasing the average degree of separation between firms in a network. This leads to the redundancy and similarity across firms embedded in a network. A hub, a centralized network position, consists of a large number of nodes. Heavily connected nodes quickly drive out heterogeneity and thus lead to suboptimal search outcomes (Kim, Fang, & Schilling, 2007). Taken together, ceteris paribus, a focal firm located at a larger hub is more likely to be shifted toward exploitation. Thus under the conditions of higher uncertainty and interdependence between organizations, the adaptibility of a focal firm located at a hub position can be particularly problematic, unless other measures for exploration are not implemented. Figure A2.6 summarizes this relationship.

In all, higher centrality is favorable to resource combination, higher bargaining power and exploitation of structural holes. On the other hand, high centrality leads to the emphasis of exploitation and thus it may have negative consequences in the long run.

*Adaptation (d)*

The strength of tie is correlated with the level of commitment of organizations in an interorganizational relationship that the network tie represents. With real option logic, under environmental change, the higher strength of ties means less flexibility. In addition, when a focal
organization is tightly coupled to the network of interorganizational relations, the failure of core partners due to poor adaptation will directly and negatively affect the focal firm (Uzzi, 1997). In this regard, weak network embeddedness or loose coupling is beneficial for the sake of adaptation. Figure A2.7 summarizes this relationship.

Adaptation (e)

Whereas the preceding arguments are based on the logics of exploration and exploitation, social mechanisms, flexibility, and coupling, legitimacy based reasoning provides a different perspective. Higher level of embeddedness at each level of analysis (relational, structural, and positional embeddedness) implies higher intensity and frequency of interactions and codifications between focal organizations. This leads to the imitation and diffusion of practices and strategies of a successful organization especially in the presence of environmental uncertainty.

Therefore, above arguments suggest that strong ties as well as other forms of strong network embeddedness are conducive to adaptibility of focal organization. Figure A2.8 summarizes this relationship.

B.3 Coordination functionality of governance

Coordination/Control (a)

Cooperation and coordination are two distinct yet interdependent concepts (Gulati & Singh, 1998). While cooperation refers to the alignment of interests and incentives, coordination is associated with the alignment of actions (Gulati & Singh, 1998). In the cases of alliance and market governances, cooperation between parties to an exchange is a necessary condition that precedes coordination. The need for coordination stems from interdependencies amongst organizations or tasks. Coordination costs are associated with communication, information transfer, task decomposition, and etc. (Gulati & Singh, 1998). Furthermore, preceding sections of
this study show that network structure affects interorganizational cooperation. Given these foundations, it is suggested that the structure of network affects coordination, precisely because network structure conditions information flows and defines the structure of interdependences amongst organizations.

At the dyadic level, it is shown that strong ties facilitate the exchange of fine grained information (Uzzi 1997; Gulati). Hence, a network composed of strong ties has a good fit with problem structures that require extensive coordination. In addition, compared to indirect ties, direct ties are better at resource sharing and coordination (Ahuja, 2000).

At the structural level, dense or redundant network facilitates coordination and monitoring, primarily because this structure facilitates repeated exchange (Coleman, 1990; Kogut, 2000). Repeated exchange leads to the development of efficient interorganizational routines (Reuer, Zollo, & Singh, 2000) and collective identity, and the alignment between incentives and contributions by firms to an exchange. In a dense network structure, firms have more incentives to exchange information, precisely because such behavioral norms as trust and reciprocity are instituted within such networks and restrain opportunism (Ahuja, 2000; Gulati & Singh, 1998).

In addition, dense or redundant network structure facilitates communication and collective problem solving through facilitating shared understanding of and disseminating alternative interpretations of problems and solutions (Powell & Smith-Doerr, 1994; Brown & Duguid, 1991; Powell et al., 1996; Kogut, 2000). A high level of embeddedness up to a threshold level facilitates joint problem solving, since focal organizations are willing to provide coordination efforts and resources necessary to jointly solve problems beyond what is specified in a contract (Uzzi 1996) in a more flexible manner than under a pure formal contract.
B.4 Summary of the Association Between Network Structure and Governance Functionalities

As shown in the previous sections A2.1 – A2.3, multiple layers of network embeddedness – relational, positional, and structural embeddedness shape a complete set of governance functionalities. Table A.1 summarizes the correlation between network constructs and governance functionalities.
FIGURES

**Figure B.1 function: Safeguard (a)**

Strength of ties → Trust → Governance function: Safeguard

**Figure B.2 Governance function: Safeguard (b)**

Strength of ties → Information asymmetry → Governance function: Safeguard

**Figure B.3 Governance function: Safeguard (c)**

Clustering → Reputational sanction → Governance function: Safeguard

**Figure B.4 Governance function: Adaptation (a)**

Tie Strength → Exploration & Exploitation → Governance function: Adaptation
Figure B.5 Governance function: Adaptation (b)

Figure B.6 Governance function: Adaptation (c)

Figure B.7 Governance function: Adaptation (d)

Figure B.8 Governance function: Adaptation (e)

Figure B.9 Governance function: Coordination (a)
### Table A.1 Association between network construct and the supply of governance functions

<table>
<thead>
<tr>
<th>Network Construct</th>
<th>Governance Functions</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Safeguard</td>
<td>Coordination</td>
<td>Adaptation</td>
</tr>
<tr>
<td>Relational embeddedness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strong ties</td>
<td>+</td>
<td>+</td>
<td>-/+</td>
<td></td>
</tr>
<tr>
<td>Weak ties</td>
<td>-</td>
<td>-</td>
<td>+/-</td>
<td></td>
</tr>
<tr>
<td>Positional embeddedness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centrality</td>
<td>+</td>
<td>+</td>
<td>-/+</td>
<td></td>
</tr>
<tr>
<td>Structural embeddedness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clustering</td>
<td>+</td>
<td>+</td>
<td>-/+</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>+</td>
<td>+</td>
<td>-/+</td>
<td></td>
</tr>
<tr>
<td>Characteristic Path Length</td>
<td></td>
<td>+</td>
<td>+</td>
<td>-/+</td>
</tr>
</tbody>
</table>

†. + denotes a positive correlation, – a negative correlation. In the case of -/+, the sign of correlation depends on additional conditions.
REFERENCES


(Eds.), *The Art and Science of Entrepreneurship*. Ballinger, New York: 3-23.


Doukas J. 1995. Overinvestment, Tobin’s Q and gains from foreign acquisitions. Journal of


Long J, Freese J. 2006. *Regression models for categorical dependent variables using Stata* (2nd ed.). College Station, Tex.: StataCorp LP.


Foresman.


Rowley T, Baum J. 2004. Sophistication of interfirm network strategies in the Canadian


StataCorp. 2009. *Stata: Release 11. Statistical Software*. College Station, TX: StataCorp LP.


