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REAL OPTIONS THEORY: IMPLICATIONS ON ENTREPRENEURSHIP
DEVELOPMENT AND OPTIONS VALUE UNDER UNCERTAINTY

DISSERTATION

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

By

Seung-Hyun Lee, MBA

The Ohio State University
2002

Dissertation Committee:
Professor Oded Shenkar, Co-advisor
Professor Jay Barney, Co-advisor
Professor Mona Makhija
Professor Mike Peng

Approved by

Oded Shenkar
Co-advisor

Jay Barney
Co-advisor

Business Administration Graduate Program
ABSTRACT

This study uses real options theory to explain macro environmental changes and its impact on entrepreneurship development and value of the firms. Composed of three related topics, this study first theoretically examines how bankruptcy policy can facilitate entrepreneurship development. Second, using Korean economic crisis as a context for environmental shifts, this study tests various real options investments and their value in uncertain environment. Third, using the same context of Korean economic crisis, this study also specifically examines international investments and its value in uncertain environments. To be more specific, first this study extends the real options view from the firm level to the societal level, by exploring how bankruptcy policy facilitate entrepreneurship development. Bankruptcy policy can focus on generating positive externalities, as opposed to avoiding failure for individual firms. Treating the bundle of productive assets within a country as entrepreneurial options, bankruptcy policy concentrated on maximizing the variance of such a bundle would facilitate entrepreneurship development. Second, according to real options theory, real options investments are expected to take their greatest value during periods of abnormally high uncertainty. Yet, this important proposition of real options is empirically difficult to test, since one cannot readily find such well-defined unanticipated periods affecting large numbers of firms. This study attempts to address this problem in the real options literature in this research by focusing on the case of Korean firms during the recent
Korean economic crisis in 1998. The largely unanticipated nature of this Korean economic crisis, along with its highly uncertain implications, created the conditions of a "natural experiment" for investigating this issue. The findings support the notion that real options investments provide value both in themselves, and relative to those investments made by peers within their industry. We also find support for the notion that the value of real options varies with the level of uncertainty faced by the firm. Third, not only investments in a domestic context, but also international investments provide firms with important real options that allow them to gain strategic flexibility during periods of uncertainty. While firms' international investments include those relating to exporting capability as well as foreign productive capability (i.e., FDI), prior empirical work has focused overwhelmingly on only FDI. Since exports and FDI may have overlapping as well as synergistic characteristics, we investigate several hypotheses comparing the real options value of both types of investments for Korean firms in the highly uncertain period of the Asian economic crisis. We find evidence that firms' value during the crisis were consistent with the differential real options value of a priori export and FDI investments made by these firms. We further find important differences in the real options value of such investments made by firms imbedded in a closed network and those in embedded in an open network.
Dedicated to my parents, my family, and to Jesus Christ
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VITA

October, 5, 1966 ....................... Born – Seoul, Korea

1992 .................................................. Bachelor, Political Science and Diplomacy
  Hankuk University of Foreign Studies,
  Seoul, Korea

1996 – 1998 ............................... MBA, The Ohio State University

1998 – present .............................. Teaching Assistant, The Ohio State University

PUBLICATIONS


FIELD OF STUDY

Major Field: Business Administration
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CHAPTER 1

INTRODUCTION

In recent years, accelerating rate of change in demand, technology, and customer preferences have created growing dynamic environment for the firms and their stakeholders. In this day and age, the only constant is change. At the same time, there is a growing evidence that resources and skills and way of thinking that allows firms to have competitive advantage in a dynamic uncertain market are inherently different from those likely to lead firms better compete in a stable environment (Sanchez, 1993; Tushman and Romanelli, 1985; Kogut and Kulatilaka, 1994a). What a firm should do to gain and sustain competitive advantage in such an environment?

As a result, research interests in uncertain environments have been surging in recent years. Especially real options theory, due to its explicit emphasis on uncertainty and firm strategies in exploiting uncertainties, has been one of the most frequently visited theories in explaining firm strategies in uncertain environments. In line with the importance of the real options theory and its implications on uncertain environments, this dissertation, using real options theory, provides theoretical reasoning how governments, applying real options logic, can encourage entrepreneurship development and empirical results on what kinds of real options investments render options values in uncertain periods.
To date, real options theory has been applied to several different aspects of management research. These include multinational flexibility (Kogut & Kulatilaka, 1994b; Reuer & Leiblein, 2000), joint venture valuation (Kogut, 1991; Chi, 2000), technology development (McGrath, 1997), market entry (Chang & Rosenzweig, 2001), diversification (Kim & Kogut, 1996), governance structure (Folta, 1998), human resource management (Malos & Campion, 2000), and entrepreneurship development (McGrath, 1999). One trend is to use real options as an analogy (e.g. McGrath, 1997, 1999) and the other is to use it as an analytical tool (e.g. Reuer & Leiblein, 2000; Kim & Kogut, 1996).

First, using real options theory as an analogy, this dissertation examines how governments can encourage entrepreneurship development. Second, taking real options as an analytical tool, we look into what kind of strategic investments would provide real options value and third, which international investments would render flexibility in an uncertain period.

Chapter 2 uses real options theory as an analogy and takes on how bankruptcy policy, informed by real options, can encourage entrepreneurship development. Despite a tendency in entrepreneurship research and practice that governments should leave entrepreneurs “alone,” it is widely acknowledged that government policies can significantly affect entrepreneurship by changing the “rules of the game” (North, 1990).

Although pervasive failure is a fact of life in entrepreneurship practice, researchers, practitioners, and policymakers seem to have “an equally pervasive antifailure bias” (McGrath, 1999: 13). However, it is evident that risk-taking goes hand-in-hand with entrepreneurship, so does failure. If economies are to be developed through entrepreneurship, the challenge for governments lies in how to a priori encourage more.
risk-taking entrepreneurial initiatives, many of which will inevitably fail but some of which may be successful. If successful entrepreneurial initiatives outweigh entrepreneurial failure, it is worthwhile from a societal standpoint, encourage more risk-taking.

A real options view, suggests that entrepreneurial failure is not necessarily bad, and that entrepreneurs should not be afraid of failure as long as useful lessons can be derived and the cost of failure is limited which would lead to higher entrepreneurial success for some cases and some firms (Bowman & Hurry, 1993; McGrath, 1999). In the absence of concrete information on which entrepreneurial options are likely to be successful, the key lies in developing a bundle of these options with enough variance that at least some of them are likely to be successful.

Echoing the insight that as real options theory continues to develop, “it may become possible to apply these concepts to additional levels of analysis” (McGrath, 1999: 26), we focus on the societal level, by exploring a critical, under-studied question: How can bankruptcy policy, from a real options view, affect entrepreneurship development and generate positive externalities for the society? Having variety generation as an important engine for entrepreneurship development, we examine how bankruptcy policy can affect entrepreneurship development.

Chapter 3 empirically examines how real options investments render real options value in an uncertain period. Real options take on its greatest value during periods of abnormally high uncertainty faced by firms, since these constitute the circumstances under which managers require the most flexibility. The most appropriate test of the value of a firm's real options is therefore under such conditions. Firms with
larger such investments should fare demonstrably better than other related firms in such periods. It is difficult, however, to pinpoint when firms experience unusually high and sudden uncertainty, since this will depend on the firm's own resources and capabilities, its particular industry context as well as its national and international situation. The unique conditions faced by most firms makes it difficult to identify periods of great uncertainty for assessing the true value of their real options investments. Indeed, much of the prior work on real options has assumed conditions of uncertainty rather than provide real evidence of its existence and exploit its important role in real options. Given the importance of uncertainty for real options investments, this limits our understanding of the true value of real options investments.

The purpose of this chapter is to address this limitation in the literature by focusing on the case of the South Korean economic crisis that began in late 1997 and became full blown in 1998. The virtually unanticipated nature of the crisis, the massive accompanying changes in the operating environment of the firms, and the uncertain impact of these changes, are all critical elements in helping us to understand the true value of real option investments made by Korean firms in the period prior to the crisis.

Our results support the notion that a priori real options investments in general contributed significantly to firm values during the period of the Asian economic crisis experienced by Korea, and more so for firms with greater investments in real options. Furthermore, while some investments are found to be relevant only within the context of industry, we find that other investments contribute to firm value across all firms (that is, only when they exceed levels invested by peer firms in their industry). Finally, we find
general support for the notion that the value of real options is higher in periods associated with greater, rather than less, uncertainty. This was possible by examining multiple years.

Chapter 4 provides empirical evidence that firms’ international investments work as real options rendering higher value in uncertain periods. International investments provide firms with notable real options that allow them to gain strategic and operational flexibility, particularly during periods of heightened uncertainty (Miller and Reuer, 1998; Tang and Tikoo, 1999). Indeed, a respectable body of theoretical work has expounded on the value of such multinational flexibility (Kogut and Kulatilaka, 1994b; Mello et al., 1995). Firms’ international investments include direct exports to other countries (Broll, 1999; Roberts and Tybout, 1997) and foreign direct investment (Campa, 1994; Dunning, 1980).

Despite the attention given to international investments in the literature, there is scant empirical evidence on the real options value of such international investments. In addition, past research such as (Allen and Pantzalis, 1996) and Tang and Tikoo (1999) do not have any construct on uncertainty for their studies. Not having explicit uncertain period makes it hard to differentiate diversification benefits from real options benefits of multinational firms. Therefore, we are not sure if their studies capture real options value or diversification benefits. For example, Kogut and Kulatilaka (1994b: 125) argue “the benefits of diversification are created by reduction in variance of the overall portfolio of subsidiary results. An option, on the other hand, is valuable because it gives managerial discretion to respond profitably to the realization of uncertain events.” Rangan (1998), on the other hand, while taking uncertain period for the study, uses industry level, not firm level, data in assessing firm flexibility in uncertain period. Considering the heterogeneity
of the firms, industry level study does not provide full picture of a real options value. In addition, he makes an assumption that real options theory suggests full flexibility. Real options theory, however, explicitly argues that hysteresis (e.g. such as switching cost and investment in goodwill) would inhibit flexible shift of production and sales from one location to another (Kogut and Kulatilaka, 1994b). In this regard, it is imperative to test international real options investments in uncertain period using firm level data acknowledging the existence of hysteresis.

Moreover, the real options value of international investments may depend on the organizational context under which they are undertaken (Sanchez, 1993). In this regard, some authors have suggested that networked firms benefit from enhanced real options (Sanchez, 1995; Foss, 1998), while others argue that networks can actually limit the flexibility of the firm (Sedaitis, 1998; Larson, 1992; Rowley et al., 2000). It remains unclear how networks, an important phenomenon in many developing countries, affect the value of firms' international real options.

Our objectives are threefold: (1) to examine the real options value of firms' international investments under conditions of greater and lower uncertainty; (2) to compare the real options value of different types and configurations of international investments (exports and FDI); and, (3) to explore how the real options value of international investments may differ for firms that are embedded in comparison to those not embedded in networks.

We find that the necessary conditions prevailed for our sample of 554 publicly traded firms listed on the Korean Stock Exchange (KSE) during 1996-1998. The unanticipated major jump in uncertainty is a crucial feature of our natural experiment.
Our findings support the notion that international investments provide identifiable real options benefits to firms in a period of greater uncertainty. We also find support for our argument that varying configurations of exports and FDI accord differing real options benefits to firms under uncertainty. Finally, our results indicate that the real options value of international investments differ in important ways for networked and non-networked firms. In all, as expected, higher environmental uncertainty was found to enhance the real options value of such investments in our analysis.

In all, we believe that this dissertation makes several contributions to the literature. First of all, in terms of theory development, this dissertation extends real options theory and applies it at the macro level. While past research mainly focused on project or firm level applications of real options theory, extension of the theory to the macro level was called for and at the same time was necessary to broaden the understanding of the theory (McGrath, 1999). We do this by focusing on government policies in promoting entrepreneurship development. We argue that government policies encouraging risk-taking initiatives by unlocking upside gains and limiting downside risks would promote entrepreneurship development. Second, this dissertation overcomes the difficulty of empirically testing real options theory in an uncertain period. As real options theory suggests, environmental uncertainty is one of the critical conditions for real options theory to hold. We do this by examining firms in Korea during the late 1997 economic crisis. While, due to the difficulty of capturing the moment of uncertainty, past research have taken piecemeal approach in testing real options theory, this dissertation was able to test multiple real options investments at the same time. In addition, this dissertation tests real options value of exports along with foreign direct investments.
(FDIs) in an uncertain period. This was the first empirical test of real options value of exports and interaction between exports and FDIs in an uncertain period. We were also able to test the network effect in international investments such as exports and FDIs. We specifically find detrimental effect of closed network in environmental uncertainty.
CHAPTER 2

BANKRUPTCY POLICY AND ENTREPRENEURSHIP DEVELOPMENT:
A REAL OPTIONS PERSPECTIVE

2.1 Introduction

Despite a tendency in entrepreneurship research and practice that governments should leave entrepreneurs “alone,” it is widely acknowledged that government policies can significantly affect entrepreneurship by changing the “rules of the game” (North, 1990), which are sometimes referred to as the “payoff structure” (Baumol, 1990). For example, Van de Van (1993) argued that in entrepreneurship literature, individuals, rather than enabling institutions, were of focus in the past. Compared with other fields (e.g., economics) which have visibly asserted their influence on government policies, in the long run, management researchers’ tendency to eschew engagement with major entrepreneurship policy issues around the world may keep the field “on the sidelines in debates about issues in which it potentially has much to contribute” (Pfeffer, 1997: 24).

In this sense, while individual level entrepreneurship research is valuable, societal level entrepreneurship research can also shed light on interesting and meaningful issues. Given entrepreneurs’ role in wealth creation, employment generation, and...
economic development, the challenge confronting governments at various levels is how to put in place an enabling policy infrastructure that facilitates entrepreneurship development at the societal level (Birch, 1987; Schumpeter, 1950).

Although pervasive failure is a fact of life in entrepreneurship practice, researchers, practitioners, and policymakers seem to have "an equally pervasive antifailure bias" (McGrath, 1999: 13). However, it is evident that if inefficient firms do not exit, but operate, the whole economy will stagnate. Therefore, to foster vital economy, letting inefficient firms to fail might be essential. A recent perspective, termed a real options view, suggests that entrepreneurial failure is not necessarily bad from a societal standpoint. Entrepreneurs need not be afraid of failure as long as useful lessons can be derived and the cost of failure is limited which would lead to higher entrepreneurial success for some cases and some firms (Bowman & Hurry, 1993; McGrath, 1999). In the absence of concrete information on which entrepreneurial options are likely to be successful, the key lies in developing a bundle of these options with enough variance that at least some of them are likely to be successful. Efficient bankruptcy policy would enhance exit of failing firms. In turn, the exit of failing firm would facilitate reallocation of resources to better users.

In this article, our motivation stems from the unique and sometimes counter-intuitive contribution that the real options perspective may contribute to bankruptcy policy centered on entrepreneurship development, thus helping correct the parochial tendency that Pfeffer (1997) cautioned against. Establishing an adequate bankruptcy policy...
policy can be a way of making failure less painful for entrepreneurs. In this article, using
real options logic, we focus on how bankruptcy policy can limit downside risk and
increase upside gains and eventually encourage entrepreneurship development.

Echoing the insight that as real options theory continues to develop, “it may
become possible to apply these concepts to additional levels of analysis” (McGrath,
1999: 26), we focus on the societal level, by exploring a critical, under-studied question:
How can bankruptcy policy, from a real options view, affect entrepreneurship
development and generate positive externalities for the society? Building on a long line
of research starting with Knight (1921) and Kirzner (1973), who argued that
entrepreneurs attempt to predict and act upon changes within markets, we define
entrepreneurship not according to the size of the firm, but according to an initiative, “a
specific effort by an existing firm or new entrant to introduce a new combination of
resources” (McGrath, 1999: 14; see also Shane & Venkataraman, 2000: 219; Stevenson
& Jarillo, 1990: 23-25; Wennekers & Thurik, 1999: 29). We define entrepreneurship
development as a set of activities taken by governments at different levels that directly
and indirectly provides incentives and punishments for firms to take risk.

2.2. Governments, Bankruptcy Policy, and Entrepreneurs

Governments have not figured prominently in entrepreneurship research.
Summarizing the work of Schumpeter (1942), Van de Van (1993: 212) noted that “[a]
common bias in Western culture is to attribute innovations to a particular individual
entrepreneur, who at a particular date and place came up with the innovation through a
stroke of genuine or fortune.” Technological progress (Schumpeter, 1950) and market inefficiency (Kirzner, 1979) are the two most widely recognized factors as sources of entrepreneurship. Note that there is little role that governments can play in this process other than leaving entrepreneurs “alone.” Consequently, the Schumpeterian perspective, despite its merits, suffers from “the paucity of insights on policy that emerge from it” (Baumol, 1990: 896).

Since governments play a significant role in shaping the rules of the game in which entrepreneurs play (or choose not to play), governments’ effort at a societal level can actually lower the opportunity costs for new ventures and incumbent firms to engage in entrepreneurial activities. Consequently, Busenitz, Gomez, and Spencer (2000: 1001) suggested that scholars attempt to understand the specific impact of government policies on entrepreneurship.

While it may be helpful to provide firms with better incentive system such as lower corporate tax rate, the most binding constraints against entrepreneurship development may be related not to success but failure (Surlemont et al., 1999). Due to the negative implications on bankruptcy and anti-failure biases, the right to file bankruptcy or bankruptcy protection is usually not considered as a privilege. Bankruptcy, however, occurs when stockholders exercise their right to default (Brealey and Myers, 1996). This is a valuable right. Limited liability allows stockholders simply to walk out and leave all the trouble to its creditors. In addition, beyond the firm level, adequate bankruptcy law can facilitate efficient reallocation of resources to better users. Bankruptcy law includes both bankruptcy protection and bankruptcy filing. In this sense, market economy can be characterized as permanent flow of resources from inefficient users to more efficient
users. This is why one of the essential reforms in former-communist countries was establishing efficient bankruptcy law (Legros and Mitchell, 1995; Hashi, 1997). The remainder of this article takes a real options view to examine the relationship between bankruptcy law and entrepreneurship development.

2.3 A Real Options View

Originated from financial options theory (Black and Scholes, 1973; Dixit and Pindyck, 1994), real options reasoning focuses on the real business application of financial options (Bowman and Hurry, 1993). In financial options, if uncertainty is higher the upside is higher while the downside remains constant as the option price (Fama and Miller, 1972). This also applies to real options. The higher the volatility, the higher the variance in expected return. In the strategy literature, a real option at the firm level is defined by “an investment decision that is characterized by uncertainty, the provision of future managerial discretion to exercise at the appropriate time, and irreversibility” (Kogut and Kulatilaka, 2001: 746). Thus, the ex ante uncertainty is the source of option value (McGrath, 1999). In other words, the higher the variance in outcome, the higher the option value.

To date, real options theory has been applied to different aspects of management research. These include multinational flexibility (Kogut and Kulatilaka, 1994a; Reuer and Leiblein, 2000), joint venture (Kogut, 1991; Chi, 2000), market entry (Chang and Rosenzweig, 2001), diversification (Kim and Kogut, 1996), governance structure (Folta, 1998), human resource management (Malos and Campion, 2000), and entrepreneurship
development (McGrath, 1999). But, to our best knowledge, real options theory has not been applied to the macro environment, in which governments are main players.

McGrath (2002) argued that real options can be well applied at the institutional level as well as organizational or regional level. Baumol (1990) also provided rationale that institutional level incentives can alter risk-taking behaviors of individuals and firms. At the macro level, each firm can be understood as an element of a bundle of options and so the bundle of options, not individual firms, can be focus of the analysis. At the macro level, however, the emphasis of real options logic should be on how to provide an institutional environment suitable for real options thinking given that the management environment is uncertain and that managers will use discretion in exercising options. The basic logic of real options is taking advantage of uncertainty by limiting downside risk while enjoying high upside possibilities. Therefore government policies that limit downside risk and increase upside potentials would foster firms to act with real options thinking.

When the whole economy composed of different firms is understood as a bundle of options, each firm is not a stand-alone option (Bowman and Hurry, 1993; McGrath, 1999). Rather it is part of a bundle of options. Therefore, higher variance in a bundle of options is desirable to take advantage of uncertainty at the macro level. In this paper, we take this notion of variety in real options and explicitly apply it in a setting how bankruptcy policy might encourage or discourage entrepreneurship development.
2.4. Real Options-based Bankruptcy Policy

Real options theory suggests "[a] high failure rate can even be positive, provided that the cost of failing is bounded." (McGrath, 1999: 16). Therefore, if we change our perspective from understanding success in a specific initiative to understanding success as a bundle in an industry or country, failure of individual entrepreneurial initiatives can be of great value to economic development. There are at least two benefits of having entrepreneur-friendly bankruptcy policy at the societal level. First, by providing adequate bankruptcy policy, failing firms would be replaced with more efficient firms. Second, firms in temporary distress can efficiently recover by going through reorganization process. As a result, higher variance among firms in a bundle would provide a higher chance of option-strike in a bundle. In other words, each entrepreneurial initiative can be regarded as an "experiment" in an economy, in which hypotheses about new combinations of resources are being tested.

Business failure is a necessary condition for future economic growth. It appears that "extensive turbulence is apparently intricately entwined with industries under the entrepreneurial regime," and that "such industries may generate innovative activity and perhaps ultimately employment growth" (Acs and Audretsch, 1992: 63; D'Aveni, 1994). Consequently, contrary to traditional protectionist policies, policies encouraging entrepreneurship development may not need to be afraid of temporary job displacement and unemployment associated with business failure (Acs and Audretsch, 1992). Empirical evidence suggested that when innovative activity in an industry increases, firm's overall survival rates often decreases, but those that do survive tend to be stronger,
thus propelling the degree of innovativeness in an industry (Audretsch, 1991; Amirkhalkhaly and Mukhopadhyay, 1993). This is why Nickell (1996: 741) argued “perhaps competition works not by forcing efficiency on individual firms but many flowers bloom and ensuring only the best survive …” For example, while the biotechnology industry has a very high failure rate, its degree of innovativeness is also striking. If one firm makes a breakthrough, the possible gains not only for this firm but also for the entire industry and country are likely to be very high. The recent experience of e-commerce companies, featuring a tremendous number of both failures and innovations, serves as another case in point. Therefore, it is plausible to suggest that from an industry or societal standpoint, massive failure and spectacular innovativeness may go hand in hand.

As a result, as long as the downside risk is limited, the higher the upside potential for success, the higher the options value. The pursuit of opportunities by many entrepreneurs at once may result in key uncertainties being resolved more rapidly and less expensively (on a per firm basis and a societal basis) than if only a few entrepreneurs are in the game (McGrath, 1999). In addition, greater competition across firms facilitates the entry of new firms with new ideas specializing new product niche (Feldman and Audretsch, 1999).

Of course, governments need not deliberately fail firms. Instead, it is imperative that governments make business failure less painful so as to encourage more entrepreneurs to undertake risky projects.
In an economy with failing firms, the liquidation of some existing firms is essential to a healthy economy (Khanna and Poulsen, 1995). This also goes hand in hand with Schumpeter's (1942) "creative destruction." In this line, adequate bankruptcy policy is an essential element in entrepreneurship development.

Because of the antifailure bias, however, research on bankruptcy is scant. Yet, relatively easy creation and termination of companies are both necessary conditions for the efficient reallocation of resources. Not only is the formation of new firms essential for economic growth, the termination of bankrupt firms, from a societal standpoint, is also crucial. As rules of the "end game," bankruptcy legislation regulates exit by imposing financial discipline on firms and ensuring an orderly enforcement of property rights in the event of business failure (OECD, 1998: 58). For example, Callejon and Segarra (1999) found that in Spanish manufacturing sector, exits of the firms actually have a positive impact on total industry factor productivity, thus supporting the argument that exists of inefficient incumbents can enhance efficient use of resources. Hamao et al. (2002) also find that lack of creative destruction in Japan led to market inefficiency and a vicious circle of capital misallocation.

Operating in a precarious terrain, bankruptcy legislation has to balance the conflicting interests of the bankrupt owners and those of creditors, suppliers, customers, employees, and other stakeholders. As a result, bankruptcy legislation can generate ex post barriers to exit, when they are so unfavorable to the entrepreneurs that they may try, by all means, to avoid business exit. This legislation can also create ex ante barriers to
entry, by discouraging entrepreneurs who are afraid of the damaging consequences of a possible bankruptcy to consider starting up their own firms (Surlemont, Leleux, and Denis, 1999). In real options terms, these barriers are not conducive for entrepreneurship development.

2.5.1. Speed of bankruptcy procedure

In a bankruptcy process, cost is involved in the length of time spent on bankruptcy filing. The long procedures in going through the bankruptcy filing can be one of the reasons why entrepreneurship is not prospering. Fast procedure leads to quick reallocation of assets of failed firms to better users should a firm decide to liquidate. Fast process can free an entrepreneur from failing businesses and provide opportunity to start a new business. By eliminating failing firms and reallocating resources to better users, fast bankruptcy process increase variance in a bundle of firms.

In case of reorganization or bankruptcy protection, fast procedure would protect assets of the firm from inadequate dissipation (Bebchuk, 2000). Inadequate dissipation of assets may lead a firm to liquidate when fast process could have saved the firm if the firm was financially, but not economically, distressed. Financial distress and economic distress are two different kinds of distress. If the bankruptcy protection filing was due to financial distress such as high debt, firms might have capabilities to survive and become more competitive should pass the difficult times. On the other hand, firms in economic distress such as ailing from higher cost or lower quality in production may deserve liquidation since it would mean reallocation of the resources to better users that would
lead to variety. By providing opportunities to reorganize, firms with economic distress
would be filtered through and will be liquidated while those with financial distress would
revive.

In this regard, long process for bankruptcy protection filing may limit diversity of
the firms by forcing even firms in financial distress to liquidate by depriving the
opportunities of reorganization. Since the risk involved in going through the bankruptcy
protection procedure would be especially high for firms in financial distress, long process
deprives the opportunity to reorganize from the firms in financial distress. This biased
incentive would *ex ante* discourage entrepreneurs to engage in new businesses. As a
result, reducing the cost of failure, via entrepreneur-friendly bankruptcy legislation, may
stimulate entrepreneurship development.

It takes more than two years to go through the bankruptcy process in Japan (Imai
and Kawagoe, 2000). In 1989, half of all liquidations took more than three years and
more than 75 percent of reorganizations exceeded five years from application to
conclusion in Japan (Alexander, 1999). It is not surprising that many entrepreneurs there
simply give up on their ideas. In the U.S., on the other hand, the process is relatively
faster. For example, recent bankruptcy protection filing of Enron in 2002 took only a few
weeks (International Herald Tribune, 2002). We can observe that fast bankruptcy process
in the U.S. encourage entrepreneurship development. For example, in 1989, there were
only 160,000 newly incorporated firms in Japan, whereas the United States, with twice
the population, had more than four times of new firms (690,000) set up in 1988 (Tezuka,
1997). Thus we propose:
Proposition 1: Less time in bankruptcy filing will be positively associated with entrepreneurship development by curtailing the downside risk of entrepreneurs.

2.5.2. Financial Liabilities

Bankruptcy legislations can either be just discharging the bankrupt individuals, or allowing the pursuit of the bankrupt entrepreneurs for several years (OECD, 1998). By just discharging the bankrupt entrepreneurs, creditors can claim residual assets, but cannot pursue for any remaining claims which have not been met. For example, in the United States, creditors cannot pursue for any remaining claims. If bankruptcy laws, however, allow for further pursuit, then creditors can pursue any remaining claims. For instance, in Germany creditors can go beyond claiming residual assets. For example, the debtor remains liable for unpaid debt for up to 30 years (Ziechmann, 1997: 12-25). In addition, in some countries (e.g. Germany), managers can also be liable for criminal penalties (Fialski, 1994). Not surprisingly, such differences in limiting downside losses can make a huge difference in the risk-taking propensity between American and German entrepreneurs.

Given the real options logic to limit the downside risk while maximizing upside gains, a society that limits the bankruptcy risk by allowing for the discharging of bankrupt entrepreneurs is more likely to have a more vibrant entrepreneurial sector. In turn, the society with limited bankruptcy risk may have a higher degree of variance desirable for innovation and growth (McGrath, 1999). We can also find this notion in practice from the Silicon Valley phrase “fail fast, fail cheap, move on” (Saxenian, 1994).
In other words, lower cost in failure can lead to new experiment. In contrast, the recent Asian economic crisis revealed that little protection against creditors actually kept firms from filing bankruptcy even when they were heavily loosing money (New York Times, 1998). For the executives of failing companies, knowing that the consequences would really heart them personally, filing bankruptcy is the last thing they would do in any circumstances and consequently incompetent firms might stay alive hurting entrepreneurial development.\textsuperscript{2} Thus:

\textit{Proposition 2: Enacting and enforcing discharging bankrupt entrepreneurs rather than allowing the pursuit of remaining claims will encourage entrepreneurship development by curtailing the downside risk of entrepreneurs.}

2.5.3. Management careers

Bankruptcy law may entail an automatic stay and discharge some portion of debt. An automatic stay upon commencement of bankruptcy proceedings means that creditors must cease debt collection efforts, and direct claims to the court (Alexopoulos and Domowitz, 1998). For example, in U.S., bankruptcy law stipulates automatic stay in case of bankruptcy protection filing for the management. On the other hand, countries such as England, Germany and Japan do not guarantee automatic stay of management, but rather appoint a trustee or administrator during bankruptcy procedures to collect unpaid debt

\textsuperscript{2} We do admit that opportunism by some entrepreneurs exists. Entrepreneur-friendly bankruptcy law might provide opportunities for some opportunistic entrepreneurs to take advantage of the system and intentionally fail the firm. However, as far as the upside gains from entrepreneur-friendly bankruptcy law exceeds the costs from opportunistic behaviors, it is worthwhile to pursue it.
(Alexander, 1999; Hashi, 1997). La Porta et al. (1998), in their study on legal rules of countries, found that nearly half of the countries they studied did not have an automatic stay on assets.

Managers make firm-specific investment during their stay with firms. This firm-specific knowledge is most required when a firm is in distress. Automatic stay also provides incentives for managers to make firm-specific investments. Because managers know *ex-ante* that they will not be automatically replaced in case of bankruptcy protection filing, automatic stay works as a ‘bonding device’ (Gaston, 1997). By suspending payments to creditors, bankruptcy filing provides opportunity for firms in financial, not economic distress, to revive (Pulvino, 1999; Flynn and Farid, 1991). Therefore when a firm filed bankruptcy, automatic stay would provide managers with firm-specific investment a better chance to revive the firm in the absence of interference of creditors. As firms are heterogeneous, firm-specific investments by managers would increase variety in a bundle of firms (Barney, 1986, 1991). This increased variety would increase options value in a bundle. On the other hand, trustee system, by appointing non-expert for reorganization, does not lead to proper reorganization (Hashi, 1997). Lack of expertise and firm-specific knowledge by the trustee would not lead to optimal decision. Thus we propose:

*Proposition 3: Enacting and enforcing automatic stay rather than trustee-appointment system in bankruptcy case will encourage entrepreneurship development by curtailing the downside risk of entrepreneurs.*
2.5.4. Delay

Delay of bankruptcy protection can also be a source of lagging entrepreneurship development. Bankruptcy process itself can be considered as a real options for stockholders. In financial distress, rather than liquidating the firm, stockholders can choose to file a bankruptcy. This is a real options because they have nothing to lose, but only gains should the firm recovers from the distress (Miller, 1977). Delay in protection, however, generally leads to deterioration of asset value of firms in distress. When the fact that a firm filed a bankruptcy becomes public knowledge, not only asset value deteriorates, but also other negative things take place. Customers become reluctant to buy the product, suppliers become less willing to provide materials, and creditors are unwilling to provide further financing. The longer the delay takes place, the harder it will be for the firms in distress to stay in business. This would increase the chance of liquidation while providing little hope for reorganization. In case that the firm is only in a temporary financial, not economic, distress and is worth staying business, eventual liquidation would mean terminating viable firm. This kind of type II error would discourage firms to file bankruptcy protection (White, 1994). Especially firms in financial distress, not economic distress would be more reluctant to resort to the bankruptcy protection procedures because filing bankruptcy protection incurs higher opportunity cost.

Out-of-court work-out will also be not a good option in the existence of delay in bankruptcy process. In out-of-court work out, knowing that there exists low chance or reorganization opportunity, creditors would be unwilling to renegotiate debt terms.
Providing an opportunity to reorganize minimizes the possibility of liquidating firms that would add variance in an economy. Reorganization usually involves sales of assets which would lead to focus on core competencies (Flynn and Farid, 1991). Thus, the firms successfully reviving during the reorganization process would add variance in a bundle. If, however, the firm that would have recovered gets liquidated due to the delay in bankruptcy petition, the variance would be decreased.

For example, in Japan, advance payment of estimated court costs is required with bankruptcy application. The fact that firms have to withdraw cash from their account alerts banks and lead creditors in panic even before a firm can get to the court protection (Alexander, 1999). In addition, in Japan, rather than automatically accepting bankruptcy petition such as in the U.S., the court examines the case and approves it if certain conditions are met. In other words, while being insolvent is not a necessary condition for filing bankruptcies in U.S., being insolvent is a necessary condition in other parts of the world such as Japan. This process takes more than three months (Alexander, 1999). Thus we propose:

*Proposition 4: Enacting and enforcing automatic acceptance of bankruptcy protection rather than delaying the protection of bankruptcy will encourage entrepreneurship development by curtailing the downside risk of entrepreneurs.*

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1 Similar conditions apply in Germany (Zeichmann, 1997), Denmark (Wessels, 1997), and Sweden (Graver, 1997).
2.6. Consideration of Contingencies

Above consideration of bankruptcy policy might have different implications for the firms in different institutional and cultural environment (Claessens, Djankov, and Klapper, 2002). Lee and Makhija (2002) showed that there exists huge difference in real options value for firms with strong ties and weak ties to creditors. Strong ties to creditors such as banks would be associated with lower information asymmetry between the banks and firms (Jayaraman, Saherwal, and Shirkhande, 2000). High co-dependence and low information asymmetry between the bank and the firm would situate the firm to resort to the banks rather than filing bankruptcy in case of financial distress. High stake in a firm would also provide incentive for the bank to further assist the firm in distress. This is why there is an old saying, “Borrow $1,000 and you’ve got a banker. Borrow $10,000,000 and you’ve got partner (Brealey and Myers, 1996). Creditors, in the hope of recovery, would look over the firm in distress in a difficult period with less attention to actual viability of the firms.

For example, in an institutional environment of intimate bank-firm relationship such as Japan and Germany, banks would prefer out-of-court settlement to filing bankruptcy (Brown, 1989; Jayaraman, Saherwal, and Shirkhande, 2000). In a bank centered institutional environment, bank serves the role of debt holder and shareholder. This results in low information asymmetry between debt holders and equity holders. From 1980 to 1990, only 8.5 percent of business failures in Japan involved formal proceedings (Alexander, 1999). This would be quite contrary in a country such as the U.S. (Giammarino, 1989).
In this regard, entrepreneur-friendly bankruptcy policy would be less effective in an institutional environment characterized with intimate bank-firm relationship. The fact that banks are partly substituting the role of bankruptcy policy might contribute to the slower development of entrepreneur-friendly bankruptcy policy in countries such as Japan and Germany. The strong bank-firm relationship, however, may delay dissolution of economically distressed firms. Sedaitis (1998), for example, showed that strong relationship tend to insulate firms from environmental changes. In other words, strong bank-firm relationship would preserve economically unviable firms due to the insulation from environmental shift when change is most needed. In this sense, enacting and enforcing entrepreneur-friendly bankruptcy policy would better enhance variance among firms in a society when strong bank-firm relationship is absent.

Filing a bankruptcy can also incur huge cost to top management. The stigma of bankruptcy can spoil the image of top management of a bankrupt firm. In the study of management turnover in bankruptcy filing, Gilson (1989) found that more than 70 percent of the senior manangers either left the firm or moved down to subordinate positions. Sutton and Callahan (1987) also find that customers, suppliers, and creditors altogether viewed top management team of bankrupt firms as tainted and incompetent people.

In terms of cultural differences, we may find different implications of the stigma of bankruptcy in different cultural environment. In a culture of high stigma of bankruptcy such as risk-averse culture, firms filing bankruptcy would incur higher cost (Hofstede, 1980). For example, in Japan, filing bankruptcy is even considered as a crime and as a result in extreme cases, top management commits suicide (Time Asia, 1999).
In this regard, entrepreneur-friendly bankruptcy policy would be less effective in a cultural environment characterized with high stigma of bankruptcy. Stulz and Williamson (2001) note that culture matters in institution-building. Maybe countries with risk-averse culture such as Japan might have difficulty in having entrepreneur-friendly bankruptcy policy. When enacting entrepreneur-friendly bankruptcy policy violates cultural norms, enacting and enforcing entrepreneur-friendly bankruptcy policy not only would be less effective in risk-averse culture, but also would be harder to initiate. This must be why Japan requires bankruptcy protection approval when bankruptcy protection is filed. So we may be able to argue that when the bankruptcy policy clashes with cultural norms, its initiation as well as effectiveness can be questioned if enacted.

Different industry environments would also result in difference in the effectiveness of entrepreneur-friendly bankruptcy policy. When an industry is in a recession, systematic risk will increase while, in comparison, idiosyncratic risk would decrease for firms in an industry. The increase in systematic risk then would make it harder for the firm in financial distress to differentiate itself from firms in both financial and economic distress (Hamao, Mei, and Xu, 2002). As a result, the market for industry-specific assets will be illiquid (Pulvino, 1998). Thus the productivity of firms filing bankruptcy in declining industry is no less than the industry average (Maksimovic and Phillips, 1998). This would mean that entrepreneur-friendly bankruptcy policy would be less effective in a declining industry.

In contrast, in a high growth industry, idiosyncratic risk will be relatively higher compared to systematic risk of the firms in an industry in recession. Therefore bankruptcy filing will be more likely to be attempted by firm with firm-specific
inefficiency (Maksimovic and Phillips, 1998). In addition, the market for industry-specific assets will be liquid and thus liquidated assets would go to better users. In this sense, entrepreneur-friendly bankruptcy policy would be more effective in a growing industry.

2.7. Discussions

2.7.1. Contributions

In our view, three contributions distinguish this article. First, we build on earlier work by extending real options thinking from a firm level to a societal level through an exploration of how bankruptcy policy. Informed by this new perspective, government, by enacting and enforcing entrepreneur-friendly bankruptcy policy, can promote entrepreneurship development. Although management research rarely addresses bankruptcy policy, we contend that the real options perspective holds some promise in influencing entrepreneurship policies. From a societal perspective, thinking of options as a bundle of firms, instead of single firms, is important. Designed to fail the failing firms and provide opportunities to revive for firms with future, bankruptcy policy which curtail downside losses of entrepreneurial initiatives are likely to stimulate entrepreneurship development, enhance the variance and value of the bundle of productive assets within an economy, and lead to stronger and more sustained economic growth.

Second, while traditionally bankruptcy is deemed negatively, influenced by the pervasive antifailure tendency, we advocate that entrepreneurship friendly bankruptcy policy, informed by real options, may encourage entrepreneurship development. Similar
to the saying “No pain, no gain,” we suggest that an economy unwilling to shoulder the costs of certain entrepreneurial failure is not likely to reap the benefits of a vibrant entrepreneurial sector and the growth it may bring. Consequently, we advocate a bankruptcy policy designed to embrace the “pain” of heightened competition and hopefully “gain” from more sustained entrepreneurship development.

Third, this article opens new avenue of research for bankruptcy policy. While bankruptcy policy was rather widely studied in finance and economics, bankruptcy policy was not of keen interest among management scholars (Daily and Dalton, 1994). Past research on bankruptcy in finance and economics generally focus on the efficiency of bankruptcy law at the firm level (e.g. Bebchuk, 2000; Pulvino, 1999; White, 1994; Gilson, 1989). This article takes a different approach by examining the role of bankruptcy policy in terms of facilitating entrepreneurship development. Especially increasing variance via entrepreneur-friendly bankruptcy policy is a noble idea that was hardly visited in the past in bankruptcy as well as in entrepreneurship research.

2.7.2. Implications and Future Research Directions

For policymakers, it seems that the question is not whether to intervene or not, but how to intervene. Having the real options logic as a dominant logic (see Prahalad and Bettis, 1986) in bankruptcy policymaking can encourage failing firms to be terminated and firms with options given an opportunity to revive when in financial distress, thus enhancing the variance of a country’s bundle of productive assets. While curtailing downside losses may inevitably lead to failure of more firms, the risk of not taking such risk, in the long run, may be higher.
For entrepreneurship scholars, to the best of our knowledge, this article is the first attempt to integrate the role of bankruptcy policy in entrepreneurship development using a real options perspective.

2.8. Conclusions

As the world enters the third millennium, we have just set out on the long road to achieving an understanding of how a bankruptcy policy, informed by a real options perspective, can combat the antifailure bias and stimulate more entrepreneurship development. While it has long been known that the rules of the game that specify the relative payoffs play a key role in determining the scale and scope of entrepreneurial activities within a society, certain bankruptcy policies uninformed by the real options view have a tendency to restrict variance. In conclusion, if this article could only contain one message, then we would like it to be a sense of the staggering power of variance-maximizing entrepreneurship, fueled by bankruptcy policy which curtails its downside losses.
3.1. Introduction

The increasing change, uncertainty and instability characterizing firms' external environments (Grant, 1991) has reduced the effectiveness of traditional capital budgeting procedures, which are unable to adequately anticipate and deal with such changes with requisite accuracy (Dixit & Pindyck, 1994). This increases the probability that projected cash flows associated with investments will differ considerably from realized cash flows. Under such conditions, management's ability to operate with flexibility in their investment decisions is associated with considerably more value (Bowman & Hurry, 1993; Trigeorgis, 1996). Investments with built-in flexibility provide more than one option for future courses of action to the firm (McGrath, 1997). As future conditions unfold, managers can then, befitting emergent new circumstances, choose the most appropriate course of action. This approach to investments, widely known as a real options approach, has been increasingly recommended in the strategy literature.

Real options take on their greatest value during periods of abnormally high uncertainty faced by firms, since these constitute the circumstances under which managers require the most flexibility. The most appropriate test of the value of a firm's
real options is therefore under such conditions. Firms with larger such investments should fare demonstrably better than other related firms in such periods. It is difficult, however, to pinpoint when firms experience unusually high and sudden uncertainty, since this will depend on the firm's own resources and capabilities, its particular industry context as well as its national and international situation. The unique conditions faced by most firms makes it difficult to identify periods of great uncertainty for assessing the true value of their real options investments. Indeed, much of the prior work on real options has assumed conditions of uncertainty rather than provide real evidence of its existence and exploit its important role in real options. Given the importance of uncertainty for real options investments, this limits our understanding of the true value of real options investments.

The purpose of this research is to address this limitation in the literature by focusing on the case of the South Korean economic crisis that began in late 1997 and became full blown in 1998.\(^4\) The virtually unanticipated nature of the crisis, the massive accompanying changes in the operating environment of the firms, and the uncertain impact of these changes, are all critical elements in helping us to understand the true value of real option investments made by Korean firms in the period prior to the crisis.\(^5\)

We examine the effect of the uncertainty accompanying the 1998 crisis on the value of six different types of real options investments made by Korean firms in the period prior to the crisis. These include investments made in 1997 relating to capital, R&D and patents, an international sales base, human capital, firm and product reputation, etc.

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\(^4\) Although the economic crisis experienced by Southeast Asian economies began earlier in 1997, its effects were felt in South Korea as late as the end of November, 1997 and became evident to most only by 1998. For this reason, in this research we refer to the crisis in South Korea in terms of 1998.

\(^5\) Hereinafter Korea refers to South Korea.
and network relationships. Thus, we exploit the differential values of real options across Korean firms, at a time when these real options are likely to be a substantial proportion of firm values. At the same time, it has been suggested that while the uncertainty might have been most severe in 1998, it did not dissipate until perhaps 2000. We therefore assess the value of the real options investment in each of the subsequent three years (1998-2000). Since the three years varied in their level of environmental uncertainty, we are able to examine the impact of such varying uncertainty on firm value. Our results support the notion that a priori real options investments in general contributed significantly to firm values during the period of the Asian economic crisis experienced by Korea, and more so for firms with greater investments in real options. Furthermore, while some investments are found to be relevant only within the context of industry, we find that other investments contribute to firm value across all firms (that is, only when they exceed levels invested by peer firms in their industry). Finally, we find general support for the notion that the value of real options is higher in periods associated with greater, rather than less, uncertainty.

3.2. The Value Of Real Options During An Economic Crisis: Conditions For A Natural Experiment

Real investments refer to those investments that are in the form of physical and human assets, as opposed to financial instruments (Kogut & Kulatilaka, 1994a). These investments are associated with higher value when there is a concurrent ability to adapt and revise investment-related decisions in response to unexpected market conditions. Management's flexibility to adapt its future actions in response to altered future market conditions...
conditions expands the value of an investment by improving its upside potential while
limiting downside losses relative to management's initial expectations under passive
management (Trigeorgis, 1993). This adaptability gives the firm additional "options" for
action under differing scenarios.

Real options, then, are investments that are discretionary in that they provide
firms with the right, but not the obligation, to undertake some future action (Bowman &
Hurry, 1993). A real options approach conceptualizes the value of options in terms of the
active management of a given investment or set of investments. Investments made in
period (t-1) interact with environmental changes in period (t), providing flexibility that
will be reflected in firm value (Bowman & Hurry, 1993). Management has the right to
select an outcome only if it has favorable implications (McGrath, 1997). Flexibility,
obviously, is more valuable when there exists more uncertainty. In this regard, through an
options lens, firm strategy is a process of resource investment choices (Bowman &

To date, real options theory has been applied to several different aspects of
management research. These include multinational flexibility (Kogut & Kulatilaka,
1994b; Reuer & Leiblein, 2000), joint venture valuation (Kogut, 1991; Chi, 2000),
market entry (Chang & Rosenzweig, 2001), diversification (Kim & Kogut, 1996),
governance structure (Folta, 1998), human resource management (Malos & Campion,
2000), and entrepreneurship development (McGrath, 1999). Real options are typically
embedded in the nature of the investment, and occur in a variety of forms. They can be
manifest in the firm's ability to more easily defer, contract or shut down operations, build
or expand capacity, as well as change its product mix. This operational flexibility is the
root of a firm's real options. Since an investment that incorporates real options typically entails up-front costs for a firm, real options valuation provides a tool for evaluating the trade-offs between commitment and flexibility under an uncertain environment (Reuer & Leiblein, 2000). By the same token, investments that do not have built-in real options are structured in such a manner that limits flexibility.

There are two aspects of a real options approach, then, that are particularly important. First, the highest value of real options is realized in the face of extremely high uncertainty (Dixit & Pindyck, 1994). This high uncertainty typically stems from a change in the environment that is completely unanticipated and therefore difficult to formally incorporate into the firm's capital budgeting process. A true economic crisis, by its very nature, is largely unanticipated, with consequent uncertainty of outcomes for significant numbers of firms. Across these firms, the impact of uncertainty may vary widely. Thus, such episodes of crises make for "natural experiments" for the absolute and cross-sectional impact of real options investments.

Second, it has been suggested that for real options to be truly meaningful, they should provide firms with a competitive advantage over other firms. This raises issues of differential value of real options investments across firms. Bowman and Hurry (1993) note the existence of two types of market strike signals in real options: One indicates the arrival of opportunity while the other signals its expiration due to the threat of preemption by competitors in the firm's industry. All else being equal, the more competition, the smaller the window of opportunity firms may have to exercise their investment options (Schultz, 2000). A large number of prior studies do take into account industry implications of firms' real options (e.g. Folta & Miller, 2001; Williamson, 2000; Tang &
It is not always clear, however, under what conditions industry matters most for exercising real options. Industry effects may be less important when all firms in an economy experience the same economic uncertainties (Khanna and Palepu, 2000; Makhija, 2002).

Both of the issues above need to be considered further for the accurate assessment of the value of real options investments. The need to analyze the value of firms' real options under great uncertainty stems from the role of these options in delivering flexibility to firms when it is most needed (Sanchez, 1993; Foss, 1998). Admittedly, this is difficult to accomplish. The sources of uncertainty for any given firm are often difficult to isolate and vary across firms. We attempt to address this problem in the real options literature by focusing on the case of Korean firms during the recent economic crisis of 1998. As the details of the case show below, this crisis creates the conditions for a "natural experiment" for examining real options.

3.3. Korea Prior To The Asian Economic Crisis

Korea had been one of the fastest growing economies in the last three decades. This country, which began with approximately US$87 per capita GNP in 1962, had raised its per capita GNP to well beyond US$10,000 by 1997 (World Bank, 2001). By 1994, Korea ranked second in the world in shipbuilding and consumer electronics, third in semiconductor memory chips, and sixth in automobiles in the world (Kim, 1998).
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<td>2.6</td>
<td>6.8</td>
<td>6.3</td>
<td>4.1</td>
</tr>
</tbody>
</table>

*a* period average  
*b* calculated from Gross Fixed Capital Formation (GFCF) in International Financial Statistics  
Sources:  
World Bank Group  
International Financial Statistics, IMF  
Center for Economic Information, Korea Development Institute  
Monthly Statistical Bulletin, various issues. The Bank of Korea, Seoul, Korea

Table 3.1. Selected Economic Indicators for Korea, 1985-2000
Evidence of this rapid growth is seen in Table 3.1. The tremendous effectiveness of Korea's economic model and of those followed by the other three "Asian Tigers" (Taiwan, Singapore, Hong Kong) was held up for other developing countries to follow (Chowdhry & Goyal, 2000).

Of the four Asian Tigers, the Korean economy in particular had been developing at an extremely rapid rate since the 1960s, and through much of the 1990s it continued to see rapid growth. As seen in Table 1, annual growth rates in the period between 1985 and 1997 remained very high, at 5 percent or higher, and often reaching 9 percent. The exchange rate between the won and dollar remained relatively stable, at approximately 800 won to the dollar during most of this time. The country's inflation rate also remained relatively low, averaging about 5 percent. Likewise, the unemployment rate averaged about 2.5 percent, indicating a fully utilized workforce consistent with a growing economy. With this long history of ongoing economic success, there was little indication of any change in its future growth. As Korea's per capita income continued to climb, at best we might have expected a gradual slowdown in growth, ultimately approximating that of more developed economies. For these reasons, the sudden and highly negative effect of the Asian economic crisis in the end of 1997 was entirely unexpected.

3.4. The Asian Economic Crisis

Singh and Yip (2000) note that "the crisis that struck Southeast and East Asia in 1997 was, for most countries in the region, the most severe of the last 50 years. Coming after more than two decades of high growth and numerous claims of impending Asian
economic dominance, the crisis was a major shock to the region and firms operating there” (p 706). Yet, while this shock had an adverse effect to all the countries involved, we argue that it was particularly difficult for Korea. The four hardest-hit countries were Thailand, Indonesia, Malaysia, and Korea (World Bank, 1999). However, the impact on the Korean economy differed remarkably from that of Thailand, Indonesia, and Malaysia, the three of which shared important features in their economies. To begin, these three countries are part of the Association of Southeast Asian Nations (ASEAN), which integrates their economies through free trade. In fact, intra-trade among the members of ASEAN has increased tremendously since the establishment of ASEAN (Yusoff, 1997). Korea is not a member of ASEAN, and its economy is not deeply integrated with these other countries. Therefore, when the Asian economic crisis first hit the countries of Southeast Asia in July of 1997 (beginning with Thailand), there was little reason to expect it to spread to Korea.

Korea was instead typically compared with the higher-income economies of Hong Kong, Singapore and Taiwan (the other three Asian Tigers). The fact that the other three Asian Tigers had not been affected by the crisis created the expectation that Korean firms too would remain insulated. Although in September 1997 there was some evidence of economic slowdown, there was generally strong confidence that it was not serious and that it would not lead to any major crisis (Business Korea, 1997). Indeed, as Table 1 shows, evidence of this slowdown in 1997 was somewhat subtle. At best, it was considered to be a temporary problem rather than a major crisis (Kim, 1998). By 1998, however, the full effects of the crisis were evident. The economy contracted by 6.7% in this year, in stark contrast to the spectacular growth rates of prior years. The won lost
approximately 40% of its value, while unemployment nearly tripled, averaging 6.8 percent for 1998.

It is interesting that even though many scholars assume that July of 1997 is the official starting date of the Asian economic crisis, Ang and Ma (2001), in their study of stock analysts' forecasts, conclude that analysts in all four countries completely missed the event. Furthermore, in the case of Korea, they did not revise their forecasts downward until December 1997, which indicates a five-month lag from the start of the crisis in Thailand. Even after the year-end, analysts still made optimistic forecasts for approximately three-fourths of the firms. Significant corrections by analysts in Korea occurred only seven to eight months after the July 1997 crash in Thailand (Ang and Ma, 2001). It was in fact in early 1998 that the majority opinions agreed that Korea was under crisis.

In sum, these events allow us to come to three conclusions with respect to the Korean economic crisis in late 1997. First, it was a highly unexpected phenomenon for Korea. Second, in addition to being unexpected, it also resulted in a massive change in the economic environment. Third, the impact of these changes was highly uncertain, with unknown implications for different firms. It is these attributes of the Korean economic crisis that set the stage for our real options analysis below.

3.5. The Value Of Real Options Investments Made By Korean Firms Prior To The Crisis

We had noted earlier that firms operating under great uncertainty benefit from investments that enhance their flexibility by providing options for adapting to unanticipated changes. In the section below, we discuss several types of investments that
provide firms with such options value. Consistent with Dixit and Pindyck (1994), these
include patents, proprietary technologies, human capital, reputation or brand name, scale
and market power, and valuable network relationships. We argue that such options
related investments in the period preceding the Korean economic crisis will result in
higher firm value in the aftermath of the crisis. We agree with Bowman and Hurry (1993)
that “a firm is valued as a going concern on the assumption that it will continue to invest.
Its market value therefore includes the value of these options. The value of the firm is
thus the sum of earnings generated by investments in place plus the options value of
future strategic choices (p. 773).”6 In other words, the value of real options is the
expected present value of the right or ability to choose whether or not to take some
actions at some time in the future (Sanchez, 1993). We expect that organizations holding
better developed bundles of options can persist longer in economic downturns and
expand more aggressively in economic upturns (Bowman and Hurry, 1993). Future-
oriented options value can therefore only be captured by examining the value of the firm
rather than current profitability. Hypotheses relating the value of the firm to different real
options investments and level of environmental uncertainty are proposed below.

**Investment in R&D and Patents.** Past research suggests that R&D is an important
source of competitive advantage (Henderson & Cockburn, 1994; Dierickx & Cool, 1989).
Investment in R&D can ultimately result in improvements in existing products, new
products in line with emerging demand, reductions in costs or increase in quality.
Investment in R&D is necessary for product innovation (Hambrick & MacMillan, 1985;

---

6 Kester (1984) notes that well over half the firm's total value is determined by the options it holds. In
highly turbulent environments, this proportion increases to about 70-80% of firm value (Kester, 1984).
Capon, Farley, & Lehmann, 1992). While all of these activities provide the firm with competitive benefits at any time, in a period of great uncertainty such investment provides the firm with the ability to be more flexible in meeting the newly changing needs of consumers. Developing technology through investment in R&D now will provide the firm with flexibility—that is, options—to develop new products in the future (Sanchez, 1993). In fact, Arman and Kulatilaka (1998) claim that most of the value of R&D is attributable to the options implicit in it. Although R&D investments constitute considerable upfront expenditure for the firm, it increases the flexibility of the firm in the future (Morris, Teisberg and Kolbe, 1991; Jagle, 1999). A priori R&D investments allow firms to gain competitiveness more rapidly than they otherwise would be able to accomplish.

Hypothesis 1a: Firms with greater a priori investments in R&D will have higher value during a period of great uncertainty.

In a manner somewhat similar to R&D investment, patents possessed by the firm also serve to increase its flexibility in a period of tremendous uncertainty (Bowman & Hurry, 1993). Patents held by a firm reflect the technological strength of a firm (Narin et al. 1987). Completing the development of the technology creates an asset, consisting of the underlying right to commercialize the technology (McGrath, 1997). Therefore holding patents is similar to holding options on future value creation (Pakes, 1986). This is consistent with Pakes' (1985) finding that a 1 percent increase in patents of a firm is associated with a 4.4 percent increase in the market value of the firm. In a manner similar to R&D, patents provide the firm with additional options for changing its product mix, or
improving the attributes of existing products. In a period of unanticipated change, patents allow the firm to more rapidly adapt its products or product mix to new circumstances, thereby allowing it to retain its competitiveness.

Hypothesis 1b: Firms with greater a priori investments in patents will have higher value during a period of great uncertainty.

Investment in an International Sales Base. International sales can be a source of real options value under volatile exchange rates (Broll, 1999). International sales have value due to its ability to provide both diversification benefits and stabilization of revenues (Hirsh & Lev, 1971). Firms that do not have previously established exporting relationships, however, cannot immediately begin exporting costlessly. As with any other investment, there are sunk costs associated with exporting (Roberts, & Tybout, 1997) and export-related knowledge (Malekzadeh & Nahavandi, 1985), without which exporting cannot be initiated. Past research shows that nonexporters have huge misconceptions about exporting. Malekzadeh and Nahavandi (1985) note that "nonexporters perceive tax incentives as important to the initial decision to export, unlike exporters. Likewise, proximity to foreign markets is perceived as ar. important factor to nonexporters, but not by exporters" (p. 7). Investments in acquiring market knowledge can expand the firms' product options and thereby increase the export flexibility of the firm (Sanchez, 1993). Exports operate as an option because a firm's domestic market return is more or less certain whatever the realized exchange rate turns out to be (Broll & Eckwert, 1999). The domestic price, then, is the "strike price" of the real export option. In the case of Korean firms, the economic crisis resulted in a huge devaluation of Korean
currency. Hence, firms with an already established international sales base would benefit tremendously from the option to export (since Korean exports would benefit from resulting lower international prices). A higher level of international sales would therefore provide firms with more flexibility in future periods of great uncertainty.

**Hypothesis 2:** Firms with greater *a priori* investments in an international sales base will have higher value during a period of great uncertainty.

**Investment in Brand and Reputation.** Another type of investment is that associated with the firm's brand recognition and reputation, reflected in its investment in advertising. Firms advertise to reduce consumer search (Stigler, 1961), stabilize sales (Milgrom & Roberts, 1986), and increase barriers to entry (Comanor & Wilson, 1974). Most investments in advertising are firm specific (Pindyck, 1988). Such investment provides options to the firm in future periods of greater uncertainty by enhancing consumer awareness of its products over and above others, and promoting a positive image of these products (Denekamp, 1995). Hirschey's (1982) finding that current advertising expenditures are positively associated with a firm's market value support such notions regarding the future effects of advertising. Similarly, Wu and Bjormson (1986), using Tobin's q as market value of the firm, find similar support that the advertising activity of food manufacturing firms is strongly related to intangible capital value during periods of both product proliferation and recession. Over time, advertising helps firms develop strategic positions that are differentiated from those of their competitors (Rumelt,
1987; Weiss, 1969; Fombrun & Shanley, 1990). Thus, in periods of tremendous uncertainty brought on by economic downturn, greater competition or other adverse forces, prior investment in brand recognition and reputation provides the firm with a cushion under such negative circumstances.

**Hypothesis 3:** Firms with greater a priori investments in brand and reputation enhancement will have higher value during a period of great uncertainty.

**Investment in Human Capital.** The ability of a firm to develop the expertise of its employees is essential to its ability to create organizational capabilities (Kogut & Kulatilaka, 1994a). In this regard, human resource practices help to create a source of sustained competitive advantage (Huselid, 1995; Wright & McMahan, 1992). In particular, training is one of the important human resource practices widely believed to improve the performance of organizations (Pfeffer, 1994; Knoke & Kalleberg, 1994; Russell, Terborg, & Powers, 1985). Investment into the quality of human capital, in the form of training for workers and management (Pfeffer, 1995), benefits the firm in a period of tremendous uncertainty in a variety of ways. The employees' superior skills and capabilities provide the firm with greater flexibility in addressing uncertain future state of affairs (Grossman and Shapiro, 1982). A survey of training activities in the U.K. finds that training is regarded as an investment for the future (Stevens, 1984). Bouillon et al. (1996) find that investment in human capital such as training is reflected in stock price.
despite the fact that training is regarded as costs in relation to accounting rules.⁷

Furthermore, a study by Couch (1992) finds that the earning effect of training does not decay over the first eight post-training years. Employees can potentially make faster and more accurate decisions in a complex new market environment, adapt to new production processes and procedures as necessary, as well as engage in creative problem solving (Pfeffer, 1995; Bartel, 1994). Not surprisingly, Knoke and Kalleberg (1994) find that training investments are more extensive in firms that face more complex and uncertain environments than those in more stable ones.

_Hypothesis 4:_ Firms with greater a priori investments in workforce training will have higher value during a period of great uncertainty.

**Investment in Networks.** Firms can also invest in network relationships with suppliers, customers, banks and the government. In periods of tremendous uncertainty, we expect that such relationships will disproportionately benefit firms compared with their competitors who do not have similar relationships. Strong ties to other organizations mitigate uncertainty and promote adaptation (Kraatz, 1998). Such ties are more likely to promote in-depth, two way communications and facilitate exchange of detailed information (Grannovetter, 1982; Uzzi, 1996). Further, the trust that is likely to exist when ties are strong will make it less costly to help each other (Rogers, 1995; Uzzi, 1996). The firm has access to resources, information and goodwill that can be used by the firm to facilitate adaption to new circumstances (Kraatz, 1998). Kulatilaka and

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⁷ For this reason, these authors suggest that "public or regulatory policy needs to be established to require firms to include at least some rudimentary information regarding their human capital investment, such as turnover rates and training costs, in their annual report (p. 30). Similarly, there is a move in the U.S. to capitalize and amortize R&D, rather than to expense it immediately.

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Marks (1988) take this perspective when they examine the strategic bargaining value of flexibility in a firm's negotiations with input suppliers in its network. Along with technological capabilities, such network ties are important for providing flexibility for high-technology firms (Jagle, 1999). Similarly, Makhija (2002) finds that ties to government and banks, evidenced by higher leverage, were a source of support for firms during the uncertain time of Czech privatization. Frankel (1991) and Saraswathy and Chatterjee (1984) also find that a high level of leverage is indicative of preferential access to banks in Japan. It not only reduces the firm's overall cost of capital, but also diminishes information asymmetry between banks and firms (Sheard, 1989). Firms with such ties had more unencumbered access to loans in an otherwise capital poor environment. We therefore argue:

\textit{Hypothesis 5a: Firms with greater a priori investments in network relationships will have higher value during a period of great uncertainty.}

The value of network relationships has also been highlighted for less developed institutional environments by Khanna and Palepu (1999). They argue that less developed institutional environments are associated with greater uncertainty, and that large diversified organizational forms such as chaebols and keiretsus help to reduce this uncertainty. In a manner similar to keiretsus, Korean chaebols utilize the network structure (Ghauri & Benjamin, 1995), which approximates a portfolio of options-related assets (Bowman & Hurry, 1993). Bowman and Hurry (1993: 771) use the example of German networks (e.g., Deutschebank/Daimler-Benz) and Japanese keiretsu (e.g.,
Mitsubishi) to argue that these operate like a portfolio of options, with minimal corporate-level interference.

In addition, chaebols' ties to nationalized banks also provide valuable flexibility. These ties have traditionally allowed for access to cheaper loans, while firms without the ability to secure such a preferential treatment have had to rely on much higher interest rates (Cole & Park, 1983). In addition, Chang and Hong (2000) show that groupwide resource sharing and internal business transactions of chaebols in Korea enabled group-affiliated firms to outperform those that are not affiliated.

We therefore argue:

*Hypothesis 5b:* Membership in a chaebol will be associated with a positive effect on firm value during a period of great uncertainty.

**Investment in Fixed Assets.** Higher investment in fixed assets typically involves greater risk and a higher risk-adjusted rate in calculating discounted future cash flows (Luehrman, 1998). In other words, the increased opportunity cost of irreversible investment makes larger investment in fixed assets more costly especially in the presence of demand uncertainty (Pindyck, 1988). Due to this inflexibility, irreversible investment is frequently used as an entry barrier into an industry (Bain, 1956; Porter, 1980; Yip, 1982). Kotha and Nair (1995) note that capital intensive businesses tend to be less efficient in their use of assets when compared with less capital intensive competitors, due to lack of asset parsimony (p. 503). Since investment in fixed assets tends to limit a firm's flexibility, we argue that there will be a negative relationship between such investment and its effect in a period of uncertainty.
Hypothesis 6: Firms with greater a priori investments in fixed assets relative to its total assets will have lower value in a period of great uncertainty.

The Extent of Uncertainty. As we have noted earlier, real options investments are associated with greater value in periods of greater uncertainty. Thus, we would expect that when uncertainty is reduced, the value of these options is accordingly reduced. The year of 1998 posed the greatest uncertainty for Korean firms. By 1999, by many accounts it appeared that Korea had fully recovered from their economic crisis (see Table 1). Real gross domestic product (GDP) grew 10.9 percent in 1999, while unemployment fell slightly to 6.3 percent (Businessweek, 1999a). Korea's inflation rate was reduced tremendously, to 0.8 percent. The value of the won also rose in this period, rising to 1188.8 won to the dollar. Standard and Poors Corporation lifted its credit rating for Korea to its pre-crisis level and accorded it as Asia's only “positive outlook” in 1999. Equally positive macro-economic indicators are generally characteristic of 2000 as well. These indicators, seen in Table 1, indicate that both 1999 and 2000 reflect periods of less uncertainty in comparison with 1998. Thus, we argue:

Hypothesis 7: The value of real options investments will be greater in the more uncertain period of 1998 than the less uncertain periods of 1999 and 2000.
<table>
<thead>
<tr>
<th>KSIC 2 digit</th>
<th>Description</th>
<th>No. of firms</th>
<th>Tot. Asset97 (mil won)</th>
<th>Tot. Sales97 (mil won)</th>
<th>ROA97</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Mining of coal, crude petroleum</td>
<td>1</td>
<td>200,509</td>
<td>35,494</td>
<td>-0.10</td>
</tr>
<tr>
<td>11</td>
<td>Mining of metal ores</td>
<td>1</td>
<td>349,673</td>
<td>192,951</td>
<td>0.01</td>
</tr>
<tr>
<td>15</td>
<td>Mnf. of food products &amp; beverages</td>
<td>52</td>
<td>349,639</td>
<td>281,280</td>
<td>-0.03</td>
</tr>
<tr>
<td>17</td>
<td>Mnf. of textiles except wearing apparel</td>
<td>44</td>
<td>483,112</td>
<td>312,996</td>
<td>-0.03</td>
</tr>
<tr>
<td>18</td>
<td>Mnf. of sewn wearing &amp; fur articles</td>
<td>19</td>
<td>143,928</td>
<td>128,010</td>
<td>-0.05</td>
</tr>
<tr>
<td>19</td>
<td>Mnf. of luggage &amp; footwear</td>
<td>11</td>
<td>45,958</td>
<td>65,260</td>
<td>-0.09</td>
</tr>
<tr>
<td>20</td>
<td>Mnf. of wood &amp; wood products</td>
<td>5</td>
<td>165,090</td>
<td>153,639</td>
<td>0.01</td>
</tr>
<tr>
<td>21</td>
<td>Man of pulp, paper, &amp; paper products</td>
<td>28</td>
<td>231,540</td>
<td>127,545</td>
<td>-0.02</td>
</tr>
<tr>
<td>22</td>
<td>Publishing, printing &amp; reproduction</td>
<td>5</td>
<td>65,194</td>
<td>78,547</td>
<td>0.04</td>
</tr>
<tr>
<td>23</td>
<td>Mnf. of coke, refined petroleum products</td>
<td>6</td>
<td>3,564,649</td>
<td>3,215,482</td>
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</tr>
<tr>
<td>24</td>
<td>Mnf. of chemicals &amp; chemical products</td>
<td>89</td>
<td>278,498</td>
<td>188,334</td>
<td>0.02</td>
</tr>
<tr>
<td>25</td>
<td>Mnf. of rubber &amp; plastic products</td>
<td>21</td>
<td>275,054</td>
<td>197,659</td>
<td>0.03</td>
</tr>
<tr>
<td>26</td>
<td>Mnf. of other non-metallic mineral products</td>
<td>31</td>
<td>431,455</td>
<td>213,214</td>
<td>0.02</td>
</tr>
<tr>
<td>27</td>
<td>Mnf. of basic metals</td>
<td>55</td>
<td>617,862</td>
<td>390,368</td>
<td>-0.03</td>
</tr>
<tr>
<td>28</td>
<td>Mnf. of fabricated metal products</td>
<td>19</td>
<td>58,442</td>
<td>45,623</td>
<td>0.02</td>
</tr>
<tr>
<td>29</td>
<td>Mnf. of other machinery &amp; equipment</td>
<td>33</td>
<td>105,451</td>
<td>104,559</td>
<td>0.02</td>
</tr>
<tr>
<td>30</td>
<td>Mnf. of computers &amp; office machinery</td>
<td>11</td>
<td>139,509</td>
<td>136,462</td>
<td>0.00</td>
</tr>
<tr>
<td>31</td>
<td>Mnf. of electrical machinery &amp; apparatuses</td>
<td>25</td>
<td>308,401</td>
<td>270,978</td>
<td>0.01</td>
</tr>
<tr>
<td>32</td>
<td>Mnf. of electronic components</td>
<td>83</td>
<td>786,401</td>
<td>584,079</td>
<td>0.02</td>
</tr>
<tr>
<td>33</td>
<td>Mnf. of medical, precision and optical instruments</td>
<td>11</td>
<td>71,602</td>
<td>45,026</td>
<td>0.07</td>
</tr>
<tr>
<td>34</td>
<td>Mnf. of motor vehicles, trailers</td>
<td>43</td>
<td>682,714</td>
<td>601,995</td>
<td>0.00</td>
</tr>
<tr>
<td>35</td>
<td>Mnf. of other transport equipment</td>
<td>7</td>
<td>1,551,348</td>
<td>986,525</td>
<td>-0.03</td>
</tr>
<tr>
<td>36</td>
<td>Mnf. of furniture</td>
<td>10</td>
<td>121,244</td>
<td>103,484</td>
<td>0.00</td>
</tr>
<tr>
<td>40</td>
<td>Electricity, gas, steam, &amp; hot water supply</td>
<td>8</td>
<td>6,091,761</td>
<td>1,838,432</td>
<td>0.02</td>
</tr>
<tr>
<td>45</td>
<td>General construction</td>
<td>50</td>
<td>821,235</td>
<td>575,660</td>
<td>0.00</td>
</tr>
<tr>
<td>50</td>
<td>Sale of motor vehicles &amp; motorcycles</td>
<td>6</td>
<td>472,606</td>
<td>776,964</td>
<td>-0.05</td>
</tr>
<tr>
<td>51</td>
<td>Wholesale trade &amp; commission trade</td>
<td>37</td>
<td>584,493</td>
<td>2,559,143</td>
<td>-0.01</td>
</tr>
<tr>
<td>52</td>
<td>Retail trade except vehicles &amp; motorcycles</td>
<td>9</td>
<td>561,508</td>
<td>491,852</td>
<td>-0.01</td>
</tr>
<tr>
<td>55</td>
<td>Hotels and restaurants</td>
<td>1</td>
<td>542,413</td>
<td>268,241</td>
<td>-0.03</td>
</tr>
<tr>
<td>60</td>
<td>Water transport; transport via pipelines</td>
<td>14</td>
<td>905,548</td>
<td>634,704</td>
<td>-0.02</td>
</tr>
<tr>
<td>62</td>
<td>Air transport</td>
<td>1</td>
<td>8,974,489</td>
<td>4,286,190</td>
<td>-0.05</td>
</tr>
<tr>
<td>63</td>
<td>Supporting &amp; auxiliary transport activities</td>
<td>2</td>
<td>87,285</td>
<td>133,005</td>
<td>0.05</td>
</tr>
<tr>
<td>64</td>
<td>Post &amp; telecommunications</td>
<td>7</td>
<td>3,342,944</td>
<td>1,772,362</td>
<td>0.05</td>
</tr>
<tr>
<td>72</td>
<td>Computer related activities</td>
<td>6</td>
<td>29,479</td>
<td>18,719</td>
<td>0.05</td>
</tr>
<tr>
<td>74</td>
<td>Professional, scientific &amp; technical services</td>
<td>4</td>
<td>266,671</td>
<td>311,792</td>
<td>-0.01</td>
</tr>
<tr>
<td>75</td>
<td>Business support services</td>
<td>1</td>
<td>259,909</td>
<td>252,587</td>
<td>0.04</td>
</tr>
<tr>
<td>87</td>
<td>Motion picture, broadcasting</td>
<td>1</td>
<td>7,542</td>
<td>3,879</td>
<td>0.01</td>
</tr>
</tbody>
</table>

| a. total, b. average | 757a | 918.247b | 604.947b | 0b |

Table 3.2: Selected industry attributes
3.6. Data And Methods

3.6.1. Data

In order to test our hypotheses, we used the WISEfii database of Korean firms, consisting of all publicly listed firms on both Korea Stock Exchange (KSE) and KOSDAQ (similar to NASDAQ in the U.S.). In order to test the seven hypotheses above, we used firm-specific data for the years 1997-2000. The number of firms included in each year ranged from 900 in 1997 to 1,114 in 2000. Following Chang and Hong (2000), we do not include any financial services firms in our sample since their accounting scheme is not compatible with firms in other industries. This lowered our sample to 778 in year 1997. Table 3.2 provides some descriptive statistics associated with the industries covered in the database for year 1997. Chaebol membership was identified through the Korea Fair Trade Commission (KFTC) list of the top 30 chaebols for 1997. Due to missing data, the number of firms in our regression analysis varied from 757 in 1998 to 828 in 2000.

3.6.2. Methodology And Measurement Of Variables

The hypothesized relationships outlined above are tested with a cross-sectional linear regression methodology, with White's adjustment for heteroskedasticity (STATA 7, 2001). To control for firm-specific variations due to size, where necessary we assessed each variable relative to firm total sales.\(^8\) The specific regression equation with the

\(^8\) Exceptions include return on assets and debt over assets.
variables related to hypotheses 1-6 and other control variables (listed first) are as follows for firm i:

\[
\text{Tobin's } q_{1998} = \alpha + \beta \text{ ROA}_{97} + \gamma \log \text{ of Total Assets}_{97} + \delta \text{ R&D Intensity}_{97} + \\
\epsilon \text{ Patent Intensity}_{97} + \phi \text{ International Sales Intensity}_{97} + \\
\chi \text{ Advertising Intensity}_{97} + \eta \text{ Training Intensity}_{97} + \\
\iota \text{ Debt/Assets}_{97} + \varphi \text{ Chaebol Dummy }_{97} + \kappa \text{ Capital Intensity}_{97} + \\
e(1)
\]

In order to assess Hypothesis 7, we repeat the above regression equation using Tobin's q for 1999 and 2000 as the dependent variable. We hypothesize that the coefficients for the 1999 and 2000 regressions differ from those of the 1998 regressions. Finally, in order to assess the effects of industry on the value of a firm's real options investments, we repeat these three relationships with industry adjustments for all variables as appropriate.

The dependent variable of Tobin's q is used to assess the value of the firm since it is a "forward looking" measure that adjusts for risk. We calculated Tobin's q for 1998-2000 in the manner suggested by Chung and Pruitt (1994), as follows:

\[
\text{Market value of common stock} + \text{book value of preferred stock} + \text{book value of debt} \\
\text{Book value of total assets}
\]

Market value of common stock is calculated as the price at year-end multiplied by the number of shares outstanding.

The independent variables are measured as indicated in Table 3.3. All such variables are measured at 1997 levels. To control for firm size effects, we divide these

---

9 Chung and Pruitt (1994) have shown that some variants of Tobin's q are highly correlated (at more than 96%) with more detailed measures.
variables by total sales in 1997. Exceptions include *investment in fixed assets*, which is measured as fixed assets over total assets in 1997, and *network effects*, for which we used total debt over total assets in 1997 to show a firm's relationships with banks, in a manner consistent with Makhija (2002). A dummy variable is used to indicate membership in a chaebol. To measure *R&D intensity*, separate expenditures for research and development in the income statement were combined. Training expenditures were those reported under statistics entitled "cost of goods produced," which is the reporting practice.

3.6.3. Control Variables

Tobin's q is affected by other firm characteristics as well, so we include control variables in our analysis. In particular, we control for the firm's past performance by including the firm's 1997 ROA in the equation. Firm size also can affect the value of the firm independent of the explanatory variables we included in the analysis. In particular, we might expect smaller firms to be more flexible in an uncertain environment. To control for this effect we included log of total assets in US$1,000, converted from Korean won based on the annual average exchange rate found in *International Financial Statistics* (IMF, 1998).

For industry-adjusted equations, we adjusted all explanatory and control variables by subtracting industry average from firm specific intensity values. For example, in the case of R&D intensity, we calculated industry average R&D intensity (total R&D/total sales in an industry) for each industry and subtracted it from firm-level R&D intensity. For industry classification, following Chang and Hong (2000), we used Korean Standard Industrial Classification (KSIC) at the 2-digit level.
<table>
<thead>
<tr>
<th>Variables</th>
<th>Operationalization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control variables</strong></td>
<td></td>
</tr>
<tr>
<td>ROA</td>
<td>Net profit/Total assets</td>
</tr>
<tr>
<td>Firm size</td>
<td>Natural log of total assets in US$1,000</td>
</tr>
<tr>
<td><strong>Independent variables</strong></td>
<td></td>
</tr>
<tr>
<td>Capital intensity</td>
<td>Fixed Assets/Total assets</td>
</tr>
<tr>
<td>R&amp;D intensity</td>
<td>(Research expenditure + Development expenditure)/Total sales</td>
</tr>
<tr>
<td>Patent intensity</td>
<td>Patent expenditure/Total sales</td>
</tr>
<tr>
<td>International sales intensity</td>
<td>(Sales - Domestic sales)/Total sales</td>
</tr>
<tr>
<td>Advertising intensity</td>
<td>Advertising expenditure/Total sales</td>
</tr>
<tr>
<td>Training intensity</td>
<td>Training expenditure/Total sales*</td>
</tr>
<tr>
<td>Network effect</td>
<td>Total Debt/Total assets</td>
</tr>
<tr>
<td>Chaebol affiliation</td>
<td>Chaebol dummy</td>
</tr>
<tr>
<td></td>
<td>Affiliated to chaebol=1</td>
</tr>
<tr>
<td></td>
<td>Not affiliated to chaebol=0</td>
</tr>
</tbody>
</table>

* Training expenditure is acquired from cost of goods.

Table 3.3: Definitions of variables
3.7. Results And Discussions

Table 3.4 shows the correlation coefficients for the variables in our analysis. Based on this table, we can see that multicollinearity is not a serious problem, since the overwhelming majority of the correlations appear extremely low, and that all are below the accepted cutoff value of .80 (Judge et al., 1980). This allows us to test the variables in our basic valuation model above.

The purpose of our analysis is to evaluate the value of a priori investments for a number of real options by Korean firms in a period of great uncertainty. The results of the industry-adjusted analysis, which we discuss first, are given in Table 3.5, while those without industry adjustment are given in Table 3.6.

We had expected that industry-adjusted R&D and patent-related expenditures in 1997 would indicate real options investments resulting in higher value in 1998. Our findings support this role for R&D (hypothesis 1a) but not patents (hypothesis 1b). We also find international sales in 1997 relevant for enhancing value in 1998, thus supporting hypothesis 2. Neither industry-adjusted training expenditures nor industry-adjusted advertising significantly affected value in 1998; thus, both hypotheses 3 and 4 were unsupported. Finally, we find that our measure of network relationships (debt-asset ratio, indicating preferential treatment in procuring loans) was positively related to such value, supporting hypothesis 5a. However, the chaebol dummy was not found to be significant, contrary to hypothesis 5b. The results in Table 5 indicate that lower investments in fixed capital in 1997, relative to the industry, resulted in higher value in the uncertain period of 1998. We had argued that lower capital investments allowed firms to retain flexibility. This finding therefore supports hypothesis 6.
<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>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Tobin’s q 98</td>
<td>1.00</td>
<td>0.46</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Tobin’s q 99</td>
<td>1.40</td>
<td>2.10</td>
<td>0.25***</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Tobin’s q 00</td>
<td>0.98</td>
<td>0.99</td>
<td>0.31***</td>
<td>0.25***</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>ROA 97</td>
<td>0.02</td>
<td>0.14</td>
<td>-0.38***</td>
<td>-0.03</td>
<td>-0.14***</td>
<td>-0.07*</td>
<td>-0.20***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>T. Assets 97*</td>
<td>11.13</td>
<td>1.87</td>
<td>-0.07*</td>
<td>-0.14***</td>
<td>-0.07*</td>
<td>-0.20***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Capital int 97*</td>
<td>0.47</td>
<td>0.17</td>
<td>-0.08*</td>
<td>-0.03</td>
<td>-0.14***</td>
<td>0.23***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>R&amp;D int 97*</td>
<td>0.00</td>
<td>0.02</td>
<td>0.10**</td>
<td>0.06*</td>
<td>0.04</td>
<td>0.10***</td>
<td>-0.16***</td>
<td>-0.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Patent int 97b</td>
<td>0.00</td>
<td>0.00</td>
<td>0.13***</td>
<td>0.08*</td>
<td>0.02</td>
<td>-0.00</td>
<td>0.08*</td>
<td>0.02</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Intl.sales int 97b</td>
<td>0.16</td>
<td>0.26</td>
<td>0.06*</td>
<td>-0.12***</td>
<td>-0.05</td>
<td>-0.08*</td>
<td>0.29***</td>
<td>0.14*</td>
<td>-0.05</td>
<td>0.24***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Adv. int 97b</td>
<td>0.01</td>
<td>0.03</td>
<td>0.09**</td>
<td>0.25***</td>
<td>0.04</td>
<td>-0.04</td>
<td>-0.04</td>
<td>-0.10**</td>
<td>0.01</td>
<td>-0.02</td>
<td>-0.14***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Training int 97b</td>
<td>0.00</td>
<td>0.00</td>
<td>0.08*</td>
<td>0.03</td>
<td>0.00</td>
<td>0.07*</td>
<td>0.05</td>
<td>0.06*</td>
<td>-0.01***</td>
<td>0.02</td>
<td>-0.00</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Debt/asset 97b</td>
<td>1.79</td>
<td>1.34</td>
<td>0.27***</td>
<td>-0.02</td>
<td>0.10**</td>
<td>-0.10**</td>
<td>-0.08***</td>
<td>-0.62**</td>
<td>-0.03</td>
<td>-0.07*</td>
<td>-0.10**</td>
<td>0.05</td>
<td>-0.05*</td>
</tr>
<tr>
<td>13.</td>
<td>Chaebol 97</td>
<td>0.10</td>
<td>0.31</td>
<td>-0.02</td>
<td>-0.05</td>
<td>-0.03</td>
<td>-0.05*</td>
<td>0.48***</td>
<td>0.16***</td>
<td>-0.03</td>
<td>0.02</td>
<td>0.15***</td>
<td>-0.03</td>
<td>0.04</td>
</tr>
</tbody>
</table>

\*Values are logged and in US$, \*\*Values are percentages; \* \* \* p<.10, \* \* \* p<.05, ** p<.01, *** p<.001

Table 3.4: Descriptive statistics and correlations
<table>
<thead>
<tr>
<th>Variable</th>
<th>Tobin's q 98 (s.e.)</th>
<th>Tobin's q 99 (s.e.)</th>
<th>Tobin's q 00 (s.e.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROA 97</td>
<td>-1.58*** (0.43)</td>
<td>-0.81 (0.54)</td>
<td>-1.22*** (0.35)</td>
</tr>
<tr>
<td>Total assets 97 (US$)*</td>
<td>-0.02t (0.01)</td>
<td>0.01 (0.06)</td>
<td>-0.02 (0.04)</td>
</tr>
<tr>
<td><strong>Explanatory variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D int 97 b</td>
<td>8.68* (3.73)</td>
<td>8.59 (12.51)</td>
<td>7.50 (6.68)</td>
</tr>
<tr>
<td>Patent int 97 b</td>
<td>-7.40 (5.35)</td>
<td>-25.85 (24.23)</td>
<td>-0.22 (3.00)</td>
</tr>
<tr>
<td>Intl sales int 97 b</td>
<td>0.14* (0.07)</td>
<td>-0.30 (0.23)</td>
<td>-0.15* (0.08)</td>
</tr>
<tr>
<td>Advertising int 97 b</td>
<td>1.24 (1.22)</td>
<td>21.47* (9.32)</td>
<td>1.49* (0.65)</td>
</tr>
<tr>
<td>Training int 97 b</td>
<td>-13.18 (15.90)</td>
<td>-623.11* (300.27)</td>
<td>-32.18 (19.77)</td>
</tr>
<tr>
<td>Debt asset ratio 97 b</td>
<td>0.07** (0.02)</td>
<td>-0.13t (0.07)</td>
<td>0.06* (0.02)</td>
</tr>
<tr>
<td>Chaebol dummy 97</td>
<td>0.03 (0.04)</td>
<td>-0.07 (0.15)</td>
<td>-0.02 (0.09)</td>
</tr>
<tr>
<td>Capital int 97 b</td>
<td>-0.17*** (0.03)</td>
<td>-0.31 (0.30)</td>
<td>-0.10* (0.05)</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.84** (0.04)</td>
<td>1.35*** (0.16)</td>
<td>0.81*** (0.08)</td>
</tr>
<tr>
<td>N</td>
<td>757</td>
<td>794</td>
<td>828</td>
</tr>
<tr>
<td>Adjusted R^2</td>
<td>0.24***</td>
<td>0.16***</td>
<td>0.04***</td>
</tr>
</tbody>
</table>

* Values are logged, † Values are percentages.
p<.10, * p<.05, ** p<.01, *** p<.001

Table 3.5: Results of multiple regression analysis: Investments in real options of Korean firms in 1997 (with industry adjustment)
<table>
<thead>
<tr>
<th>Variable</th>
<th>Tobin's q 98 (s.e.)</th>
<th>Tobin's q 99 (s.e.)</th>
<th>Tobin's q 00 (s.e.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROA 97</td>
<td>-1.30*** (0.48)</td>
<td>-0.01 (0.67)</td>
<td>-1.24** (0.03)</td>
</tr>
<tr>
<td>Total assets 97 (US$) a</td>
<td>-0.04** (0.01)</td>
<td>-0.22** (0.07)</td>
<td>-0.05</td>
</tr>
<tr>
<td><strong>Explanatory variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D int 97 b</td>
<td>7.46* (3.46)</td>
<td>8.97 (9.70)</td>
<td>7.50 (6.28)</td>
</tr>
<tr>
<td>Patent int 97 b</td>
<td>44.75** (15.87)</td>
<td>126.52** (43.55)</td>
<td>15.78 (0.07)</td>
</tr>
<tr>
<td>Int. sales int 97 b</td>
<td>0.11 t (0.06)</td>
<td>-0.55** (0.16)</td>
<td>-0.11 (0.64)</td>
</tr>
<tr>
<td>Advertising int 97 b</td>
<td>1.78 t (1.06)</td>
<td>19.70* (9.06)</td>
<td>1.30* (22.03)</td>
</tr>
<tr>
<td>Training int 97 b</td>
<td>51.89 t (30.24)</td>
<td>84.70 (60.19)</td>
<td>16.94 (0.08)</td>
</tr>
<tr>
<td>Debt asset ratio 97 b</td>
<td>0.12** (0.05)</td>
<td>-0.01 (0.09)</td>
<td>0.05 (0.06)</td>
</tr>
<tr>
<td>Chaebol dummy 97</td>
<td>0.03 (0.04)</td>
<td>0.25 t (0.15)</td>
<td>0.04 (0.45)</td>
</tr>
<tr>
<td>Capital int 97 b</td>
<td>0.28 (0.23)</td>
<td>0.50 (0.76)</td>
<td>-0.09 (0.31)</td>
</tr>
<tr>
<td>Intercept</td>
<td>1.02*** (0.17)</td>
<td>3.49*** (0.72)</td>
<td>1.46*** (0.31)</td>
</tr>
<tr>
<td>N</td>
<td>757</td>
<td>794</td>
<td>828</td>
</tr>
</tbody>
</table>

Adjusted $R^2$           | 0.24***             | 0.16***             | 0.04***             |

Values are logged, a Values are percentages.

*, p<.10, ** p<.05, *** p<.01

Table 3.6: Results of multiple regression analysis: Investments in real options of Korean firms in 1997(without industry adjustment)
In all, we find support for four of our six hypothesized relationships when controlling for industry. Overall, from our industry-adjusted analysis, based on the adjusted R-squared and the general support for several of the variables, our results affirm the value of 1997 real options investments by Korean firms in the uncertain period of 1998.

We compare the results of the industry-adjusted analysis with those without industry adjustment. By making the industry adjustment above, we in effect understate the amount of real options investments for industries that have actually undertaken larger real options investments. However, it may be argued that the absolute amount of real options investments are important for a firm's survival in a broad economy-wide crisis, such as the Korean economic crisis, and are therefore more meaningful than relative amounts. Indeed, as our unadjusted results now confirm, firms with larger absolute real options investments do fare better in a far-reaching economic crisis.

We find that, without industry adjustment, all variables are significant in the hypothesized direction with the exception of chaebol dummy and capital intensity. Patent intensity now becomes very significant at .001, indicating that patents provide real options value irrespective of the firm's immediate competitive environment. Training and advertising intensity are both significant at the .10 level. The significance of these two variables suggests that both training and advertising provide real options value to the firm in a period of uncertainty beyond its industry context. We do not find the insignificance of capital intensity in this regression to be particularly surprising given the strong relationship between capital intensity and the production-specific characteristics of industries.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Industry adjusted</th>
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<th>Non-industry adjusted</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(t-value)</td>
<td>(t-value)</td>
<td>(t-value)</td>
<td>(t-value)</td>
</tr>
<tr>
<td><strong>Control Variables</strong></td>
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<td></td>
<td><strong>(t-value)</strong></td>
<td></td>
</tr>
<tr>
<td>ROA97</td>
<td>-0.46</td>
<td>1.58</td>
<td>-0.23</td>
<td>-1.30</td>
</tr>
<tr>
<td></td>
<td>(63.66)***</td>
<td></td>
<td></td>
<td>(53.81)***</td>
</tr>
<tr>
<td>Total assets97</td>
<td>-0.04</td>
<td>-0.02</td>
<td>-0.07</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(29.75)***</td>
<td></td>
<td></td>
<td>(48.82)***</td>
</tr>
<tr>
<td><strong>Explanatory Variables</strong></td>
<td></td>
<td></td>
<td><strong>(t-value)</strong></td>
<td></td>
</tr>
<tr>
<td>R&amp;D int. 97</td>
<td>5.38</td>
<td>8.68</td>
<td>4.38</td>
<td>7.46</td>
</tr>
<tr>
<td></td>
<td>(-19.68)***</td>
<td></td>
<td></td>
<td>(-20.03)***</td>
</tr>
<tr>
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<td>5.86</td>
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<tr>
<td></td>
<td>(11.51)***</td>
<td></td>
<td></td>
<td>(-56.17)***</td>
</tr>
<tr>
<td>Int. sales int. 97</td>
<td>0.05</td>
<td>0.14</td>
<td>-0.02</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>(-32.68)***</td>
<td></td>
<td></td>
<td>(-49.65)***</td>
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<td>Advertising int. 97</td>
<td>2.24</td>
<td>1.24</td>
<td>2.04</td>
<td>1.78</td>
</tr>
<tr>
<td></td>
<td>(15.19)***</td>
<td></td>
<td></td>
<td>(4.55)***</td>
</tr>
<tr>
<td>Training int. 97</td>
<td>-19.87</td>
<td>-13.18</td>
<td>51.07</td>
<td>51.89</td>
</tr>
<tr>
<td></td>
<td>(-7.38)***</td>
<td></td>
<td></td>
<td>(-0.59)***</td>
</tr>
<tr>
<td>Debt asset ratio97</td>
<td>0.05</td>
<td>0.07</td>
<td>0.09</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>(-18.68)***</td>
<td></td>
<td></td>
<td>(-12.56)***</td>
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<tr>
<td>Chaebol dummy97</td>
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<td>0.07</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(-11.65)***</td>
<td></td>
<td></td>
<td>(23.77)***</td>
</tr>
<tr>
<td>Capital int. 97</td>
<td>-0.08</td>
<td>-0.17</td>
<td>0.21</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>(54.12)***</td>
<td></td>
<td></td>
<td>(-5.38)***</td>
</tr>
</tbody>
</table>

\[ p<.10, \* p<.05, \** p<.01, \*** p<.001 \]

Table 3.7: Tests of univariate mean difference between 1997 and 1998 coefficients
Interestingly, we find that the two control variables (ROA and size) are significant for both regressions. As expected, size is negatively associated with value, consistent with our expectation that smaller firms will be more flexible in adapting to uncertain environments. ROA is also found to be significantly negative, suggesting that firm profitability during the stable period of 1997 has an adverse effect on value in an unstable period. This supports Kogut and Kulatilaka (1994a), who suggest that firms performing well in a stable environment do not invest adequately in options. Such myopic firms pay the penalty in a period of great uncertainty. We also find little significance for chaebol dummy in our analysis. It may be that the concurrent existence of both positive and negative effects of chaebol affiliation on firm value cancel out each others’ effects. While Bowman and Hurry (1993) argue that chaebol-like structures such as keiretsu approximate a portfolio of options-related assets, McGrath (1999) stresses that affiliation to chaebol network actually decreases flexibility due to their centralized decision making systems. In addition, a chaebol network has other implications such as superior political connections (Evans, 1995; Amsden, 1989) and preferential treatments in financial resources (Cole and Park, 1983). These multiple and contradictory real options implications may in fact cancel out, rendering this variable insignificant.

Table 3.7 contains univariate mean difference tests for the industry- and non-industry-adjusted coefficients for 1997 and 1998. The results generally confirm that the value of the real options investments in both cases are significantly different across the two years, with p-values of above .001, in a manner consistent with our above findings.
These results provide further support for our argument that the real options investments examined in this research have a greater impact on firm value in the more uncertain period of 1998 than that of 1997.

To assess hypothesis 7, which evaluates the role of real options investments in subsequent years of less uncertainty, we examine the relationship between our independent variables and measures of Tobin's q for the years 1999 and 2000. We had noted that 1999 was a year of considerably less uncertainty than 1998. We therefore expect that the value of these investments would diminish for this period. We find that, consistent with this hypothesis, most of the industry adjusted variables that were significant in 1998 are no longer so in 1999. The change of the sign of debt/equity ratio suggests that in good times, ties to financial institutions have a negative impact on firm value. The adjusted $R^2$ is considerably lower for this regression as well (.24 versus .16).

Interestingly, and contrary to our expectations, industry-adjusted training, which was insignificant in 1998, appears to have a significant and negative effect on firm value in 1999. This may be explained by the fact that for training to have a real options value, it is necessary that employees stay with the firm. If employees, especially those with firm-specific knowledge, leave the firm, the real options value of training is lost. In fact, immediately after economic crisis, many firms restructured and laid off employees (Far Eastern Economic Review, 1999). In addition, the economic situation may have provided the impetus for new business start-ups by former employees. Thus, many people may leave their employment of their own accord to start their own businesses. An example of this is CoMiCo, a new venture firm established by a former employee of Hyundai.
Electronics. This firm has Hyundai as one of its major clients because the founder utilized his firm-specific knowledge of this firm (Asian Business, 1997).

The non-industry-adjusted findings indicate that patents and advertising are still significant for 1999. These findings suggest that advertising is a type of investment that is less related to real options than other types of investments, and appears to be equally or more valuable during periods of relative stability (level of significance of .10 in 1998 versus .05 in 1999 and 2000). Patents are also valuable during both stable and unstable times (.01 in both 1998 and 1999). Both variables exhibit much larger coefficients for the 1999 equation as well. International sales, interestingly, while significant and positive in 1998 as expected, changes its sign in 1999. Salomon and Shaver (2000) find that there is at least a short-term trade-off between domestic and international sales when capacity constraints are considered. When domestic sales pick up in the ensuing period of stability, international sales will go down. Thus, international sales no longer operate as a source of real options for the firm.

We find that firm size remains both significant and negative in 1999. This is consistent with the notion that smaller firms benefit from their size in both stable and uncertain environments. In addition, the chaebol dummy becomes significant and has positive relationship to firm value in 1999. Chaebol success can therefore be associated with more stable periods, which also helps to explain its role in the Korean economy even prior to the crisis.

It may be that the level of uncertainty for 2000, while not as great as 1998, was still higher than 1999. Predictions of a second crisis were being made at this time, although this largely did not pan out (BusinessWeek, 2000a, 2000b). Some of the results
for 2000 support this expectation, primarily for the industry-adjusted relationships. Two variables that did not show significance in the correct direction in 1999 do so in 2000 (debt/asset ratio and capital intensity). Advertising continues its significance from 1999 into 2000. The negative relationship between ROA and firm value found for 1998 reappears in 2000. International sales show significance as well, but in an unexpected direction. Overall, however, the low adjusted R² (.04) for this equation suggests that the real options value of these investments, once "exercised" in 1998, no longer contributes much to the firm's value. It may be that once the option is exercised, subsequent value of the investment is reduced.

3.8. Robustness Check: The Incremental Effect Of Real Options Investments

In order to assess the incremental effect of real options investments on a firm's tobin's q, we reexamined the hypotheses while controlling for the previous year's tobin's q. Our results remain mainly consistent with those discussed above (Tables 3.8 and 3.9), although the adjusted R² is considerably higher, ranging from .43 in 1999 to .08 in 2000. We find that for both the industry and non-industry adjusted equations, most variables are significant in a manner similar to our original results in explaining firm value in 1998. We also have largely similar findings for the subsequent years of 1999 and 2000. These results support the notion that real options investments have an incremental greater effect on firm value under conditions of higher uncertainty.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Tobin's q 97</th>
<th>(s.e.)</th>
<th>Tobin's q 98</th>
<th>(s.e.)</th>
<th>Tobin's q 99</th>
<th>(s.e.)</th>
<th>Tobin's q 00</th>
<th>(s.e.)</th>
</tr>
</thead>
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<td><strong>Control variables</strong></td>
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<tr>
<td>Tobin's q 97</td>
<td>0.66***</td>
<td>(0.09)</td>
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<tr>
<td>Tobin's q 98</td>
<td></td>
<td></td>
<td>1.03***</td>
<td>(0.25)</td>
<td></td>
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<tr>
<td>Tobin's q 99</td>
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<td></td>
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<td>0.12</td>
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<tr>
<td>Total assets 97 (US$)*</td>
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<td>(0.05)</td>
<td>-0.01</td>
<td>(0.04)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D int 97 b</td>
<td>5.28*</td>
<td>(2.52)</td>
<td>7.93</td>
<td>(10.16)</td>
<td>7.45</td>
<td>(8.08)</td>
<td></td>
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<tr>
<td>Patent int 97 b</td>
<td>-3.10</td>
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<td>(21.84)</td>
<td>3.07</td>
<td>(4.41)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intl sales int 97 b</td>
<td>0.14*</td>
<td>(0.06)</td>
<td>-0.50*</td>
<td>(0.22)</td>
<td>-0.10</td>
<td>(0.07)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advertising int 97 b</td>
<td>-0.39</td>
<td>(0.50)</td>
<td>16.57t</td>
<td>(9.44)</td>
<td>-1.37</td>
<td>(1.95)</td>
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<tr>
<td>Training int 97 b</td>
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<td>-404.84</td>
<td>(246.52)</td>
<td>47.63</td>
<td>(62.34)</td>
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</tr>
<tr>
<td>Debt asset ratio 97 b</td>
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<td>(0.03)</td>
<td>-0.19*</td>
<td>(0.07)</td>
<td>0.11*</td>
<td>(0.02)</td>
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<td>Intercept</td>
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<td>(0.11)</td>
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<td>(0.22)</td>
<td>0.62***</td>
<td>(0.06)</td>
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<td>N</td>
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<td>751</td>
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<td>792</td>
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<tr>
<td>Adjusted R^2</td>
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<td>0.18***</td>
<td></td>
<td>0.08***</td>
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* Values are logged, b Values are percentages.
, p<.10, * p<.05, ** p<.01, *** p<.001

Table 3.8: Results of multiple regression analysis: Investments in real options of Korean firms in 1997 (with industry adjustment)
<table>
<thead>
<tr>
<th>Variable</th>
<th>Tobin's q 97</th>
<th>(s.e.)</th>
<th>Tobin's q 98</th>
<th>(s.e.)</th>
<th>Tobin's q 99</th>
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<td>(0.08)</td>
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<td></td>
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<td>(0.26)</td>
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<tr>
<td>Tobin's q 99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.12</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Total assets 97 (US$)*</td>
<td>-0.01</td>
<td>(0.01)</td>
<td>-0.17**</td>
<td>(0.05)</td>
<td>-0.03</td>
<td>(0.04)</td>
</tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D int 97 b</td>
<td>3.36</td>
<td>(2.40)</td>
<td>8.25</td>
<td>(9.47)</td>
<td>5.94</td>
<td>(7.60)</td>
</tr>
<tr>
<td>Patent int 97 b</td>
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<td>(13.23)</td>
<td>90.04*</td>
<td>(44.97)</td>
<td>-3.41</td>
<td>(27.05)</td>
</tr>
<tr>
<td>Intl sales int 97 b</td>
<td>0.17**</td>
<td>(0.05)</td>
<td>-0.66***</td>
<td>(0.15)</td>
<td>0.00</td>
<td>(0.07)</td>
</tr>
<tr>
<td>Advertising int 97 b</td>
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<td>13.38</td>
<td>(8.51)</td>
<td>-0.80</td>
<td>(1.48)</td>
</tr>
<tr>
<td>Training int 97 b</td>
<td>16.40</td>
<td>(22.97)</td>
<td>54.85</td>
<td>(55.79)</td>
<td>11.10</td>
<td>(26.27)</td>
</tr>
<tr>
<td>Debt asset ratio 97 b</td>
<td>0.15**</td>
<td>(0.05)</td>
<td>-0.26*</td>
<td>(0.11)</td>
<td>0.15**</td>
<td>(0.05)</td>
</tr>
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<td>Chaebol dummy 97</td>
<td>-0.02</td>
<td>(0.03)</td>
<td>0.35**</td>
<td>(0.12)</td>
<td>-0.02</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Capital int 97 b</td>
<td>0.57*</td>
<td>(0.23)</td>
<td>-0.70</td>
<td>(0.61)</td>
<td>0.36</td>
<td>(0.34)</td>
</tr>
<tr>
<td>Intercept</td>
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<td>(0.20)</td>
<td>2.95***</td>
<td>(0.61)</td>
<td>0.75*</td>
<td>(0.40)</td>
</tr>
<tr>
<td>N</td>
<td>751</td>
<td></td>
<td>751</td>
<td></td>
<td>792</td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.44***</td>
<td></td>
<td>0.16***</td>
<td></td>
<td>0.08***</td>
<td></td>
</tr>
</tbody>
</table>

* Values are logged, b Values are percentages.

Table 3.9: Results of multiple regression analysis: Investments in real options of Korean firms in 1997(without industry adjustment)
3.9. Conclusions And Implications

The purpose of this research has been to examine the value of real options investments of firms under conditions of tremendous uncertainty. The largely unanticipated nature of the Korean economic crisis in 1998, along with its highly uncertain implications, created the conditions of a "natural experiment" for investigating this issue. Given the economy-wide impact of the economic crisis, we are able to examine a large set of firms to examine several hypotheses relating the effect of different types of real options investments to firm value, as discussed in the literature. At the same time, we are able to compare these relationships across multiple industries, and across years of varying uncertainty.

Our findings support the real options reasoning for many types of investments discussed in the literature, including investments relating to R&D, international sales base, and network ties to banks (both adjusted and not adjusted for industry), capital intensity (adjusted for industry) patents, advertising and training (not adjusted for industry). In this regard, all six hypotheses were supported to some degree. Our seventh hypothesis, relating to periods of greater or less uncertainty, was also generally supported with several variables gaining significance in 2000 over 1999. Nonetheless, these findings were considerably weaker than those for 1998 (adjusted R² .24 versus .04). These findings provide support to the argument that real options investments are associated with greater value during periods of uncertainty than those characterized by relative stability.
This research also highlights the role of uncertainty outside the context of a firm’s industry, in contrast to the preponderance of work that mostly examines industry-related uncertainty. The results suggest that uncertainty associated with a broad-based economic crisis situation creates different imperatives for options than those associated with a given industry. In the case of an economic crisis, it appears that firms benefit from real options even when these do not differ considerably from other firms in their industry. Instead, such options may help them to overcome the adverse conditions of the crisis (that is, survive or ride out the crisis situation). After this, their value dies out more rapidly than that of those options related to the firm’s industry (see Tables 3.4 and 3.5).

There are a number of implications for future work. Our findings indicate that many forms of real options provide value above and beyond a firm’s own industry, while other types are more focused in scope. For example, we find that R&D and international sales provide advantages both within and beyond the firm’s industry, while capital intensity does not. The value of capital-related investment is constrained by industry context. In contrast, the options value of training was found to be unrelated to a firm’s industry. We also found that some types of investments such as advertising are more valuable in stable environments. This suggests, contrary to prior research (Dixit and Pindyk, 1994), that advertising is not a real options investment for firms. We believe the conditions under which different types of investments provide real options value deserves greater study.

This study only examined the real options value in an uncertain environment falling short in knowing if firms actually exercise the options they have and how. For future studies, one can examine the actual realizations of real options investments. In
addition, there are many other countries such as Thailand, Malaysia, and Indonesia that suffered from the recent economic crisis than Korea. Examining firms in different institutional environments to find out how these institutional differences affect firms' investments and realization of real options would also render better understanding of the theory.
CHAPTER 4

THE REAL OPTIONS VALUE OF INTERNATIONAL INVESTMENTS
BY KOREAN FIRMS

4.1. Introduction

International investments provide firms with notable real options that allow them to gain strategic and operational flexibility, particularly during periods of heightened uncertainty (Miller and Reuer, 1998; Tang and Tikoo, 1999). Indeed, a respectable body of theoretical work has expounded on the value of such multinational flexibility (Kogut and Kulatilaka, 1994; Mello et al., 1995). Firms' international investments include direct exports to other countries (Broll, 1999; Roberts and Tybout, 1997) and foreign direct investment (Campa, 1994; Dunning, 1980). An established exporting infrastructure, for example, allows firms to rapidly respond to unanticipated changes in demand in both domestic and international markets (Lee and Makhija, 2002; Roberts and Tybout, 1997). Firms with production facilities located in multiple countries can benefit from their ability to change production locations in response to unexpected adverse conditions in any given country, such as increases in labor costs or exchange rate volatility (Reuer and Leiblein, 2000; Kogut and Kulatilaka, 1994), as well as increased political risks (Makhija, 1993).
Despite the attention given to international investments in the literature, there is scant empirical evidence on the real options value of such international investments. Furthermore, while exports and foreign direct investment may both provide real options to firms, they are markedly different types of investments. Researchers have not previously considered differences in the real options value of these highly contrasting international investments. Moreover, the real options value of international investments may depend on the organizational context under which they are undertaken (Sanchez, 1993). In this regard, some authors have suggested that networked firms benefit from enhanced real options (Sanchez, 1995; Foss, 1998), while others argue that networks can actually limit the flexibility of the firm (Sedaitis, 1998; Larson, 1992; Rowley et al., 2000). It remains unclear how networks, an important phenomenon in many developing countries, affect the value of firms' international real options.

An important reason why such important questions have been empirically difficult to investigate stems from the need to assess the real options value of firms' international investments in the context of a sudden change (e.g., onset of great uncertainty, since real options take on their greatest value under such conditions). The purpose of this paper is to address these limitations in the literature, by analyzing the natural experiment embedded in the recent Asian crisis experienced by Korean firms. Our objectives are threefold: (1) to examine the real options value of firms' international investments under conditions of greater and lower uncertainty; (2) to compare the real options value of different types and configurations of international investments (exports and FDI); and, (3) to explore how the real options value of international investments may differ for firms that are embedded in comparison to those not embedded in networks.
We find that the necessary conditions prevailed for our sample of 554 publicly traded firms listed on the Korean Stock Exchange (KSE) during 1996-1998. This database is tailor-made for assessing the real options value of firm investments for two important reasons. First, it includes the highly uncertain period of the Asian economic crisis which began in the end of 1997, becoming full-blown in 1998. According to analysts' and news reports at the time, the crisis was unanticipated as well, thereby providing us with the appropriate conditions under which to examine the consequent real options value of international investments (Ang and Ma. 2001). The unanticipated major jump in uncertainty is a crucial feature of our natural experiment. This jump underlies a potential large differential in options values according to the size and nature of the international investment. Being unanticipated, the consequent changes in 1998 firm values reflect the real options value of the prior international investments. Given the prevalence of both exporting and foreign direct investments among Korean firms, this sample permits a study of their differential effects. Finally, since the sample includes significant numbers of both chaebol and non-chaebol firms, we are also able to compare the effect of networks on the real options value of international investments. At any rate, among Korean firms, it is important to recognize potential differences in investment behavior among chaebol and non-chaebol firms.

Our findings support the notion that international investments provide identifiable real options benefits to firms in a period of greater uncertainty. We also find support for our argument that varying configurations of exports and FDI accord differing real options benefits to firms under uncertainty. Finally, our results indicate that the real options value of international investments differ in important ways for networked and non-
networked firms. In all, as expected, higher environmental uncertainty was found to enhance the real options value of such investments in our analysis.

4.2. The Conceptual Underpinnings Of This Research

Macroeconomic and other forces can cause unpredictable, fundamental shifts in the level of demand and in the relative costs of inputs, causing firms to scramble to adjust or even to radically reconfigure their value chains in response to new opportunities for, or threats to, profitable production (Kogut, 1991, 1994; Lee and Makhija, 2002). For this reason, successfully competing in dynamic markets requires resources, capabilities and strategies that are fundamentally different from those that are likely to lead to success in more stable markets (Bowman and Hurry, 1993; Kogut, 2001). In particular, a firm must have the flexibility to respond advantageously to unknown future changes in its environment (Foss, 1998). In light of this, firms' strategies should revolve around optimizing strategic options (Sanchez, 1993, p. 253). These options are embedded in prior investments made by the firm, and serve to enhance its access to markets and help it to internalize the necessary resources and capabilities for operating in a dynamic environment.

The greater the uncertainty faced by firms, the more important it is for them to have strategic flexibility that allows them to deal with future unknown environmental outcomes (Bowman and Hurry, 1993; Sanchez, 1993). Firms can in fact make a variety of *a priori* investments that confer more options for dealing with unanticipated environmental changes that would otherwise pose considerable risk (Sanchez, 1993,
These include investments in research and development that allow firms to rapidly improve product attributes over those of competitors (McGrath, 1997; Pakes, 1986; Arman and Kulatilaka, 1998), flexible manufacturing capabilities that allow for adaptation of product configurations to unknown future demand (Pindyck, 1988; Bowman and Hurry, 1993), as well as investment in the training and development of employees that give them greater ability to anticipate and address rapid environmental changes (Bartel, 1994; Stevens, 1994). Such investments allow the firm more options for the best courses of action, particularly as unexpected future conditions unfold. For this reason, real options investments take on greater value under conditions of higher uncertainty. Firms' international investments, relating to exporting and foreign direct investment, also allow a firm to optimize its strategic options in several valuable ways. International investments confer at least two types of real options benefits: those associated with within-country growth and those relating to across-country flexibility (Kogut and Kulatilaka, 1994). Within-country growth options can be obtained by ex ante investments in relationships, market knowledge, or brand image. In contrast, across-country flexibility options can be generated by shifting sales or production from one country to another.

When a firm engages in exporting, it is able to allocate sales of its domestic production among both domestic and foreign markets. In the face of exchange rate volatility (Broll, 1999), demand for differentiated products (Aulakh et al., 2000), or decline in domestic demand (Lee and Makhija, 2002), the value of the option to export increases. The benefits of the export option under exchange rate fluctuation takes the following form. When exchange rates increase, exports can also be increased in line with
more advantageous realized prices. When the exchange rate decreases, exports can be reduced, potentially to zero. When the exchange rate once again permits profitable exports, the firm resumes exporting (Broll, 1999). The possibility to export when exchange rates are favorable conveys a real call-like option that increases income for the firm. In other words, exports function as an option because a firm's domestic market return is more or less certain whatever the realized exchange rate turns out to be (Broll & Eckwert, 1999). The domestic price, then, is the "strike price" of the real export option. In fact, the greater the volatility of the exchange rate, the higher will be the value of the option to export.

The ability to rapidly address demand fluctuations, and particularly declines, in their domestic markets is not a benefit that non-exporting firms have, however. The establishment and nature of exporting relationships involves a priori investment (Lee and Makhija, 2002). Lack of export-related knowledge creates greater risks and reduces flexibility (Roberts, & Tybout, 1997). For example, Malekzadeh and Nahavandi (1985) note that for firms with exporting experience, the distance of additional foreign markets ceases to be a constraint in considering new markets to enter. In contrast, this is a primary constraint for firms without such experience. Investments in acquiring market knowledge can expand the firms' options and thereby increase the export flexibility of the firm (Sanchez, 1993). Furthermore, rapidly changing markets characterized by high competition allow exporters more opportunities to introduce innovative and differentiated products that might be new in foreign markets. In contrast to exports, foreign direct investment involves the establishment of subsidiaries or affiliates in foreign locations. In this regard, Aulakh et al. (2000) note that foreign direct investment involves escalated
operational commitment to foreign markets. Often, markets that are difficult to penetrate via exports are entered into via foreign direct investment. Due to the fact that its operations are distributed across multiple geographic locations, a multinational firm can respond to country-specific environmental shocks and fluctuations, or unanticipated opportunities, by shifting factors of production across national borders (Kogut, 1983, 1985; Kogut and Kulatilaka, 1994). In this regard, such foreign investments provide firms with enhanced flexibility to avoid downside risk and exploit new profit opportunities (Tang and Tikoo, 1999).

Multinational firms with productive subsidiaries benefit from operational flexibility in several ways that differ from pure exporters. First, and most obviously, they can make production decisions that maximize profit by shifting production to locations with more beneficial cost structures (Tang and Tikoo, 1999). For example, if an environmental change causes the labor costs in a given location to rise, a firm with operational flexibility can shift labor-intensive operations to other lower-cost locations. Second, multinational firms may be able to vary the locations in which to declare profits, depending on differential taxation in the countries in which they operate. Third, they can modify the locations in which to concentrate market power, depending on competitive forces. Hamel and Prahalad's (1995) discussion of cross-subsidization can be extended in this direction. Multinational firms have the ability to cross-subsidize their operations, flexibly allocating profits of some subsidiaries to support others experiencing unexpected environmental fluctuations. Finally, differences in tax codes across countries make it possible for the firm to rapidly transfer some profits and/or losses to locations where they are tax-advantaged. Such operational flexibility gives a firm the ability to enhance its
overall production capabilities, resulting in increased cash flow and growth potential by providing profit-loss transfer benefits for tax purposes (Mello et al., 1995).

While operational flexibility is of potential value to the firm, it must also be recognized that managing a multinational network of subsidiaries is associated with higher costs as well (Rangan, 1998). The complexity of managing such a network can offset the real options benefits. Hitt, Hoskisson and Kim (1997) point out the transactions costs associated with the myriad of country-specific transactions in a given subsidiary. These include those associated with suppliers, customers, distributors and government agencies, to name a few. In addition, the implementation of decisions to transfer production is not typically clearcut. Transportation costs, changes in export and import duties, and variations in deals made with the government, for example, may make it difficult to determine the true costs of switching production from one location to another. Finally, the ability to transfer production from one location to another depends on the nature of the specific operations in each country. To the extent that the firm's factories in different countries are geared towards satisfying country-specific demand, the potential for transferring production from one country to another is greatly limited. In sum, while the potential for operational flexibility is enhanced by multinational operations across multiple countries, such benefits must exceed the costs of managing the multinational network.

Although both exports and foreign direct investment are thought to confer valuable real options on firms, in terms of within-country growth as well as across-country flexibility, there are clear differences in their potential to do so. It may be argued that exports require less commitment, entail lower costs, and thereby provide greater
strategic flexibility than foreign direct investment. These features should lead to greater comparative real options value. On the other hand, exports are limited to market flexibility. They do not allow firms to benefit from the operational flexibility potentially afforded by an internationally dispersed productive capability. At the same time, the higher costs of foreign direct investment, the difficulty of changing production configurations, and opacity of operating conditions in specific countries, also makes its relative options benefits unclear. The relative real options value of exports versus FDI is therefore an empirical issue.

The real options value of international investment is also likely to depend on the organizational context within which it is undertaken. Indeed researchers have noted that the extent to which firms are embedded in an inter-firm network has important options related implications (Bowman and Hurry, 1993; McGrath, 1999). More specifically with regard to international investment, Guillen (2002) notes that economies of scope and transfer of learning among members of chaebol networks lower the necessary level of international investment, and at the same time, increase its benefits. Chang (1995) documents such benefits for firms associated with a keiretsu when they invest in countries in which other member firms are already invested.10 This is further confirmed by Axelsson and Johanson (1992), who find that interorganizational networks assist in foreign market entry, and Ellis and Pecotich (2001), who show that such relationships help to initiate exporting into countries. In this way, the benefits of a domestic network can extend to foreign activity. Nonetheless, the literature is not uniform in its assessment

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10 Chang (1995: 391) cites the comment made by the president of Mitsubishi Semiconductor: "When we came to the United States, we asked other Mitsubishi companies to support us. If we had to develop everything from scratch or ask other (outside) companies we are not familiar with, it would be more difficult (Business Week, 1990: 102)."
of the real options benefits of networks. An explanation for this may stem from differing
network attributes such as the strength of the network (Sedaitis, 1998).

Researchers have noted the existence of at least two kinds of networks, those that
are open and those that are closed (Burt, 1992; Walker et al., 1997; Sedaitis, 1998). An
open network is characterized by loose ties among member firms, and with ties to firms
outside the network (Burt, 1992; Walker et al., 1997). A closed network, on the other
hand, is characterized by strong ties among member firms, with no or scant ties to firms
outside of the network (Coleman, 1988; Walker et al., 1997). While both have been
shown to be positively related to firm performance (Sedaitis, 1998), they differ in ways
relevant for their real options value. Rowley et al. (2000) argue that closed networks are
more advantageous in a stable environment, while open networks are more useful in an
unstable or uncertain environment. Since open networks have fewer constraints
stemming from strong inner and overlapping ties, they are open to diverse and new
opportunities.11 In contrast, the higher investment in relational capital characterizing
closed networks reduces risk, but at the same time constrains opportunity or new search
that is important under uncertainty (Walker et al., 1997; Sedaitis, 1998). Clearly, open
and closed networks differ in terms of their flexibility. In light of this, the nature of the
network to which the firm belongs will affect its ability to realize the real options benefits
of its international investments.

11 Sedaitis (1998), comparing spin-offs of state agencies and independent start-ups in an unstable post-
Soviet Union era, actually finds that dense strong ties among spin-offs works as a constraint in the
subsequent outreach process to outside world after founding. For example, diversity of client-firms was
lower for spin-offs compared to that of independent start-ups. On the other hand, founders of independent
start-ups were better able to seek new outside opportunities.
Although many authors have discussed the real options value of international investments from a theoretical perspective (Broll, 1999; Kogut, 1983, 1985; Kogut and Kulatilaka, 1994), the empirical evidence on such investments is both limited and mixed. For example, both Allen and Pantzalis (1996) and Tang and Tikoo (1999) find support for operational flexibility in their studies of breadth and depth of multinational networks. They indicate that firms with a broad distribution of subsidiaries across many national contexts are associated with higher market value than those characterized by a higher concentration of subsidiaries in a single country. Miller and Reuer (1998) show some evidence of real options benefits derived from exchange rate risk in the pricing strategies of a small percentage of U.S. manufacturing firms. In contrast, Reuer and Leiblein (2000) observe that greater multinationality does not help firms to reduce downside risk. Instead, they find that such investments result in higher bankruptcy and income stream risks. Rangan (1998) finds that firms attempt to manage flexibly, but the need for localization in their foreign direct investment has the effect of impeding intended flexibility. In addition, Campa's (1994) study on multinational investment under uncertainty provides support for the notion that such firms invest abroad for the purposes of risk diversification rather than operational flexibility.

Clearly, the conflicting findings of these studies point to the need for further investigation of the real options value of international investments. Since real options take on its greater value under higher uncertainty, the external conditions under which international investments are examined is extremely important. Exchange rate risks, for example, are easily hedged, or otherwise not necessarily the source of uncertainty for the firm, making it difficult to determine the true value of real options investments. It is
often assumed that exchange rate risks are the greatest source of uncertainty faced by multinational firms, when in fact a volatile industry context, unanticipated political risks and operational uncertainties may be of greater concern for the firm (Kogut and Kulatilaka, 1994; Allen and Pantzalis, 1996; Tang and Tikoo, 1999). Firms exercise options only when the value of the underlying asset exceeds the exercise price by more than the value of holding the option (Folta and Miller, 2002). Since exchange risk is easily hedged, it is not clear if exchange risk is a source of uncertainty great enough to exceed the threshold for exercising the option.12

It is also important to note that, since virtually all of the prior studies have focused only on foreign direct investment, the literature currently offers little or no evidence on the real options value of exporting, or on the relative real options benefits of different types of international investments. Clearly, exports are important sources of real options for firms that should also be examined (Broll, 1999). While exports entail fewer costs and is the preferred mode of entry for firms without extensive international experience (Chang, 1995; Chang and Rosenzweig, 2001), foreign direct investment is associated with potentially higher costs and benefits (Aulakh et al., 2000). It remains an empirical question, then, which is a preferable source of real options for firms. In addition, since firms often use a combination of the two, it would be interesting to examine the existence of possible synergistic benefits between them. By the same token, the relationship between networks and the real options value of international investments has not been previously examined. Given the significant theoretical treatment given to this topic,

12Consistent with the threshold argument, punctuated equilibrium theory (Tushman and Romanelli, 1985; Miller and Friesen 1980, 1984) also posits that major environmental changes require firms to possess fundamentally different resources.
particularly in light of the considerable international investments of keiretsus and chaebols, this relationship deserves empirical consideration. In this research, we attempt to address some of these concerns. The next section develops four sets of testable hypotheses assessing the real options value of the international investments of Korean firms.

4.3. Hypotheses

4.3.1. Real Options Value in Higher Uncertainty

We noted above that international investments provide firms with real options that are more valuable under uncertainty. Exports and foreign direct investment enhance the firm's flexibility in responding to changes in markets by prior investments in distribution, market knowledge and market development. Foreign direct investment also helps to provide flexible production configurations that can be used to respond to environmental changes (Hirsh & Lev, 1971). In a period of uncertainty, such international investments give firms options with respect to where they can sell their products and how they can produce them. In contrast, domestic firms have fewer options to reconfigure their operations and sales base in response to domestic uncertainty. Domestic firms cannot immediately begin exporting costlessly. As with any other investment, there are sunk costs associated with exporting (Roberts, & Tybout, 1997). Critical export-related knowledge (Malekzadeh & Nahavandi, 1985) needs to be acquired without which exporting cannot be initiated.
The year of 1998 reflected a period of extremely high uncertainty for Korean firms. It was during this period that the Korean economic crisis became full-blown. The Korean currency experienced unprecedented devaluation in comparison to other hard currencies. The exchange rate soared to 1401.4 won relative to the dollar, reflecting more than 40% decline in value. The massive economic changes experienced by the Korean economy could also be seen in the severe reduction of GDP over the previous year (-6.7 percent). The inflation rate nearly doubled, while the unemployment rate nearly tripled. These changes were exacerbated by the unanticipated nature of the Korean economic crisis.\(^1\)\(^3\)

Hence, in this period of crisis, we would expect that firms with established overseas exporting relationships would benefit tremendously from the option to export (due to lower international prices). At the same time, higher input prices domestically caused by the devaluation may make overseas production more profitable. Firms can reconfigure their markets and production away from the problematic domestic market and benefit from focusing on those locations that are less effected by the crisis.

The value of international investments will increase under periods of significant uncertainty. In this manner, we would expect that a higher level of international investments would provide firms with more flexibility in a period of great uncertainty, as follows:

\(^{13}\) This shift in environment enables us to test the real options value in a highly uncertain period. The pegging of the local currency to the dollar was abandoned at this time. As governments in crisis-inflicted countries abandoned their attempt to hold the currency, perceived uncertainty surged (Economist, 1997). Specifically, South Korean government abandoned its attempt to hold the won above 1,000 to the U.S. dollar on November 17, 1997 (Financial Times, 1997).

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**Hypothesis 1a:** Firms with a priori international investments will be associated with greater value than those without international investments during a period of greater uncertainty.

Since real options investments are associated with greater value in periods of greater uncertainty, we would expect that when uncertainty is reduced, the value of these options is also reduced. From the period of 1985 to 1997, prior to the crisis, Korea's GDP annual growth rates had remained very high, ranging from 5.0 to 9.2 percent. While there was some indication of a slowdown in the years 1996 and 1997, during which the growth rates averaged 6.8 and 5.0, respectively, these were nonetheless still very high in comparison to those experienced by most other countries. While the average exchange rate for the won/$ registered an increase in comparison to previous periods (804.5 and 951.3 for 1996 and 1997, respectively), it was not alarmingly so. Both inflation (4.9 and 4.4 percent) and unemployment (2.0 and 2.6 percent) rates held steady at low rates during this period (Lee and Makhija, 2002).

Thus, in comparison to 1998, the years of 1996 and 1997 reflect a period of far less uncertainty. In light of this, we would expect that a priori international investments would be associated with lower indistinguishable real options value during this period. Specifically, we propose:

**Hypothesis 1b:** Firms with a priori international investments will not be associated with greater value than those without international investments during a period of stability.

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4.3.2. The Real Options Value of Chaebol and Non-chaebol International Investments

According to Khanna and Palepu (2000), firms' networks play an important role in uncertain institutional environments by reducing uncertainty in factor, labor and product markets. Such firms benefit from the additional resources within the network, which provide a "cushion" of resources and knowledge not easily available elsewhere. In this regard, participating in networks and other interfirm arrangements may increase the number of real options available to the firm (Foss, 1998). Bowman and Hurry (1993: 771) argue that German and Japanese (keiretsu) networks operate like a portfolio of options, with pooled resources that create a greater variety of reserves than can be accommodated within a single firm.

We noted earlier, however, that networks could be characterized by open ties among member firms (Burt, 1992) or by closed and insular relationships (Coleman, 1988). These have differing implications for real options. Networks with open ties are characterized by greater openness to new information and opportunity, and while there is reliance on member firms, this does not preclude relationships with external firms. In contrast, closed networks reflect a greater interdependence of member firms for information, resources and support. In light of this, Rowley et al. (2000) suggest that open networks allow member firms to operate with greater flexibility than closed networks. In a period of uncertainty, then, open networks will tend to enhance firms' ability to realize the real options value of their international firms more than closed networks.
Sedaitis (1998) notes that ties among firms in closed networks tend to be both strong and redundant, which increases trust and repeated exchange within a network. This in turn reduces monitoring cost and opportunistic behavior by member firms (Coleman, 1988, 1990). Such ties facilitate the diffusion of norms across a network, fostering shared behavioral expectations (Meyer and Rowan, 1977; Oliver, 1991). For this reason, firms in a closed network tend to turn to themselves and to other familiar firms rather than seek new sources of information when confronted with crisis (Katz, 1982; Staw et al. 1981; Sedaitis, 1998). In such a network, strong coordination deprives individual firms of potential avenues of exploration (Kogut, 2000). Closed networks can therefore limit a firm's openness to alternatives ways doing business, leading collective blindness that can produce negative effects (Nahapiet and Goshal, 1998). Repeated exchange among firms within a closed network also leads to highly redundant (i.e., less diverse) outside ties. All in all, closed networks are likely to reduce firms' flexibility in periods of uncertainty.

Member firms of a chaebol network are interconnected to each other with strong ties that approximate closed networks. Significant cross shareholding and high internal transactions represent the strength of the ties among members of a chaebol network. For example, during the 1990s, the total in-chaebol network ownership held by either family members or subsidiaries for the largest 30 chaebols was maintained at a stable ratio of 43-45 percent (Nam, 2001). Not surprisingly, internal transactions among top five chaebols in 1997 amounted to over 30 percent of their total sales (Nam, 2001).

The relationships within the chaebol network are not limited to domestic operations; they extend to overseas operations as well. Firms within the network share
country-related market knowledge, supplier relationships, and extend financing to overseas subsidiaries within the network (Chang, 1995; Guillen, 2002).\textsuperscript{14} As closed networks, the international chaebol relationships are therefore likely to provide similar benefits to those domestically. We therefore propose the following hypothesis:

\textit{Hypothesis 2a: A priori international investments of chaebols will be associated with lower value than those of non-chaebol firms during a period of greater uncertainty.}

In contrast, we would expect that firms that are members of chaebols are most comfortable in stable periods. This is in accordance with Rowley et al. (2000), who argue that the strong interfirm relationships characterizing closed networks are more advantageous at this time when flexibility is not as valuable. This leads us to propose the following:

\textit{Hypothesis 2b: A priori international investments of chaebols will be associated with higher value than those of non-chaebol firms during a period of stability.}

4.3.3. Differing Configurations of International Investments

We had noted earlier that different types of international investments are associated with specific types of options-related benefits under uncertainty. Firms with overseas exporting relationships benefit from the option to differentially apportion sales across multiple markets. An increase or decline in demand in one market can be rapidly

\textsuperscript{14} An example of this is Daewoo, one of the top five Korean chaebols as of 1997. Beginning in 1994, Daewoo entered into rapid sequential FDI in Uzbekistan relating first to automobiles, followed by electronics, textile, and banking. (Harvard Business School case, 1998).
addressed by reallocating sales in other markets. As mentioned previously, a declining currency value relative to other currencies can be beneficial for exporting to external markets, since it reduces the realized price of the exported product (Broll & Eckwert, 1999).\textsuperscript{15} Thus, exports provide options for product markets under changing conditions.

While foreign direct investment also allows the firm to sell its products in different international markets, it also has the distinction of distributing the firm's productive capability to these locations. In doing so, the firm benefits from the options associated with diversified markets and operations (Ghoshal and Bartlett, 1990). A firm with foreign direct investments is able to dedicate its operations in different countries to specific types or versions of its products. In this manner, the firm derives real option value through its ability to provide differentiated products to the larger international market. In addition, in the face of environmental change, the firm has the option to reallocate not only production across its locations to take advantage of changes in tax rates, factor prices and labor costs, but also its sales to more beneficial locations.

Clearly, FDI and exporting create some overlapping options for firms, particularly in terms of international markets. Yet at the same time, the two forms of international investments provide firms with differing options. Firms that engage in exports benefit from the options to utilize their capital-intensive domestic operations more efficiently, while firms with foreign direct investment benefit from differentiated production capability as well as greater operational flexibility. We therefore argue that firms with both exports and foreign direct investment are in a position to benefit from the entire set.

\textsuperscript{15} In contrast, a declining currency (particularly if it is due to inflation) can have the effect of increasing domestic prices. This further reduces demand in the domestic economy.
of options associated with international investments, in comparison to those with only one type of international investment. Thus, we propose the following hypotheses:

*Hypothesis 3a*: Firms with export and FDI will be associated with greater value than FDI-only or exports-only firms in a period of uncertainty.

Under conditions of stability, firms' need for flexibility is far less important, and is likely to take a back seat to other goals associated with international expansion. Thus, the enhanced flexibility associated with the combination of exporting and FDI provides little value to firms at this time, particularly in comparison to less complex configurations of international investments, such as only exporting or only FDI. This leads us to the following:

*Hypotheses 3b*: Firms with export and FDI will not be associated with greater value than FDI-only or export-only firms in a period of stability.

4.3.4. The Extent of International Investments

We noted above that international investments provide real options to firms under uncertainty. Consistent with this notion, we argue that firms that are more invested in international investments will benefit from a greater level of real options associated with these investments. We expect this relationship to hold across the different types of international investments that firms can make, including exports and foreign direct investment, as well from a combination of the two. We therefore propose that:
Hypothesis 4a: The greater the a priori international investments of any type for a firm, the higher their effect on the firm's value in a period of uncertainty.

In contrast, in a period of stability, we expect that the need for strategic and operational flexibility is greatly reduced. Due to this, at this time higher levels of international investments are not likely to be of value for the options that they may have provided in a more uncertain period. Thus, we do not expect that increasing levels of international investments will be associated with higher firm value under these conditions:

Hypothesis 4b: Greater a priori international investments will not be associated with higher value in a period of stability.

4.4. Data And Methods

4.4.1. Data and Measurement of Variables

The purpose of this research is to examine the impact of more and less uncertainty on the real options value of firms' international investments. To accomplish this, we chose to focus on Korean firms over a time period that includes a period of relative economic stability as well as the highly unstable period of the Korean economic crisis. We use the WISEfn database of Korean firms, consisting of all publicly listed firms in the Korea Stock Exchange (KSE), and the Korea Listed Companies Association (KLCA) foreign affiliate database, covering the period of 1996-1998. Financial services firms are omitted due to differences in their accounting practices that make them incompatible with...
firms in other industries (Chang and Hong, 2000). Thus, the number of firms included in
the analysis ranged from 541 in the 1996-97 period to 554 in the 1997-98 period. Chaebol
membership was identified through the Korea Fair Trade Commission (KFTC) list of the
top 30 chaebols for 1996 and 1997. To capture network effects, we additionally ran
separate models for chaebol firms and non-chaebol firms. Totals of 105 and 104 chaebol-
affiliated firms were identified for the years of 1996 and 1997 respectively.

Since the KLCA foreign affiliate database contained only the names of foreign
affiliates, other strategies were utilized to locate additional pertinent information,
including the country in which each affiliate was established. One strategy was to
examine the company homepage. However, information on foreign affiliates in 1996-97
was often not available. For the many firms that did not have the necessary foreign
affiliate information on their homepage, we next searched for company news and
affiliate/country information using LEXIS/NEXIS, the Munwha daily company
information website, and the Korea information Service company search website. More
than 95 percent of country information was acquired through this search strategy. The
information on affiliate location confirmed that affiliates were broadly distributed across
countries (Tang and Tikoo, 1999), with a .96 percent correlation between number of
affiliates and number of countries.

The hypothesized relationships outlined above are tested with a cross-sectional
linear regression methodology, with White’s adjustment for heteroskedasticity (STATA
7, 2001). The independent variables are measured as indicated below, at 1997 or 1996
levels, depending on the hypothesis:
Int'l Investments 97: Firms with any kind of international investment in 1997, (1,0 Dummy)

Export-Only 97: Firms that are only exporting in 1997, (1,0 Dummy)

Affiliates-Only 97: Firms that have only affiliates in 1997, (1,0 Dummy)

Exports & Affiliates 97: Firms that have both exports and affiliates in 1997, (1,0 Dummy)

Export Intensity 97: Export sales 97/Total sales 97

No. of Affiliates 97: Total number of affiliates in 1997

ExpInt*Affiliates 97: Interaction term of export intensity and affiliates in 1997

4.4.2. Control Variables

Since Tobin's q is affected by other firm characteristics as well, we include several control variables in our analysis. In order to control for the firm's past performance, we include the firm's prior year Tobin's q in the equation. Since smaller firm size can also affect the flexibility of the firm in an uncertain environment, we control for this effect by including log of total assets, converted to US$ at the current exchange rate based on International Financial Statistics (IMF, 1998). We also control for firm indebtedness since this may indicate a benefit to firms in a capital-poor environment. We use two separate measures to control for industry attributes that might affect the value of international investments; these include industry competition and industry capital intensity. The relevant industry is based on the Korean Standard Industrial Classification (KSIC) at the two-digit level. Competition is assessed by the total number of firms in the

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16 To better represent the number of firms in an industry, we counted number of firms in each industry in both KSE and KOSDAQ, which is equivalent to NASDAQ in U.S. KOSDAQ database is also acquired from WISEfn.
industry. Industry capital intensity is measured by measuring average industry fixed capital as a proportion of average industry total assets for different years.

4.4.3. Dependent Variable

Since we are interested in assessing the value of a priori international investments under conditions of abnormal uncertainty, we use Tobin's q as the dependent variable. This is a particularly appropriate measure for assessing real options value since it is a "forward looking" measure that adjusts for risk. We calculated Tobin's q for 1997-98 in the manner suggested by Chung and Pruitt (1994), as follows:

\[
\frac{\text{Market value of common stock} + \text{book value of preferred stock} + \text{book value of debt}}{\text{Book value of total assets}}
\]

Market value of common stock is calculated as the price at year-end multiplied by the number of shares outstanding.

The specific regression equation with the variables related to hypotheses 1 and 2 are as follows for firm i (with the four control variables listed first):

\[
\text{Tobin's q 1998} = \alpha + \beta \text{Tobin's q} \ 97 + \chi \text{Log of Total Assets} \ 97 + \delta \text{Debt/Assets} \ 97 + \\
\epsilon \text{No. of Competitors} \ 97 + \phi \text{Cap Intensity} \ 97 + \gamma \text{International Investment Dummy} \ 97 + \epsilon (1)
\]

\text{17 Chung and Pruitt (1994) have shown that some variants of Tobin's q are highly correlated (at more than 96%) with more detailed measures.}
The equation relating to hypotheses 3 and 4 takes the following form:

\[
\text{Tobin's q}\ 1998 = \alpha + \beta \text{Tobin's q}\ 97 + \chi \log \text{of Total Assets}\ 97 + \delta \text{Debt/Assets}\ 97 + \\
\epsilon \text{No. of Competitors}\ 97 + \phi \text{Cap Intensity}\ 97 + \gamma \text{Export Intensity}\ 97 + \eta \text{No. of Affiliates}\ 97 + \tau \text{interaction term} + \epsilon \ (1)
\]

The two equations are assessed for all firms, and then separately for chaebol and non-chaebol firms to examine network effects on the real options value of international investments. Utilizing a dummy variable to differentiate firms with and without chaebol affiliation would not capture important variations in the control and explanatory variables that exist between chaebol and non-chaebol firms.\(^{18}\) The interaction term allows us to assess how export intensity and number of affiliates interact with each other.

Finally, to compare the value of international investments in periods of more and less stability, we repeated the analysis using prior years of relative stability (1996-97).\(^{19}\)

\(^{18}\) Statistically, using a dummy variable for chaebol affiliation assumes homogeneity of the relationship between control and explanatory variables and the dependent variable for both chaebol and non-chaebol firms (Neter et al. 1996: 460). For example, chaebol firms are typically larger than single business firms. Chaebol firms also enjoy preferential treatment and get cheaper loans (Cole & Park, 1983).

\(^{19}\) We are interested in differing real options value in different level of uncertainty, not the comparative values of the real options investments in two different level of uncertainty. In this regard, using year dummy and interaction with other variables would not be directly testing the hypothesis (Rowley et al., 2000). Following Miller and Leiblein (1996), we use separate equations for the two different years representing two different levels of uncertainty.
<table>
<thead>
<tr>
<th>Mean</th>
<th>s.d.</th>
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<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>
<th>11</th>
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<td>1. tobin's q 98</td>
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<tr>
<td>2. tobin's q 97</td>
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<td>0.37</td>
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<tr>
<td>3. total assets 97*</td>
<td>12.27</td>
<td>1.39</td>
<td>-0.13***</td>
<td>-0.17***</td>
<td></td>
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<td>4. debt/asset 97</td>
<td>1.67</td>
<td>0.99</td>
<td>0.34***</td>
<td>0.22***</td>
<td>0.05</td>
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<tr>
<td>5. competition 97</td>
<td>49.39</td>
<td>37.27</td>
<td>0.06</td>
<td>-0.01</td>
<td>-0.13***</td>
<td>0.01</td>
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<tr>
<td>6. capital int. 97*</td>
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<td>0.01</td>
<td>0.01</td>
<td>0.04</td>
<td>-0.49***</td>
<td>-0.23***</td>
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<td>7. int'l dummy</td>
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<td>-0.13***</td>
<td>0.04</td>
<td>0.03</td>
<td></td>
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<td>8. export only 97</td>
<td>0.41</td>
<td>0.49</td>
<td>-0.02</td>
<td>0.08</td>
<td>-0.24***</td>
<td>-0.04</td>
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<td>0.03</td>
<td>0.39***</td>
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<tr>
<td>9. affiliate only 97</td>
<td>0.03</td>
<td>0.18</td>
<td>0.02</td>
<td>0.02</td>
<td>0.15***</td>
<td>0.02</td>
<td>-0.11***</td>
<td>0.10**</td>
<td>0.09</td>
<td>-0.16***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. export &amp; aff.</td>
<td>0.38</td>
<td>0.49</td>
<td>0.01</td>
<td>-0.10***</td>
<td>0.27***</td>
<td>-0.06</td>
<td>0.08*</td>
<td>-0.04</td>
<td>0.36***</td>
<td>-0.65***</td>
<td>-0.15***</td>
<td></td>
</tr>
<tr>
<td>11. export int. 97</td>
<td>0.27</td>
<td>0.30</td>
<td>0.05</td>
<td>-0.03</td>
<td>0.05</td>
<td>-0.12***</td>
<td>0.14***</td>
<td>0.03</td>
<td>0.42***</td>
<td>0.01</td>
<td>-0.17***</td>
<td>0.38***</td>
</tr>
<tr>
<td>12. no. of aff. 97</td>
<td>1.78</td>
<td>4.54</td>
<td>0.01</td>
<td>-0.05</td>
<td>0.44***</td>
<td>-0.02</td>
<td>0.12***</td>
<td>-0.03</td>
<td>0.18***</td>
<td>-0.32***</td>
<td>0.02</td>
<td>0.47***</td>
</tr>
</tbody>
</table>

*Values are logged; bindustry average at two digit KSIC

* p<0.10 ; ** p<0.05; ***p<0.01

Table 4.1: Descriptive statistics and correlation matrix
4.5. Results and Discussion

Prior to testing our four sets of hypotheses, we examine the potential for multicollinearity in Table 4.1 with correlation coefficients between our independent variables. According to Judge et al. (1980, p. 459), the rule of thumb for problematic multicollinearity is 0.8. The mean variance inflation factor (VIF) is 1.28, with the highest VIF being 1.44. This suggests that multicollinearity is of little concern since it is less than 10.\textsuperscript{20} Overall, multicollinearity does not appear to be an issue for our set of independent variables.

4.5.1. Hypotheses 1a and 1b: Real Options Value of International Investments under Conditions of Uncertainty and Stability

In Table 4.2, panel A, we test our basic hypothesis regarding the real options value of international investments under conditions of abnormal uncertainty. Along with a set of control variables, the variable of particular interest is "Int’l 97," for the full sample of 554 firms representing those firms with any kind of international investment, in comparison to those with no international investment.

\textsuperscript{20} Separate VIF analysis for chaebol and non-chaebol firms also are without any concerns for multicollinearity (mean of 1.55 and highest of 2.03 for chaebol firms and mean of 1.25 and highest of 1.42 for non-chaebol firms).
<table>
<thead>
<tr>
<th></th>
<th>Full sample</th>
<th>Chaebol firms</th>
<th>Non-chaebol firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tobin' s q 97</td>
<td>Tobin' s q 98</td>
<td>Tobin' s q 98</td>
</tr>
<tr>
<td>Tobin' s q 97</td>
<td>0.662</td>
<td>0.666</td>
<td>1.038</td>
</tr>
<tr>
<td></td>
<td>(5.55)***</td>
<td>(5.63)***</td>
<td>(3.65)***</td>
</tr>
<tr>
<td>Total assets 97</td>
<td>-0.019</td>
<td>-0.031</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td>(1.75)*</td>
<td>(2.69)***</td>
<td>(1.27)</td>
</tr>
<tr>
<td>Debt/asset 97</td>
<td>0.153</td>
<td>0.155</td>
<td>0.047</td>
</tr>
<tr>
<td></td>
<td>(3.36)***</td>
<td>(3.40)***</td>
<td>(0.79)</td>
</tr>
<tr>
<td>Competition 97</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(2.02)**</td>
<td>(1.93)*</td>
<td>(1.54)</td>
</tr>
<tr>
<td>Capital int. 97^b</td>
<td>0.819</td>
<td>0.841</td>
<td>0.414</td>
</tr>
<tr>
<td></td>
<td>(2.97)***</td>
<td>(3.02)***</td>
<td>(1.14)</td>
</tr>
<tr>
<td>Int' l dummy 97</td>
<td>0.084</td>
<td>-0.038</td>
<td>0.102</td>
</tr>
<tr>
<td></td>
<td>(2.05)**</td>
<td>(0.46)</td>
<td>(2.26)**</td>
</tr>
<tr>
<td>Export only 97</td>
<td>0.036</td>
<td>-0.095</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(0.86)</td>
<td>(1.13)</td>
<td>(1.22)</td>
</tr>
<tr>
<td>Affiliate only 97</td>
<td>0.119</td>
<td>0.194</td>
<td>0.085</td>
</tr>
<tr>
<td></td>
<td>(1.58)</td>
<td>(0.88)</td>
<td>(1.36)</td>
</tr>
<tr>
<td>Export &amp; aff. 97</td>
<td>0.146</td>
<td>0.011</td>
<td>0.167</td>
</tr>
<tr>
<td></td>
<td>(3.02)***</td>
<td>(0.13)</td>
<td>(3.06)***</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.187</td>
<td>-0.070</td>
<td>-0.619</td>
</tr>
<tr>
<td></td>
<td>(0.71)</td>
<td>(0.27)</td>
<td>(1.68)*</td>
</tr>
<tr>
<td>Observations</td>
<td>554</td>
<td>554</td>
<td>97</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.43</td>
<td>0.44</td>
<td>0.52</td>
</tr>
<tr>
<td>F-statistics</td>
<td>6.97***</td>
<td>6.19***</td>
<td>4.92***</td>
</tr>
</tbody>
</table>

Robust t-statistics in parentheses, * p<0.10; ** p<0.05; *** p<0.01
* values are logged; ^ industry average at two digit KSIC

Table 4.2: Comparison of the real options value for firms with and without international investments 1998 (Panel A: Uncertain period)
<table>
<thead>
<tr>
<th></th>
<th>Full sample</th>
<th>Chaebol firms</th>
<th>Non-chaebol firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tobin' s q 96</td>
<td>Tobin' s q 97</td>
<td>Tobin' s q 97</td>
</tr>
<tr>
<td>Tobin' s q 96</td>
<td>0.486</td>
<td>0.485</td>
<td>0.174</td>
</tr>
<tr>
<td></td>
<td>(2.87)***</td>
<td>(2.86)***</td>
<td>(1.60)</td>
</tr>
<tr>
<td>Total assets 96</td>
<td>-0.001</td>
<td>0.003</td>
<td>-0.017</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.24)</td>
<td>(0.95)</td>
</tr>
<tr>
<td>Debt/asset 96</td>
<td>0.018</td>
<td>0.018</td>
<td>0.076</td>
</tr>
<tr>
<td></td>
<td>(0.65)</td>
<td>(0.65)</td>
<td>(3.43)***</td>
</tr>
<tr>
<td>Competition 96</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.14)</td>
<td>(0.19)</td>
<td>(0.97)</td>
</tr>
<tr>
<td>Capital int. 96 b</td>
<td>0.126</td>
<td>0.114</td>
<td>0.563</td>
</tr>
<tr>
<td></td>
<td>(0.72)</td>
<td>(0.66)</td>
<td>(2.14)**</td>
</tr>
<tr>
<td>Int'l dummy 96</td>
<td>0.007</td>
<td>0.070</td>
<td>-0.012</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(1.26)</td>
<td>(0.31)</td>
</tr>
<tr>
<td>Export only 96</td>
<td>0.023</td>
<td>0.021</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>(0.60)</td>
<td>(0.51)</td>
<td>(0.16)</td>
</tr>
<tr>
<td>Affiliate only 96</td>
<td>0.013</td>
<td>0.489</td>
<td>-0.064</td>
</tr>
<tr>
<td></td>
<td>(0.26)</td>
<td>(2.39)**</td>
<td>(1.60)</td>
</tr>
<tr>
<td>Export &amp; aff. 96</td>
<td>-0.015</td>
<td>0.034</td>
<td>-0.032</td>
</tr>
<tr>
<td></td>
<td>(0.44)</td>
<td>(0.74)</td>
<td>(0.84)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.326</td>
<td>0.286</td>
<td>0.493</td>
</tr>
<tr>
<td></td>
<td>(1.16)</td>
<td>(0.99)</td>
<td>(1.64)</td>
</tr>
<tr>
<td>Observations</td>
<td>541</td>
<td>541</td>
<td>93</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.34</td>
<td>0.34</td>
<td>0.25</td>
</tr>
<tr>
<td>F-statistics</td>
<td>3.62***</td>
<td>3.46***</td>
<td>4.51***</td>
</tr>
</tbody>
</table>

Robust t-statistics in parentheses, * p<0.10; ** p<0.05; ***p<0.01

* values are logged; b industry average at two digit KSIC

Table 4.3: Comparison of the real options value for firms with and without international investments 1997 (Panel B: Stable period)
The regression has a substantial adjusted $R^2$ of 0.43. Importantly, the coefficient for "Int'l 97" is positive (0.084) and significant (at the 5% level), suggesting that the presence of international investments adds an economically meaningful 8.4% to the average Tobin's q of one in 1998. Hypothesis 1a is therefore supported by our findings.

Although we do not make explicit predictions regarding our control variables, we do find that the full sample results in Table 4.2, Panel A, are largely as might be expected. The coefficient for "tobin's q 1997" is positive and significant at the 1% level. The past year's profitability influences 1998 profitability. Since larger firms lack flexibility, size may be a liability during a period of crisis. Consistent with this notion, "t. assets 97" has a negative coefficient, at a 10% level of significance. The control variable "dt/asset 97" has multiple roles. On the one hand, higher leverage conveys financial distress, which would predict a negative sign. On the other hand, firms with greater debt have a stronger certification from banks and other lenders (Cole and Park, 1983; Saraswathy and Chatterjee, 1984; Makhija, 2002). This second interpretation is supported by our findings (coefficient is 0.153, significant at the 1% level). Similarly, "comp. 97" has contrasting interpretations. Greater rivalry may imply a negative effect on 1998 Tobin's q. However, firms that face greater competition are likely to display more aggressive and flexible responses during crisis compared with other firms in less threatening environments. Our findings support the latter view (positive coefficient of 0.001, significant at the 5% level). Finally, industry "cap. int. 97," has a positive coefficient (0.819), which is significant at the 1% level. This suggests that firms in industries with high capital intensity have the benefit of exploiting economies of scale and reduced costs. The contrasting explanation that more capital-intensive firms have
greater unavoidable fixed costs is not supportive by the positive coefficient. The findings for the control variables remain largely consistent throughout the analysis examining real option value under uncertainty.

When we delve further in the nature of international investments and their value effects as real options, some interesting findings emerge. First, for the full sample, we examine the coefficients for dummy variables relating to "exp. only 1997," "aff. only 1997," and "exp. & aff. 97," in comparison to firms with no international investment. Only the coefficient for "exp. & aff. 97" is significant (1% level), and it is positive. These findings suggest that the earlier positive effect of international investments can be attributed to the case where the firm undertakes both exports and affiliates and not just one of them. This finding suggests that firms derive real option value from international investments involving both exports and FDI, rather than from reliance on just one type of international investment. This is an important finding in that it suggests that firms gain options from the cumulative effects of different types of international investments rather than just one type, whether relating to exports or FDI. It may also support the notion that a firm's real options are greatly enhanced when exports and FDI are used together in a synergistic relationship, as in an integrated global strategy (Kobrin, 1991; Makhija et al., 1997).

Panel B of Table 4.3 (Panel B) contains the results for hypothesis 1b, which examine the real options value of international investments under conditions of stability. In contrast to those of panel A, the results for the full sample of firms indicate that those firms with "Int'l 96" are not associated with higher value compared to those without such investments. In the second estimation, in which different types of international
investments are examined separately, none of the coefficients relating to international investments are significant. These findings give strong support to hypothesis 1b. While international investments are found to provide real options value to firms in a period of uncertainty, they do not do so in a period of stability. Interestingly, the control variables are likewise without significance during this period of stability, with the exception of "Tobin's q 96." This finding suggests that the flexibility effects associated with smaller size, greater ability to procure funding, greater competition and the industry's capital intensity, do not affect firm value in a period of stability. These results further underscore the relevance for firm flexibility under conditions of uncertainty.

4.5.2. Hypotheses 2a and 2b: Real Option Value of International Investments for Chaebol and non-Chaebol Firms

We had argued that the tightly interwoven and interdependent relationships characterizing the typical chaebol network would reduce the flexibility of a chaebol firm during a period of crisis. In line with this, hypothesis 2a predicts that international investments made by chaebol firms would not be associated with higher firm value in the more uncertain period of 1998. These findings are also presented in Table 4.2. As can be seen in Table 4.2 (panel A), this prediction is supported in both estimations. Not only does "int'l 97" not show significance in the first estimation, nor do the variables associated with "exp. only 97," "aff. only 97" or "exp. & aff. 97" in the second estimation. Equally interesting, we find that four of the five control variables (the exception being "Tobin's q 97") are also not significant during this period of instability.
In contrast to chaebol firms, we find that non-chaebol firms gain significantly from their international investments in this time frame (coefficient of 0.102, significant at 5%). The results for non-chaebol firms are consistent with those for the full sample when international investments are broken out by exports, foreign direct investment and the combination of the two. We find that during the crisis period, non-chaebol firms with both exports and affiliates are found to benefit from their international investments, while those with only exports or only affiliates do not.

The control variables in the non-chaebol sample too have coefficients with signs and significance like those for the full sample. The fact that control variables are not significant for the chaebol sample suggests that chaebol firms differ in more fundamental ways than has been recognized in comparison to traditional non-chaebol firms. A plausible explanation may be that the chaebol firms with international investments carry extra burdens during crises.

In contrast, hypothesis 2b suggests that chaebol firms will derive higher value from their international investments in a period of stability. We find evidence consistent with this notion in Table 4.3 (panel B). In this case, we find that chaebol firms' investments in foreign affiliates are associated with higher firm value. This finding suggests that chaebol firms do not engage in international investments from the point of view of gaining real options. Instead, they may make such investment decisions more from the point of view of diversification of risk or markets. The benefits that have disproportionately accrued to chaebols under the long period of high growth and relative stability of the Korean economy may predispose chaebol firms to making investments in this manner.

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<table>
<thead>
<tr>
<th></th>
<th>Full sample</th>
<th>Chaebol firms</th>
<th>Non-chaebol firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tobin' s q 97</td>
<td>Tobin' s q 98</td>
<td>Tobin' s q 98</td>
</tr>
<tr>
<td>Tobin' s q 97</td>
<td>0.679</td>
<td>0.886</td>
<td>0.648</td>
</tr>
<tr>
<td></td>
<td>(5.10)***</td>
<td>(3.02)***</td>
<td>(5.07)***</td>
</tr>
<tr>
<td>Total assets 97*</td>
<td>-0.031</td>
<td>0.011</td>
<td>-0.051</td>
</tr>
<tr>
<td></td>
<td>(2.56)**</td>
<td>(0.58)</td>
<td>(2.50)**</td>
</tr>
<tr>
<td>Debt/asset 97</td>
<td>0.179</td>
<td>0.054</td>
<td>0.199</td>
</tr>
<tr>
<td></td>
<td>(3.29)**</td>
<td>(0.91)</td>
<td>(3.26)***</td>
</tr>
<tr>
<td>Competition 97</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(2.19)**</td>
<td>(1.42)</td>
<td>(1.78)*</td>
</tr>
<tr>
<td>Capital int. 97*</td>
<td>0.967</td>
<td>0.302</td>
<td>1.030</td>
</tr>
<tr>
<td></td>
<td>(2.88)**</td>
<td>(0.89)</td>
<td>(2.49)**</td>
</tr>
<tr>
<td>Export only 97</td>
<td>-0.112</td>
<td>-0.096</td>
<td>-0.116</td>
</tr>
<tr>
<td></td>
<td>(3.10)**</td>
<td>(2.20)**</td>
<td>(2.70)***</td>
</tr>
<tr>
<td>Affiliate only 97</td>
<td>-0.029</td>
<td>0.206</td>
<td>-0.082</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.95)</td>
<td>(1.41)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.040</td>
<td>-0.270</td>
<td>0.161</td>
</tr>
<tr>
<td></td>
<td>(0.14)</td>
<td>(0.68)</td>
<td>(0.46)</td>
</tr>
<tr>
<td>Observations</td>
<td>478</td>
<td>86</td>
<td>392</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.45</td>
<td>0.59</td>
<td>0.45</td>
</tr>
<tr>
<td>F-statistics</td>
<td>5.84***</td>
<td>5.89***</td>
<td>5.41***</td>
</tr>
</tbody>
</table>

Robust t-statistics in parentheses, * p<0.10 ; ** p<0.05; ***p<0.01

*values are logged; b industry average at two digit KSIC

Table 4.4: Comparison of real options value of export-only, FDI-only, and export & FDI investments 1998 (Panel A: Uncertain period)
<table>
<thead>
<tr>
<th></th>
<th>Full sample</th>
<th>Chaebol firms</th>
<th>Non-chaebol firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tobin’ s q 97</td>
<td>Tobin’ s q 97</td>
<td>Tobin’ s q 97</td>
</tr>
<tr>
<td>Tobin’ s q 96</td>
<td>0.505</td>
<td>0.124</td>
<td>0.588</td>
</tr>
<tr>
<td></td>
<td>(2.82)***</td>
<td>(1.51)</td>
<td>(3.02)***</td>
</tr>
<tr>
<td>Total assets 96*</td>
<td>0.003</td>
<td>-0.018</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.89)</td>
<td>(0.56)</td>
</tr>
<tr>
<td>Debt/asset 96</td>
<td>0.088</td>
<td>0.053</td>
<td>0.088</td>
</tr>
<tr>
<td></td>
<td>(3.65)***</td>
<td>(2.20)***</td>
<td>(3.33)***</td>
</tr>
<tr>
<td>Competition 96</td>
<td>-0.000</td>
<td>0.001</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(1.18)</td>
<td>(0.30)</td>
</tr>
<tr>
<td>Capital int. 96*</td>
<td>0.432</td>
<td>0.265</td>
<td>0.374</td>
</tr>
<tr>
<td></td>
<td>(2.58)**</td>
<td>(1.41)</td>
<td>(1.95)*</td>
</tr>
<tr>
<td>Export only 96</td>
<td>0.033</td>
<td>-0.016</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>(1.34)</td>
<td>(0.42)</td>
<td>(1.18)</td>
</tr>
<tr>
<td>Affiliate only 96</td>
<td>-0.009</td>
<td>0.451</td>
<td>-0.070</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(2.30)*</td>
<td>(2.21)**</td>
</tr>
<tr>
<td>Constant</td>
<td>0.005</td>
<td>0.802</td>
<td>-0.159</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(2.09)**</td>
<td>(0.40)</td>
</tr>
<tr>
<td>Observations</td>
<td>466</td>
<td>83</td>
<td>383</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.37</td>
<td>0.43</td>
<td>0.41</td>
</tr>
<tr>
<td>F-statistics</td>
<td>4.87***</td>
<td>3.90***</td>
<td>4.26***</td>
</tr>
</tbody>
</table>

Robust t-statistics in parentheses. * p<0.10 ; ** p<0.05; ***p<0.01
* values are logged; **industry average at two digit KSIC

Table 4.5: Comparison of real options value of export-only, FDI-only, and export & FDI investments 1997 (Panel B: Stable period)
<table>
<thead>
<tr>
<th></th>
<th>Full sample</th>
<th>Chaebol firms</th>
<th>Non-chaebol firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tobin' s q 97</td>
<td>Tobin' s q 98</td>
<td>Tobin' s q 98</td>
</tr>
<tr>
<td><strong>Tobin’ s q</strong></td>
<td>0.658</td>
<td>0.658</td>
<td>1.029</td>
</tr>
<tr>
<td></td>
<td>(5.65)***</td>
<td>(5.67)***</td>
<td>(3.59)***</td>
</tr>
<tr>
<td><strong>T. asset97</strong></td>
<td>-0.028</td>
<td>-0.031</td>
<td>0.027</td>
</tr>
<tr>
<td></td>
<td>(2.22)**</td>
<td>(2.38)**</td>
<td>(1.36)</td>
</tr>
<tr>
<td><strong>Dt/asset97</strong></td>
<td>0.156</td>
<td>0.158</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>(3.46)***</td>
<td>(3.50)***</td>
<td>(0.84)</td>
</tr>
<tr>
<td><strong>Comp. 97</strong></td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(1.67)*</td>
<td>(1.74)*</td>
<td>(1.59)</td>
</tr>
<tr>
<td><strong>Cap. int97</strong></td>
<td>0.835</td>
<td>0.855</td>
<td>0.449</td>
</tr>
<tr>
<td></td>
<td>(3.03)***</td>
<td>(3.09)***</td>
<td>(1.22)</td>
</tr>
<tr>
<td><strong>Exp. int. 97</strong></td>
<td>0.135</td>
<td>0.167</td>
<td>-0.058</td>
</tr>
<tr>
<td></td>
<td>(2.37)**</td>
<td>(2.74)***</td>
<td>(0.85)</td>
</tr>
<tr>
<td><strong>No. of aff97</strong></td>
<td>0.006</td>
<td>0.018</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(1.86)*</td>
<td>(2.19)**</td>
<td>(0.26)</td>
</tr>
<tr>
<td><strong>Exp*aff97</strong></td>
<td>-0.021</td>
<td>-0.015</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>(1.75)*</td>
<td>(1.35)</td>
<td>(0.00)</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>-0.057</td>
<td>-0.044</td>
<td>-0.706</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.17)</td>
<td>(1.68)*</td>
</tr>
<tr>
<td><strong>Obs.</strong></td>
<td>554</td>
<td>554</td>
<td>97</td>
</tr>
<tr>
<td><strong>R-squared</strong></td>
<td>0.44</td>
<td>0.44</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>F-statistics</strong></td>
<td>7.23***</td>
<td>6.45***</td>
<td>4.10***</td>
</tr>
</tbody>
</table>

Robust t-statistics in parentheses, * p<0.10 ; ** p<0.05; *** p<0.01
* values are logged; b industry average at two digit KSIC

Table 4.6: The real options value of increasing magnitude of international investments 1998 (Panel A: Uncertain period)
4.5.3. Hypotheses 3a and 3b: Real Options Value of a Combination of Exports and FDI

Our earlier findings had indicated that past investments in a combination of exports and FDI represent a more valuable real option than international investments entailing only exports or FDI. This finding was based on a comparison with firms with no international investments. Under Hypothesis 3a, we consider this issue further by comparing the combined exports and FDI strategy with an exports-only or FDI-only strategy for firms with international investments. The findings are reported in Table 4.4 (panel A). The full sample consists of the 478 firms with some type of international investment, and the regression is run relative to the base case of those firms with a combination of exports and FDI. Relative to firms with such a combination strategy, firms with exports-only in 1997 have significantly lower values (coefficient of -0.112 with a 1% level of significance), with an adjusted $R^2$ of 0.45. Firms with FDI-only have a negative coefficient as well although it is not significant. The control variables once again have coefficients with the signs and significance as before.

These findings affirm our results above that it is a combination strategy that provide firms higher valuations during a crisis period compared with firms with no international investments and even compared to firms with exports-only or FDI-only international investments. Table 4.4 also examines the exports-only and the FDI-only strategies against the combination strategy for chaebol and non-chaebol firms. The findings are similar, whether it is the chaebol or non-chaebol firms, in the sense that the coefficients for "exp. only 1997" are significant and negative, while those for FDI-only are not significant. These results suggest, then, that firms with only exports derive lower real options value than those with exports and FDI. At the same time, it is interesting that
the coefficient for "aff. only 97," while insignificant for all three estimations, takes a negative sign in the full and non-chaebol samples (as we would expect), but a positive sign for chaebol firms.

To assess hypothesis 3b, we repeat the analysis under the more stable conditions of 1996-97 (table 4.5). In this case, we find once again that the coefficients for the independent variables in the full sample are not significant, supporting our hypothesis. In the case of chaebol firms, we find that the coefficient for "aff. only 96" is significant (0.451 at 10 percent). In a stable period, then, only FDI is associated with higher value for chaebols than having a combination of FDI and exports. This suggests that the network effect of chaebols comes into play at this time. For chaebols, FDI is better because it allows them to take advantage of the network. Even though exports may also allow chaebol firms to benefit from their network, the relatively less need for sophisticated information in this case may not allow them to benefit as much. Larger size may also provide better information collecting capabilities leading to less need for the network. The lack of flexibility does not penalize such firms at this time. In contrast, non-chaebol firms (without networks) are found to have a negative relationship for "aff. only 96," significant at the 5 percent level. For these firms, even in a stable period, having both FDI and exports is associated with higher value than just having FDI. The opposite relationship found for non-chaebol and chaebol firms with respect to this variable provides further evidence on the highly differing nature of these two types of firms with respect to international investment.21

21 To further investigate the relative real options value of exports and FDI, we compared chaebol and non-chaebol firms with only exports and only FDI in both periods. While no such differences were found for the unstable period, this was not the case for the stable period.
<table>
<thead>
<tr>
<th></th>
<th>Full sample</th>
<th>Chaebol firms</th>
<th>Non-chaebol firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tobin' s q 96</td>
<td>Tobin' s q 97</td>
<td>Tobin' s q 97</td>
</tr>
<tr>
<td></td>
<td>0.485  (2.86)**</td>
<td>0.485  (2.86)**</td>
<td>0.168  (1.65)</td>
</tr>
<tr>
<td>T. asset96a</td>
<td>-0.003  (0.19)</td>
<td>-0.002  (0.14)</td>
<td>-0.010  (0.57)</td>
</tr>
<tr>
<td>Com. 96</td>
<td>0.000  (0.14)</td>
<td>0.000  (0.12)</td>
<td>0.001  (1.16)</td>
</tr>
<tr>
<td>Cap. int96b</td>
<td>0.131  (0.76)</td>
<td>0.125  (0.72)</td>
<td>0.566  (2.12)**</td>
</tr>
<tr>
<td>Exp. int. 96</td>
<td>-0.031  (0.71)</td>
<td>-0.037  (0.77)</td>
<td>-0.076  (1.29)</td>
</tr>
<tr>
<td>No. of aff96</td>
<td>0.002  (1.26)</td>
<td>-0.002  (0.35)</td>
<td>0.001  (1.11)</td>
</tr>
<tr>
<td>Exp*aff96</td>
<td>0.006  (0.80)</td>
<td>-0.002  (0.23)</td>
<td>0.015  (1.17)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.366  (1.26)</td>
<td>0.363  (1.24)</td>
<td>0.489  (1.50)</td>
</tr>
<tr>
<td>Obs.</td>
<td>541</td>
<td>541</td>
<td>93</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.34</td>
<td>0.34</td>
<td>0.25</td>
</tr>
<tr>
<td>F-statistics</td>
<td>3.10***</td>
<td>2.77***</td>
<td>4.08***</td>
</tr>
</tbody>
</table>

Robust t-statistics in parentheses. * p<0.10 ; ** p<0.05; ***p<0.01

*a values are logged; b industry average at two digit KSIC

Table 4.7: The real options value of increasing magnitude of international investments 1998 (Panel B: Stable period)
4.5.4. Hypotheses 4a and 4b: Real Options Value of the Magnitude of International Investments

In Table 4.6, we take the analysis further by considering how the extent of international investments affects firm valuations during a crisis period. Comparable to Table 4.2, we first use a full sample (554 firms) including firms with no international investments. In the first estimation, we use as independent variables "exp. Int. 1997" and "no. of aff. 97." We find that Tobin's q for 1998 is significantly and positively related with export intensity in 1997 (coefficient of 0.135 with 5% level of significance). Tobin's q for 1998 is also positively and significantly related with the number of affiliates the firm has in 1997 (coefficient of 0.006 with 10% level of significance).\textsuperscript{22} These findings support Hypothesis 4a. Thus, while the mere presence of exports or FDI does not result in a more valuable firm (Table 4.2), higher levels of either exports or FDI is beneficial to firm value.\textsuperscript{23} At the same time, when we introduce an interaction term between export intensity and number of affiliates in the second estimation, we find that this term has a significant (at 10 percent) and negative relationship to firm value in 1998. This suggests that increasing levels of both FDI and exports are associated with decreasing marginal returns to firm value.

Next, we examine the relationship between Tobin's q for 1998 with export magnitude and that of FDI, both in 1997, for chaebol firms and non-chaebol firms. The full sample results are mirrored in the sample with non-chaebol firms, since the coefficients of "exp. int. 1997" and of the two FDI measures are also significant and

\textsuperscript{22} Although not shown in the table, when the extent of FDI is measured in terms of value of log of assets in affiliates (in terms of Korean won), the coefficient of the FDI variable is even more significant (5% level of significance).
positive. In contrast, for the chaebol firms neither coefficient is significant, once again confirming our expectations for these firms. In table 4.7, we also reexamine the role of export and FDI magnitude for the firm in a period of stability. As can be seen, in the first and second estimations relating to the full sample, none of the independent variables are significant. This confirms hypothesis 4b, that higher levels of FDI and exports will not be associated with real options value in a period of relative stability.

In summary, our findings show that international investments of Korean firms represent valuable real options during a period of great uncertainty. We discuss the implications of these findings next.

4.6. Implications Of The Research

The main motivation in this paper was to examine the real options value of international investments made by firms under uncertainty. As many authors have noted, the most recognizable assessment of the real options value of investments made by firms is under conditions of unusually high uncertainty. Since under such conditions firms require the most flexibility, the value of such investments will be at its highest (Kogut and Kulatilaka, 1994; Dixit and Pindyck, 1994). Despite this, we see relatively little empirical evidence in the literature for the real options value of investments under the requisite high level of uncertainty. This is undoubtedly because of the difficulty in isolating sharp jumps in uncertainty for a large set of firms. It is to address this limitation in the literature that we undertook this research. The highly unexpected and unstable period of the Korean currency crisis provided us with the opportunity to examine the real
options value of international investments of firms under conditions of great uncertainty. Our findings generally affirm that international investments are a real option whose value can be expected to heighten during a period of great uncertainty.

Although prior literature has generally recognized that both exports and foreign direct investment provide real options to firms, there has been no previous work that has examined these two highly differing types of investments together. In this regard, this research has initiated an investigation into the comparative value of these options under uncertainty. Our findings suggest that a combined investment strategy involving both exports and FDI provides higher real options value than just exports and possibly FDI (we interpret our results relating to FDI-only firms with caution due to the very small number of such firms in our sample). Nonetheless, we find evidence that increasing intensity of exports and higher levels of FDI are associated with higher real options value. Thus, while just having exports or FDI per se does not increase real options value, higher amounts of either do benefit firms in this regard. At the same time, we find evidence supporting the existence of diminishing marginal benefits from increasing levels of both. This may be because, while the two types of international investments provide different benefits to firms, they may also provide some overlapping options as well. These findings confirm the importance of considering the joint and relative contributions of FDI and exports.

This research also considered possible differences between the international investments of chaebol and non-chaebol firms. We found evidence consistent with our prediction that the flexibility of chaebol firms would be encumbered by the highly interdependent web of relationships within the network. Thus, the international
investment variables typically did not contribute to chaebol firm value under uncertainty. Interestingly, we also found that four of the five control variables appeared to not play a role in influencing firm value under uncertainty, in contrast to non-chaebol firms. The sole exception to this was the previous year's Tobin's q. These results not only suggest that chaebol firms' international investments do not provide them with real options value, they also suggest that chaebol firms operate very differently than non-chaebol firms on many other dimensions as well. Domestic competition, the industry capital intensity, size or indebtedness do not appear to influence such firms' real options. It is likely that the network effects of the chaebol allow member firms to discount or override such issues.

It is under stable conditions that chaebol firms show the value of international investments, again in great contrast to non-chaebol firms. At the same time, it appears that they benefit from a different configuration of international investments than non-chaebol firms. FDI-only investments appear to provide greater benefits than export-only or FDI and export combinations. In contrast, non-chaebol firms benefit more from export-only investments during this period. These findings comparing the international investments of chaebol and non-chaebol firms are unique in the literature.

Although this research has initiated a deeper inquiry of the real options value of international investments, comparing different configurations of exports and foreign direct investment, this research suggests a number of avenues for further investigation. First, the network effects of chaebol firms appear to be more complex than originally expected and less conducive to providing value under uncertainty. Gaining insights from network theory to delve into this issue might be worthwhile. In this stream, several researchers have noted the benefits and dangers associated with a strong closed network
(Walker et al., 1997; Rowley et al., 2000; Sedaitis, 1998). The implications of different types of networks for real options should be explored in greater detail. Second, the results suggest that exports and FDI may have overlapping options value, with diminishing marginal returns as the levels of both increase. The real options relationship between FDI and exports appears to be complex, and deserves further consideration under varying environmental contexts. Third, while this research is focused on the value of real options investments, actual behavior of the firms in uncertain period is not examined. Examining how firms exercise options in an uncertain period would also provide better understanding of international real options investments under uncertainty.
CHAPTER 5

CONCLUSIONS

Using real options theory as an analogy, we first have shown that governments, informed by a real options theory, can encourage entrepreneurship development with bankruptcy policy. Policies unlocking upside gains and limiting downside risks would provide an entrepreneur-friendly environment. Taking that even failure can be beneficial if the cost of failure is limited and positive externalities stemming from failure exceeds the cost, it is argued that governments can promote entrepreneurship development by increasing variety in an economy. In conclusion, if chapter 2 could only contain one message, then we would like it to be a sense of the staggering power of variance-maximizing entrepreneurship, fueled by government policies such as bankruptcy policy which unlock its upside potential and curtail its downside losses.

Second, using largely unanticipated nature of the Korean economic crisis in late 1997, we empirically provided support for real options value in uncertain periods. Our findings support the real options reasoning for many types of investments discussed in the literature, including investments relating to R&D, international sales base, and network ties to banks (both adjusted and not adjusted for industry), capital intensity (adjusted for industry) patents, advertising and training (not adjusted for industry).
Especially using the "natural experiment", we could test different kinds of real options investments at the same time instead of taking piecemeal approach.

This research also highlights the role of uncertainty outside the context of a firm's industry, in contrast to the preponderance of work that mostly examines industry-related uncertainty. The results suggest that uncertainty associated with a broad-based economic crisis situation creates different imperatives for options than those associated with a given industry. In the case of an economic crisis, it appears that firms benefit from real options even when these do not differ considerably from other firms in their industry. Instead, such options may help them to overcome the adverse conditions of the crisis (that is, survive or ride out the crisis situation). After this, their value dies out more rapidly than that of those options related to the firm's industry.

Third, we also examine the value of international real options investments in an uncertain period. Although prior literature has generally recognized that both exports and foreign direct investment provide real options to firms, there has been no previous work that has examined these two highly differing types of investments together. In this regard, this research has initiated an investigation into the comparative value of these options under uncertainty. Our findings suggest that a combined investment strategy involving both exports and FDI provides higher real options value than just exports and possibly FDI (we interpret our results relating to FDI-only firms with caution due to the very small number of such firms in our sample). Nonetheless, we find evidence that increasing intensity of exports and higher levels of FDI are associated with higher real options value. Thus, while just having exports or FDI per se does not increase real options value, higher amounts of either do benefit firms in this regard. At the same time,
we find evidence supporting the existence of diminishing marginal benefits from increasing levels of both. This may be because, while the two types of international investments provide different benefits to firms, they may also provide some overlapping options as well. These findings confirm the importance of considering the joint and relative contributions of FDI and exports.

This research also considered possible differences between the international investments of chaebol and non-chaebol firms. We found evidence consistent with our prediction that the flexibility of chaebol firms would be encumbered by the highly interdependent web of relationships within the network. Thus, the international investment variables typically did not contribute to chaebol firm value under uncertainty. Interestingly, we also found that four of the five control variables appeared to not play a role in influencing firm value under uncertainty, in contrast to non-chaebol firms. The sole exception to this was the previous year's Tobin's q. These results not only suggest that chaebol firms' international investments do not provide them with real options value, they also suggest that chaebol firms operate very differently than non-chaebol firms on many other dimensions as well. Domestic competition, the industry capital intensity, size or indebtedness do not appear to influence such firms' real options. It is likely that the network effects of the chaebol allow member firms to discount or override such issues.

There are a number of implications for future work. For policymakers, it seems that the question is not whether to intervene or not, but how to intervene. Having the real options logic as a dominant logic (see Prahalad and Bettis, 1986) in policymaking can encourage more risk-taking by both new start-ups and incumbent firms, thus enhancing the variance of a country's bundle of productive assets. While encouraging risk-taking by
unlocking upside potentials and curtailing downside losses may inevitably lead to failure of some firms, the risk of not taking such risk, in the long run, may be higher. While the details of the policy domains that we have discussed remain to be worked out, we believe that it is time that policymakers look into real options theory for insights to guide policy formulation and implementation. While we only have examined a specific kind of government policy, bankruptcy legislation, other government policies such as tax policy, antitrust regulation, and patent policy can also be interesting topics for real options research.

Our findings indicate that many forms of real options provide value above and beyond a firm’s own industry, while other types are more focused in scope. For example, we find that R&D and international sales provide advantages both within and beyond the firm’s industry, while capital intensity does not. The value of capital-related investment is constrained by industry context. In contrast, the options value of training was found to be unrelated to a firm’s industry. We also found that some types of investments such as advertising are more valuable in stable environments. This suggests, contrary to prior research (Dixit and Pindyk, 1994), that advertising is not a real options investment for firms. We believe the conditions under which different types of investments provide real options value deserves greater study.

This study only examined the real options value in an uncertain environment falling short in knowing if firms actually exercise the options they have and how. For future studies, one can examine the actual realizations of real options investments. In addition, there are many other countries such as Thailand, Malaysia, and Indonesia that suffered from the recent economic crisis than Korea. Examining firms in different
institutional environments to find out how these institutional differences affect firms' investments and realization of real options would also render better understanding of the theory.

Although this research has initiated a deeper inquiry of the real options value of international investments, comparing different configurations of exports and foreign direct investment, this research suggests a number of avenues for further investigation. First, the network effects of chaebol firms appear to be more complex than originally expected and less conducive to providing value under uncertainty. Gaining insights from network theory to delve into this issue might be worthwhile. In this stream, several researchers have noted the benefits and dangers associated with a strong closed network (Walker et al., 1997; Rowley et al., 2000; Sedaitis, 1998). The implications of different types of networks for real options should be explored in greater detail. Second, the results suggest that exports and FDI may have overlapping options value, with diminishing marginal returns as the levels of both increase. The real options relationship between FDI and exports appears to be complex, and deserves further consideration under varying environmental contexts. Third, while this research is focused on the value of real options investments, actual behavior of the firms in uncertain period is not examined. Examining how firms exercise options in an uncertain period would also provide a better understanding of inertia.
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*Time Asia*. 1999. This business guru’s key credential: He went belly up. February, 15.


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