

The effects of demand, competitive, and technological uncertainty on board monitoring and institutional ownership of IPO firms

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Abstract This paper considers *industry-specific* contingencies that may account for some of the inter-firm heterogeneity in the deployment of specific corporate governance mechanisms in IPO firms. We examine how differences in demand, competitive, and technological uncertainty in the industry influence the levels of IPO firm monitoring by board outsiders and institutional investors. We test our theory using a sample of U.S. firms that completed an IPO in 24 manufacturing industries. The results indicate that industry uncertainty is, indeed, significantly related to the use of corporate governance mechanisms. In particular, the empirical results indicate that industry effects on IPO firm board monitoring and institutional investor ownership are the strongest and most consistent for *demand uncertainty* and *competitive uncertainty*.

Keywords Corporate governance · Board of directors · Institutional investors · Venture capital · Initial public offerings · and Uncertainty

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1 Introduction

In the wake of recent corporate scandals, a healthy skepticism is warranted concerning the effective use of corporate governance mechanisms to align fully the economic interests of managers with those of shareholders. The monitoring of managers' actions by independent boards and institutional owners is viewed in the research literature as an important corporate governance mechanism that can lead to effective management of the firm and to superior economic performance. However, both large-sample empirical research and recent compelling case-study evidence from firms such as Enron, Tyco and WorldCom suggest that these governance mechanisms do not always prevent self-serving or illegal activities on the part of some managers (e.g., Dalton et al. 2003).

The inconsistent effect of monitoring by boards and institutional owners may be partly due to the adoption of inappropriate governance mechanisms under different industry-specific conditions that are characterized by dissimilar types and levels of *uncertainty*. In the corporate governance literature, a number of research studies have examined firm-specific contingencies that lead to substitution among different corporate governance mechanisms (e.g., Miller et al. 2002; Pearce and Zahra 1992; Sundaramurthy 1996). These research studies indicate that the choice of specific governance mechanisms is linked to a firm's level of resources, exposure to various business risk factors, and economic performance (e.g., Beatty and Zajac 1994; Filatotchev and Bishop 2002; Zajac and Westphal 1994). However, the corporate governance research literature has been silent concerning the role of *industry-specific* contingencies on the use of governance mechanisms. Although Demsetz and Lehn (1985) found increased ownership concentration in less regulated industries, and Boyd (1990) found a positive relationship between duality and firm performance in industries with low-growth and/or high competitive uncertainty, there has been little empirical research to help us explain and predict the effects of industry-specific uncertainty on monitoring by boards and institutional owners.

Our knowledge of the role of uncertainty is *particularly lacking* with respect to the use of monitoring mechanisms among firms that completed an initial public offering. The initial public offering (IPO) constitutes a critical milestone and phenomenon for firms not only financially but also with regard to the dynamics in the use of corporate governance mechanisms (Certo et al. 2001). As a firm goes public for the first time, it becomes exposed to new pressures such as compliance with the regulations of the Securities and Exchange Commission, including information disclosure in the prospectus and issuing financial statements on a regular basis (Fischer and Pollock 2004). With the IPO event, a firm starts receiving substantial press coverage and competitive scrutiny. Due to the disclosure about the firm's financials and strategy, the firm becomes the focus of attention in the eyes of competitors that may not even have noticed the firm previously (Dodge et al. 1994). The firm and its management team also become subject to the scrutiny and expectations of the stock market, where the firm's achievements and failures are instantly impounded in its stock price. These pressures from the financial and competitive markets can substantially overwhelm and complicate the job of IPO firm managers. In the midst of the complexities and pressures of becoming a public

company, the board of directors and institutional investors can play an important role for IPO firms by enabling them to cope with the challenges and complete the transition. The relevance of board monitoring and institutional ownership has been recognized in IPO research (e.g., Brav and Gompers 1997; Megginson and Weiss 1991). However, there is limited understanding about how board monitoring and institutional ownership varies among IPO firms *based on the level and types of uncertainty in the IPO firm's industry environment*. The presence of uncertainty in the IPO firm's business environment accentuates the complexity of managers' decisions and the ambiguity about causes of poor firm performance, which leads to an environment that is highly germane to corporate governance challenges.

The concept of *uncertainty* refers to the phenomenon where, due to limited information concerning environmental conditions, managers have great difficulties in confidently assigning probabilities to how these conditions influence the effectiveness of strategic choices (Duncan 1972; Knight 1921). In industries with high levels of uncertainty, firms' actions and their subsequent economic performance become difficult to predict. Firms become more susceptible to agency problems because uncertainties about best practices and the sources of poor economic performance amplify the information asymmetry between shareholders and managers. With heightened information asymmetry between principals and agents and uncertainty about best management practices, corporate governance mechanisms such as monitoring by outsiders on the board of directors and institutional owners may become essential to mitigate potential agency problems (Eisenhardt 1989; Mahoney 2005).

Accordingly, the current research paper develops and empirically tests a model of board and institutional investor monitoring of IPO firms operating under various levels of industry uncertainty (in demand, competition, and technology), and explores the links between different types of industry uncertainty and the use of monitoring. We empirically test our hypotheses in a multi-industry sample of firms that went public in 1995 in the United States. The sample includes IPO firms from 24 manufacturing industries (SIC codes 2800–3800), including chemicals, primary metals, industrial machinery, computers, electrical equipment, transportation equipment, and measuring instruments.

2 Theory and hypotheses

2.1 Industry uncertainty

There are several elements of industry-specific uncertainty that can make it difficult to identify the appropriate firm-level strategies, and to predict subsequent economic performance outcomes. Uncertainty often stems from instability and dynamism in specific industry conditions such as demand, competitive actions, and technology. Research studies using agency-theoretic reasoning typically regard uncertainty as unpredictability that impairs forecasting (Bloom and Milkovich 1998). Similar to the concept of environmental instability or dynamism (Keats and Hitt 1988), uncertainty involves changes in the environment that are difficult to predict.

As these changes make it more difficult to identify the “best” strategic plan, even firms with similar resources and products pursue a variety of strategies and organizational actions. With unpredictable business conditions and a proliferation of potential firm strategies, the information gap between shareholders and managers widens. Information asymmetry between shareholders and managers due to outcome uncertainty and uncertainty about appropriate strategic actions diminishes shareholders’ ability to evaluate managerial decisions (Arrow 1974; Williamson 1985). Shareholders cannot clearly assess whether managers are pursuing profit-increasing strategies, and determine the marginal effect of managerial actions on firm-level performance. A highly uncertain environment could be more susceptible to managerial opportunism, because managers, who may have a different utility function than shareholders, have more opportunities to pursue their own economic interests at the expense of the shareholders (Jensen and Meckling 1976; Williamson 1975).

The heightened uncertainty can become particularly salient in industries with instability in sales and/or unpredictability in competitive and technology conditions (Bourgeois and Eisenhardt 1988). *Demand uncertainty* involves instability in overall industry sales, and this instability makes it difficult to decide on the level of investments that firms should make. Without the ability to forecast future sales with confidence, firms may easily confront business situations of under- or over-investment (Finkelstein and Boyd 1998). Thus, shareholders cannot easily assess whether poor firm-level economic performance results from “bad-luck” (e.g., due to instability in industry-wide sales) or from managerial incompetence and/or opportunism.

Competitive uncertainty involves unpredictability in rival firms’ strategic commitments and competitive actions. Without a good sense of rival firms’ capabilities for retaliatory actions or imitation, managers often experience great difficulties in choosing appropriate strategic plans. Even when managers opt for a strategy that fits well with their own firm’s resources and capabilities, unexpected competitive actions (e.g., aggressive pricing, advertising, and distribution strategies) can undermine a firm’s economic performance. Competitive uncertainty refers to the degree to which firms in a given industry have difficulty anticipating or predicting rivals’ actions because of the underlying industry structure. Industrial organization economics literature maintains that increased industry consolidation presents greater opportunities for competitive signaling. Higher industry concentration often leads to more market power in the hands of the existing firms and less industry-level competition (Eckbo 1992), because it facilitates explicit or tacit intra-industry collusion or dominant firm pricing, which consequently reduces competitive uncertainty in the industry (Oster 1999).

Technological uncertainty can further heighten the information asymmetry between shareholders and managers. With greater technological uncertainty, it becomes increasingly difficult to predict the specific new product and process technologies that will emerge in the industry. Therefore, firms struggle in opting for specific technology paths and business solutions among a number of possible strategic alternatives. Even when a firm makes outstanding advances in its product/process technologies, unexpected shifts in technology platforms in the industry can

lead to the loss of competitive advantage (Kor and Mahoney 2005). Under technological uncertainty, managers' jobs become less programmable and more difficult to observe and evaluate (Eisenhardt 1985). Shareholders cannot determine with confidence whether managers could and should have foreseen the changes in technology trends in the industry and reformulated the firm's technology strategy accordingly. Essentially, these three types of industry uncertainty—demand, competitive, and technological—impede shareholders' ability to judge the quality of strategic decisions and managerial performance due to bounded rationality and/or information asymmetry (Williamson 1996).

2.2 Industry uncertainty and monitoring by outside directors and institutional owners

Corporate governance research advocates the monitoring of managerial actions by independent boards of directors when conditions within the firm and its environments suggest that there is a high risk of managerial opportunism (Fama and Jensen 1983). The board of directors can be a powerful monitoring mechanism that encourages economic value-increasing decisions when its members are not heavily under the CEO's influence (Morck et al. 1989). Board independence can be improved by including outside directors on the board because these outside directors are often more likely to question the likely efficacy of some decisions made by the CEO and other top management team executives (Webb 2004).

Environments with heightened information asymmetry between shareholders and managers, and consequently greater potential for agency problems, create an *increased need for closer monitoring* of managerial decisions and actions. While the corporate board's ability to question managers does *not* reduce the uncertainties in the business environment, it may help reduce the information asymmetry problem (Zald 1969). In IPO firms, information asymmetry can be reduced as outside directors build firm-specific knowledge during interactions with IPO firm managers, which gives them access to public and non-public company information (Carpenter and Westphal 2001). Being a board member gives directors the rights and privileges to ask managers questions concerning the reasoning behind important managerial decisions. This ongoing discourse involves discussions about managers' goals and planned directions for the firm, and why and how formulated strategic plans fit with conditions in the environment (Carter and Lorsch 2004). Through these conversations, outside directors can develop useful insights about whether or not a firm should pursue certain strategies under specific demand, competitive, and/or technological conditions in the environment (Nahapiet and Ghoshal 1998; Sundaramurthy and Lewis 2003). Close supervision and monitoring by outside directors can be particularly valuable in IPO firms where the increased complexity of managerial jobs (due to competitive and market pressures on public firms) and the proliferation of potential strategies due to industry uncertainty make these firms a fertile ground for managerial incompetence and/or opportunism problems. Therefore, monitoring via outside directors is likely to be more prevalent in IPO firms in industries with higher uncertainty, where there is greater economic need and incentive for closer monitoring of managerial actions.

Further, resource dependence theory suggests that, besides monitoring, boards can provide the firm with additional *resources* needed for success (Hillman and Dalziel 2003; Pfeffer and Salancik 1978). In the context of IPO firms, in particular, outsider directors may be appointed to the board because these directors bring with them insight and expertise that members of the management team may not possess (Daily et al. 1999; Gimeno et al. 1997). Also, before going public, firms may lack legitimacy within their industry and among potential investors (Stinchcombe 1965). Experienced outsiders on the board may serve as a source of legitimacy and prestige to attract potential investors during the firm's IPO period (Certo et al. 2001). Significant presence of outsiders on the board of an IPO firm sends a positive signal to markets about the quality of the firm and its future prospects (Certo 2003; Spence 1974). Outside directors' ties with financial institutions and key players in the industry such as major suppliers and distributors can be quite useful to a firm when securing resources and developing its business network (Mizruchi and Stearns 1994). As the level of unpredictability in demand, competition, and technology goes up in an IPO firm's business environment, inclusion of more outside directors on the board serves as a co-optation mechanism to cope with the heightened uncertainty and to secure resources essential for survival and success (Hillman and Dalziel 2003). Given their experience, expertise, and access to various business networks (Coleman 1988; Toms and Filatochev 2004), outside directors can bolster a firm's information gathering capability and can help management to make more sound decisions in response to rapidly changing market and technology conditions in the industry (Maitles 2004; Useem 1984). Given the substantial value added potential of outside directors based on their monitoring, advisory, and resource provision (including legitimacy) functions, we predict higher presence of outsiders on IPO firm boards under elevated levels of industry uncertainty. Both agency (economic) theory and resource dependence (organization) theory suggest that the percentage of outsiders on the board will be greater as the industry conditions in which IPO firms operate become more unpredictable. Thus, the following three hypotheses are theoretically well-grounded, and are based on multiple organizational economic and management approaches:

Hypothesis 1a The higher the demand uncertainty in the industry, the higher the percentage of outsiders on the IPO firm board.

Hypothesis 1b The higher the competitive uncertainty in the industry, the higher the percentage of outsiders on the IPO firm board.

Hypothesis 1c The higher the technological uncertainty in the industry, the higher the percentage of outsiders on the IPO firm board.

In addition to monitoring by outside directors, monitoring by institutional ownership has been a common form of corporate governance in the United States (Ryan and Schneider 2002). Institutional investors can provide effective monitoring and governance because their block ownership and large voting power make it easier and more economically rewarding to influence a firm's strategic decisions (Sundaramurthy 1996). The large size of their investments frequently makes it difficult for institutional investors to sell off their investments even when companies

have poor economic performance and/or poor governance practices because these sell-offs may result in a substantive decline in price. Because of the illiquidity of institutional funds, institutional investors often become activists, attempting to influence firms through private negotiations and/or proxy fights (Carleton et al. 1998).

Monitoring and governance by institutional ownership can be particularly meaningful in business environments with high uncertainty in demand, competitive, and technological conditions that invite managerial opportunism and agency problems. When the business environment is more unpredictable, the need for monitoring of managerial decisions regarding proper deployment of firm-level resources increases substantially (Eisenhardt 1989). Because institutional investors have *more* to gain in uncertain environments through the mitigation of heightened agency problems via their own monitoring and governance, concentration of institutional ownership is likely to be greater at higher levels of uncertainty in the industry (Kor and Mahoney 2005). This outcome is likely because, in more uncertain environments, institutional owners can create *more* shareholder wealth through exerting their influence to obtain tighter management control. Specifically, “the noisier a firm’s environment, the greater the payoff to owners in maintaining tighter control. Hence, noisier environments should give rise to more concentrated ownership structures” (Demsetz and Lehn 1985: 1159).

In uncertain environments, institutional investors tend to have information advantages over small investors. Block institutional investors’ ownership-driven power and economic incentives motivate and enable these investors to communicate with managers and to monitor closely firms’ strategic decisions (Pedersen and Thomsen 2003; Shleifer and Vishny 1997). Based on the information these investors receive from firms’ managers and their own expert analysts who specialize in specific firms and industries (Sanders and Boivie 2004), institutional investors can determine when activism is necessary (Monks and Minow 2001). Given their ability to monitor and influence a firm’s strategic and managerial actions (e.g., David et al. 2001; Hoskisson et al. 2002), institutional investors are likely to be attracted to industries with high demand, competitive, and technological uncertainty, where they may achieve high economic returns. Even though these industries may involve high risk due to outcome uncertainty and higher potential for agency problems, institutional investors can mitigate such problems with information advantages and ownership-based active monitoring.

In the context of IPO firms, ownership by institutional investors constitutes one of the more visible forms of corporate governance (Kor and Mahoney 2005). The ownership structure of entrepreneurial IPO firms receives close attention from the business press and the stock market, and the presence of institutional owners is interpreted as a market signal of the credibility of new business ventures. This signal constitutes economically valuable information for investors and industry partners, as it is difficult to predict financial stability and future success of entrepreneurial firms, especially when they operate in highly uncertain environments. Because institutional ownership is a positive indicator of credibility, stability, and higher survival rates for entrepreneurial firms (Brav and Gompers 1997; Megginson and Weiss 1991), industry players may be more comfortable in engaging in business with them.

Among IPO firms, venture capitalist ownership constitutes a common form of institutional ownership. Venture capitalists possess a distinctive capability to monitor investments efficiently and to provide value-enhancing services (Amit et al. 1998). Venture capitalists take concentrated equity positions, strengthen and build the top management team, closely monitor managerial decisions, and provide counseling (Barry et al. 1990; Fischer and Pollock 2004). Venture capital financing not only reduces the undesirable IPO under-pricing phenomenon at the time of going public, but it is also shown to have a positive impact on the long-term stock performance of IPO firms (Brav and Gompers 1997). These positive effects of venture capitalist ownership on performance are attributed to the fact that they provide access to investment and commercial bankers and help with management and strategy design even after the initial public offering. While venture capitalists often prefer not to interfere with the day-to-day business of the venture, they are often ready to help with strategic decisions pertaining investment and competitive positioning, and are willing to take over in cases of a crisis or mismanagement (Gersick 1994). Combined with their access to information and resource networks in specific industries, venture capitalists' know how and industry expertise help create substantial value in venture growth and development (Barry et al. 1990; Kozmetsky et al. 1985; Megginson and Weiss 1991). Venture capitalists' value added can especially be critical under conditions of demand, competitive, and technological uncertainty where there is more room for managerial mistakes and/or opportunism given the elevated uncertainty about appropriate strategies. Thus, concentration of institutional ownership (e.g., venture capitalists) will be higher among IPO firms that operate in industries with higher levels of uncertainty. This economic logic leads us to the following three hypotheses:

Hypothesis 2a The higher the demand uncertainty in the industry, the higher the percentage of institutional ownership in the IPO firm.

Hypothesis 2b The higher the competitive uncertainty in the industry, the higher the percentage of institutional ownership in the IPO firm.

Hypothesis 2c The higher the technological uncertainty in the industry, the higher the percentage of institutional ownership in the IPO firm.

3 Data and methods

3.1 Sample

We tested our hypotheses in a multi-industry sample of United States firms that went public in 1995. In forming our sample, we identified all common stock IPOs in 1995 from 24 manufacturing industries (SIC codes 2800–3800) including chemicals, primary metals, industrial machinery, computers, electrical equipment, transportation equipment, and measuring instruments. The year 1995 was chosen for sampling due to the large number of public offerings that occurred during this year. There were 84 manufacturing firms that filed with the Securities and Exchange

Commission in 1995 to sell common stock by an initial public offering. After accounting for missing data on various variables, we arrived at our final sample, which consists of 60 firms.

Data on these IPO firms come from initial registration statements. Previous IPO research relied on prospectus data to conduct empirical analysis because the prospectus provides richer data than conventional financial statements (Filatotchev and Bishop 2002). We had access to the prospectus data through our purchase of Primark's (formerly known as Disclosure) New Issues Database.

3.2 Variables and analysis

We calculated two dependent variables. Board outsider percentage was calculated as the ratio of outside directors to the total number of directors (Beatty and Zajac 1994; Dalton et al. 1998). Institutional ownership percentage was calculated as the percentage of company stock owned by institutions including venture capital firms, investment management firms, pension funds, and insurance companies (Mahoney et al. 1997), where the first two types of investors make up 89.7% of all institutional holdings in these firms. Because the theory emphasizes governance not only by institutional investors but also by block ownership, we also empirically tested the institutional ownership hypotheses using a block ownership measure (i.e., the sum of non-executive stock holdings that are greater than 5% of total company stock) and found very similar results.

Regarding independent variables, uncertainty in the industry was measured using three variables: demand, competitive, and technological uncertainty. To measure demand uncertainty for each industry based on its 4-digit SIC code, the industry-level total sales for the years 1986–1995 were regressed on the year variable, and the standard error of the regression slope coefficient was divided by the mean total industry sales (Dess and Beard 1984). Further, we measured competitive uncertainty with the most common measure of industry concentration (i.e., four-firm concentration ratio) (Scherer 1980), where the industry's total market share percentage accounted for by the four largest firms was subtracted from 100 to indicate competitive uncertainty. Lower values of this variable indicate lower competitive uncertainty because concentration in the industry enables firms to signal each other about firm-level strategies (e.g., pricing strategy) and makes competitive dynamics more predictable (Schumpeter 1942). With an unbalanced market share distribution, the market leader can help promote coordination, reducing competitive uncertainty in the industry (Oster 1999). Data for the demand and competitive uncertainty variables were compiled from U.S. Bureau of the Census, Census of Manufacturers. Data for the competitive uncertainty variable were available only during Census years. Thus, we used data from 1992 Census as a proxy for 1995. Further, to calculate the measure of technological uncertainty, we used the number of patents issued in each industry (Sharfman and Dean 1991). The number of patents issued annually for the years 1985 through 1994 was regressed on the year variable, and for the specific industry the standard error of the regression slope coefficient was divided by the mean-number of patents. High levels of variation in the number of patents issued suggests that it is difficult to predict when and how frequently new

product and/or process technologies will emerge in the industry, making decisions about committing to specific technological paths rather risky. The data for this variable were available at the two-digit SIC code level from the U.S. Patent and Trademark Office's publication, *Patenting Trends in the United States*.

Further, we used several control variables in our regression analyses. We controlled for two indicators of performance-based management compensation. The first indicator, performance-based bonuses, was calculated as the percentage of cash compensation all top managers received in the form of bonus rather than salary. The second indicator measures top managers' stock ownership as a percentage of firm's total stock. The ownership data for both managers and institutions reflect the ownership percentage immediately after the IPO, which we compiled from prospectus documents. Also, the level of firm-based risk that IPO firms face may influence the choice of corporate governance mechanisms (Beatty and Zajac 1994). Thus, we controlled for firm-level risk with three variables. First, we controlled average age of the management team as an overall indicator of the general experience and knowledge managers possessed. Second, we controlled the number of risk factors listed in company prospectuses to inform potential investors about the conditions that may endanger the future of the company (Beatty and Zajac 1994). Risk factors indicate current and potential risks specific to firms, such as the need for expanded product line, loss of patents, dependence on a single product family, and fluctuations in results of operations. Third, we controlled firm-level risk with an indicator of profitability. We used a dummy variable to indicate firm's profitability (1 if the firm was profitable and 0 otherwise) during the year before it went public (Beatty and Zajac 1994). Further, we controlled for firm age, firm size (total assets), and market capitalization as these may affect a firm's attractiveness to block or institutional investors (Kor 2003). Market capitalization also shows a firm's ability to seek funding through capital markets. We used the prospectus data to calculate all of the control variables with the exception of the market capitalization variable, for which we used data from Compustat.

We used ordinary least squares regression in all models. Due to heteroskedastic error terms, we employed a robust regression technique that uses the White-corrected estimator of variance. This estimator produces consistent standard errors even when the residuals are not identically distributed (White 1980). Multicollinearity was not a problem in any of our models (i.e., all variance inflation factors are smaller than 2). Also, we standardized the variables because of the large unit differences among them. Firm size and firm age were normalized via logarithmic transformation. Table 1 summarizes the descriptive statistics and correlations for all variables. Table 2 shows the empirical results of hypothesis testing. Due to potential substitution effects between monitoring and managerial incentives, we controlled management bonus percentage and stock ownership percentage one at a time when estimating models (Beatty and Zajac 1994; Zajac and Westphal 1994).

4 Results

We maintain in hypothesis 1a that the higher the demand uncertainty in the industry, the higher the percentage of outsiders on the IPO firm board. This hypothesis is

Table 1 Descriptive statistics and correlations

Variable	Mean	S.d.	1	2	3	4	5	6	7	8	9	10	11	12
1. Demand uncertainty	4.52	29.46												
2. Competitive uncertainty	63.30	13.01	-0.50**											
3. Technological uncertainty	6.56	1.41	0.39**	-0.15										
4. Board outsiders ratio	0.70	0.22	0.19	0.11	0.13									
5. Institutional ownership (%)	0.37	0.26	0.23	-0.05	0.07	0.43**								
6. Management bonus (%)	0.22	0.17	0.17	-0.12	0.01	-0.24	0.00							
7. Management ownership (%)	0.14	0.15	-0.21	0.09	-0.10	-0.52**	-0.34**	0.28*						
8. Firm size	120.00	299.00	0.04	0.02	0.02	0.09	0.05	0.39**	0.46**	-0.03				
9. Management age	46.53	3.98	-0.18	0.17	0.14	0.01	0.02	0.24	-0.27*	0.26*				
10. Firm age	13.15	17.04	0.02	-0.40**	0.17	-0.11	-0.20	0.26*	0.00	0.18	0.16			
11. Number of risk factors	17.67	3.44	-0.01	-0.11	-0.32*	0.09	-0.18	-0.17	0.05	-0.51**	-0.21	-0.18		
12. Profitability	0.63	0.49	-0.07	0.02	-0.03	-0.36**	-0.34**	0.24	0.32*	0.09	-0.12	0.14	-0.08	
13. Market capitalization	262.00	341.00	-0.10	-0.03	-0.10	0.19	0.26	0.37**	-0.21	0.46**	0.26*	-0.17	-0.17	-0.17

** and * denote correlations significant at the 1 and 5 percent levels, respectively

Note: Firm size and market capitalization are in million U.S. dollars

The mean and standard deviation of demand and competitive uncertainty are multiplied by 100, and those of technological uncertainty are multiplied by 1,000

Table 2 Monitoring by boards and institutional owners

Model	I	II	III	IV	V	VI	VII	VIII
Dependent variable	Board outsiders ratio	Board outsiders ratio	Institutional ownership (%)	Institutional ownership (%)	VC ownership (%)	VC ownership (%)	Investment co. ownership (%)	Investment co. ownership (%)
Demand uncertainty	0.38** (0.12)	0.18* (0.09)	0.32** (0.11)	0.22* (0.10)	0.18 (0.13)	0.06 (0.13)	0.37* (0.20)	0.42* 0.18
Competitive uncertainty	0.36* (0.15)	0.44** (0.13)	0.22 (0.14)	0.25* (0.13)	0.33* (0.16)	0.36* (0.15)	-0.16 (0.17)	-0.18 (0.17)
Technological uncertainty	0.14 (0.16)	0.21 (0.15)	0.00 (0.11)	0.02 (0.11)	0.03 (0.16)	0.07 (0.15)	-0.04 (0.16)	-0.05 (0.15)
Management bonus %	-0.34* (0.16)		-0.12 (0.16)		-0.14 (0.18)		0.11 (0.18)	
Management stock ownership %		-0.50*** (0.13)		-0.26* (0.12)		-0.35** (0.12)		0.10 (0.14)
Log firm size	0.20 (0.18)	0.21 (0.17)	0.50*** (0.12)	0.52*** (0.12)	0.43* (0.20)	0.46* (0.19)	0.16 (0.17)	0.16 (0.17)
Management age	0.00 (0.13)	-0.20 (0.12)	-0.04 (0.11)	-0.14 (0.10)	0.00 (0.13)	-0.12 (0.12)	0.00 (0.11)	0.05 (0.14)
Log firm age	-0.12 (0.16)	-0.26+ (0.13)	-0.30* (0.16)	-0.35* (0.14)	-0.43** (0.15)	-0.49** (0.14)	0.01 (0.19)	0.04 (0.16)
Number of risk factors	0.23 (0.15)	0.25* (0.12)	-0.01 (0.14)	0.01 (0.13)	0.10 (0.16)	0.12 (0.14)	-0.24* (0.12)	-0.24* (0.13)
Profitability	-0.19+ (0.11)	-0.16* (0.08)	-0.30* (0.12)	-0.27*(0.12)	-0.17 (0.14)	-0.13 (0.15)	-0.22 (0.14)	-0.22 (0.14)
Market capitalization	0.28* (0.12)	0.07 (0.14)	0.02(0.15)	-0.07 (0.13)	0.06 (0.18)	-0.06 (0.18)	-0.07 (0.17)	-0.02 (0.14)
R-square	0.37	0.50	0.42	0.47	0.29	0.36	0.37	0.37
F-value	3.17 **	4.06***	7.69***	9.19***	2.09*	3.47**	2.53*	2.56*
n	60	60	59	59	59	59	59	59

Standard errors are provided in parantheses below the standardized coefficient estimates

***, **, * and + denote coefficients significant at the 0.1, 1, 5, and 10 percent levels, respectively

corroborated empirically. In support of hypothesis 1b, we find empirically that as the competitive uncertainty increases in the industry, the ratio of outsiders on the board increases. In hypothesis 1c, we maintained that the higher the technological uncertainty in the industry, the higher the percentage of outsiders on the board. This hypothesis is not supported.

In support of hypothesis 2a, we find empirically that institutional ownership percentage in IPO firms increases with the level of demand uncertainty. There is some support for Hypothesis 2b, based on Model IV ($P < 0.10$). Finally, Hypothesis 2c is not supported.¹ Thus, overall, it is noteworthy that the empirical results differ dramatically based on the *type* of uncertainty with strong empirical support for the hypotheses concerning demand uncertainty, support for competitive uncertainty, and no empirical support for the hypotheses concerning technological uncertainty.²

The current paper has treated institutional investors as one group of investors and has not made specific predictions for different types of institutional investors, primarily because venture capitalists make up the majority of these institutions in IPO firms. However, as a post hoc study, we examined whether different groups of institutional investors have responded differently to industry uncertainty. In the current sample setting, venture capitalists made up approximately 69.5% of institutional investments, whereas investment management firms made up about 20.2% of such investments. Pension funds, insurance firms, and family trusts made up the remaining 10.3% of these investments. Past research on institutional investors noted the difference between pension funds and investment firms with respect to their investment time horizons (Gilson and Kraakman 1991). Given the sheer size and immobility of their investments, pension funds tend to have a long-term investment approach (Tihanyi et al. 2003). Similarly, venture capitalists are noted for their long-term (developmental) investment approach where they closely monitor the venture's strategic directions, and provide significant managerial advice (Megginson and Weiss 1991). Venture capitalists hold significant equity positions in new ventures, and they tend to hold on to some of their shares even after the IPO (Barry et al. 1990). After taking into account the similarities in their investment horizons, we grouped venture capitalists and pension fund investments together. Investment management companies form a separate group since they tend to be short-term oriented in their investments, as shown with high levels of turnover in their funds (Tihanyi et al. 2003). This short-term orientation is often the result of incentive systems, where fund managers are rewarded based on quarterly returns in

¹ We also ran regressions with both management compensation variables entered in the same equation and find two changes. First, the effect of demand uncertainty on board outsider ratio was statistically significant at the 10% level instead of 5% level. Second, the P -value for the effect of demand uncertainty on institutional ownership increased to 10.9%, which is slightly above the critical value of 10%.

² We also performed sample power analysis and found that our sample has sufficient power to detect large size effects. We found that there is 81.3% likelihood that we would detect a large effect size in our sample, which exceeds the 0.80 threshold of acceptable sample power (Cohen 1988). Our sample does not have power to detect a medium or small size effect, which means that lack of significance for a particular variable could be due to medium or small size effect. Statistically significant findings, however, are robust with respect to sample size power, since the regression analysis takes into account the sample size to calculate the critical t -values needed to reject the null hypothesis.

their portfolios (Baysinger et al. 1991). Based on these two groups, we ran new regression analyses, as reported in Table 2.

The results are quite revealing. We find that venture capital ownership was significantly higher in industries with high competitive uncertainty whereas investment management company ownership was higher in environments with high levels of demand uncertainty. The results are consistent with the divergence in investment approaches between these two types of institutional owners. Venture capitalists seem to be seeking investments in environments where industry concentration is relatively low and competitive dynamics are likely to affect the IPO firm success. That a firm's competitive strategy (e.g., market positioning of products, competitive actions and reactions) plays an important role in firm-level performance (Hambrick et al. 1996), is highly appealing to venture capitalists because profits are not "distributed" ex ante due to entrenchment of major rivals in the industry. Superior management and governance are likely to pay off in these environments, and venture capitalists can contribute to this economic value creation process through monitoring, managerial advice, industry network connections.

Investment management companies, on the other hand, usually lack the resources that venture capitalists have (e.g., industry knowledge, experience, and network access), and thus are much less interested in environments with competitive dynamics. Investment management companies may steer away from these environments (as suggested by the negative regression coefficients of competitive uncertainty in Models VII and VIII in Table 2), as they can neither add economic value to venture firms nor can predict how competitive uncertainty may play out and influence their investments.

However, the results show that investment management firms are attracted to industries with demand uncertainty. Demand uncertainty involves instability in industry sales and growth patterns, which are much more difficult to control via individual firm strategic actions. Unlike competitive uncertainty, it is harder for a firm to cope with industry-wide demand uncertainty as multiple (macro-level) forces are likely to be in play (e.g., high cross price elasticity of demand, emergence of new substitute products). This macro-level dynamics in industry sales appeal to investment management companies because they are interested in holding short-term investment positions, which they frequently change via quick entry and exit moves (Tihanyi et al. 2003). These firms can actually use the industry demand fluctuations to change their ownership positions and ultimately profit from the volatility in IPO firm valuations as industry demand predictions oscillate. Thus, our post hoc analysis reveals that certain types of institutional investors are attracted to specific types of industry uncertainty based on (1) their ability to create long-term value through active corporate governance and (2) their ability to take advantage of short-term gains from certain types of market instability.³

³ We are grateful to an anonymous reviewer of this journal for making the valuable suggestion to conduct this post hoc analysis.

5 Discussion and conclusions

This paper addresses the insufficient availability of research concerning the role of *industry-specific* uncertainty on the corporate governance of IPO firms. Research in this area is essential because uncertainty in industry conditions (e.g., demand, competition, and technology) adds to the complexity and pressures of transition in becoming a public firm and invites a proliferation of managerial choices and results in an increased difficulty in attributing poor performance to managerial incompetence and/or opportunism (Finkelstein and Hambrick 1996). Thus, we developed and empirically tested a set of theoretical predictions regarding how the levels of monitoring by board outsiders and institutional investors differ on the basis of demand, competitive and technological uncertainty faced by the IPO firms in different industries. The empirical results reveal that industry uncertainty is, indeed, significantly related to board monitoring and institutional investor ownership. In particular, the empirical evidence underscores that industry effects on the use of these governance mechanisms are strongest and most consistent for demand uncertainty and competitive uncertainty.

Specifically, greater *demand uncertainty*, which reflects higher instability in sales generation in the industry from year to year, is associated with *higher* levels of board outside director percentage *and* institutional investor ownership in the IPO firm. These empirical findings suggest that increased information asymmetry caused by demand uncertainty is an *invitation* to both forms of monitoring in the IPO firm context. Outside directors can partially overcome the agency problem of information asymmetry and assess the likely marginal effect of managerial actions on economic performance through the use of knowledge about managers and key industry-specific factors (Carter and Lorsch 2004). Outside directors are also desirable because they can help the IPO firm acquire critical resources, gain legitimacy, and initiate new business relationships, which are essential for growth, but difficult to achieve in uncertain environments (Hillman and Dalziel 2003). Regarding institutional ownership, the overall findings suggest increased institutional ownership as the level of demand uncertainty goes up in the industry, although in our sample this relationship is more clearly attributed to investment management firms (rather than venture capitalists). Investment management firms tend to have a shorter investment horizon and are known to make frequent buy and sell decisions (Tihanyi et al. 2003). These firms may be attracted to environments where there is instability in demand trajectories, since this volatility enables them to create profitable short-term investment positions in the market. These investment companies are presumably much less interested in corporate governance than venture capital firms (and pension funds).

Further, the empirical results largely corroborate our theory development concerning the links between *competitive uncertainty*, and monitoring of IPO firms by boards of directors and institutional owners. Unpredictability of competitors' actions and reactions makes it more difficult to devise competitive strategy and manage competitive dynamics (Finkelstein and Boyd 1998). In such a business environment, closer monitoring and guidance (strategic advice) by the board and institutional investors are prevalent forms of corporate governance. Outside

directors and institutional owners with relevant industry knowledge and experience can help IPO firm managers craft and implement a sound competitive strategy and manage the uncertainties in competitive dynamics. Venture capitalist owners, in particular, may thrive in industries with greater competitive uncertainty because of their industry-specific expertise and access to industry networks. By signaling to the market and industry participants about the viability of the firm and its products, venture capitalists help firms initiate and secure critical business relationships. Put differently, the presence of both outside directors and institutional investors (venture capitalists) is higher under competitive uncertainty because *they can add considerable value to the firm through positive signaling and via monitoring and resource provision functions*.

Unlike demand and competitive uncertainty, the empirical evidence did not support positive effects of *technological uncertainty* on monitoring by boards or institutional investors. One possible interpretation is that specific corporate governance mechanisms may have different implications under technological uncertainty. A plausible conjecture is that the knowledge of specific product and process technologies in an industry may be highly complex and may take a long time to develop. Even though outside directors and institutional investors have access to valuable information about the firm and industry trends, it still may be extremely difficult to predict which product/process technologies will be dominant in the future. Most likely, managers will have a knowledge advantage because of their day-to-day involvement with firm-specific investments in technology (Rubin 1973). In fact, as reasoned earlier, even managers may have great difficulties envisioning future technology trends when new technologies frequently emerge in the industry in unexpected fashions (Eisenhardt and Martin 2000; Helfat and Peteraf 2003; Teece et al. 1997). Ultimately, if outsiders and institutional investors cannot reduce this technology-driven information asymmetry and effectively mitigate the potential agency problems, then there is not much to be gained by board and institutional monitoring. This line of reasoning, which can be derived from Ouchi (1979), may explain why institutional investors may not invest heavily in firms that operate in industries with high levels of technological uncertainty.

In the light of our post hoc analysis, we also acknowledge that institutional investors' response to technological uncertainty may depend on the type of the institutional investor. Venture capitalists are likely to possess the expertise to evaluate technological developments and trends in a specific industry, and thus may be attracted to environments with technological uncertainty. Investment management companies, on the hand, may want to opt out of these types of environments, as they focus on short term profit opportunities rather than long-term technology bets (Tihanyi et al. 2003). Post hoc study results were consistent with these arguments (in terms of the coefficient signs for technological uncertainty), but they were lacking in statistical significance. These relationships merit further research attention.

Alternatively, the lack of empirical evidence in support of the effects of technological uncertainty may stem from the operationalization of the construct. While the measure of technological uncertainty is based on the volatility of patents issued in the industry, future empirical studies can benefit from further examination of this relationship by using alternative measures of technological uncertainty, such

as measures based on the level or variability of research and development expenditures. Future research studies should also be conducted to understand the relationships between our industry uncertainty variables and other governance mechanisms. Also, we note that, given the IPO context of the current study, the results are limited to IPO firms and may not generalize the all firms and industries. Future research can extend the context of this study to other firm and industry contexts.

This theoretically grounded empirical paper contributes to the corporate governance literature concerning why IPO firms differ in outside director monitoring and institutional investor ownership based on different levels of types of uncertainty in their industry environment. The empirical results of the current paper highlight that, after controlling for firm-specific factors, a statistically significant level of the variation in board monitoring and institutional ownership can be attributed to the differences in the effects of industry-specific uncertainties. This empirical finding is revealing as it suggests that these governance mechanisms are adopted at different rates across industries because their effects on mitigating self-serving behaviors of managers and on providing strategic advice and access to networks are not universally and equally rewarding in all industries. These corporate governance mechanisms are more intensely utilized in business environments where there is greater opportunity of shareholder wealth creation through active monitoring and strategy guidance of IPO firms. Particularly, in industries with high demand and competitive uncertainty, outside directors and certain types of institutional investors can add significant value to the firm through monitoring, advice, and legitimacy (positive signaling) functions.

Our results underscore that, while increased potential of agency problems is usually an unwanted condition for shareholders, such potential can be economically attractive when agency problems can be mitigated. The presence of high levels of board monitoring and institutional ownership in uncertain industries *implies* that these forms of corporate governance are useful and economically profitable under demand and competitive uncertainty.

This research paper highlights the practical implications for shareholders and governance experts by directing attention to decisions about utilizing specific governance mechanisms for the IPO firms operating under different types of industry uncertainty, since these mechanisms may not be equally effective and rewarding across industries. This real-world governance implication is important because a uniform adoption of governance mechanisms across industries with different conditions can be costly for the firm. Under or over-application of certain mechanisms can be problematic, as firms may adopt governance mechanisms because of social-institutional pressures (Leblebici et al. 1991) or due to regulatory requirements. To achieve greater economic benefits from IPO firm governance, shareholders and corporate governance specialists should consider the effects of industry-specific contingencies on the effective use of specific governance mechanisms. Without examination of the *contingencies* that influence the use of these mechanisms, firms are likely to continue to suffer from agency problems and/or bear substantial irrecoverable economic costs due to the inappropriate use of corporate governance mechanisms.

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