

BOARD INDEPENDENCE AND FIRM PERFORMANCE IN THE IT INDUSTRY: THE MODERATING ROLE OF NEW ENTRY THREATS¹

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Prior research on corporate governance has offered contradictory empirical evidence on the relationship between the independence of the board of directors (the degree to which the board consists of outside directors who are not affiliated with the company) and firm performance. Building on the contingency view of corporate governance, we argue that the presence of significant new entry threats (NET), a unique feature that differentiates the IT industry from many other industries, is a critical contextual variable that moderates this relationship. Leveraging a novel NET measure based on text mining, we show that facing high NET, firms with boards that have a higher proportion of independent directors, who contribute to explorative organizational learning, carry out more effective monitoring, and offer independent opinions in strategic decision making, outperform firms with fewer independent board members. To address the endogeneity of board independence, we use the enactment of the Sarbanes-Oxley Act and related changes to the NYSE/NASDAQ listing rules as exogenous shocks; we show that our results are robust to the correction for endogeneity issues. Further, we show that our findings are generalizable to other high tech industries that face significant threats of new entry emerging from fast-moving industry dynamics. However, these results do not extend to slow-moving industries that have a stable market structure and thereby face lower and more homogenous levels of NET. We discuss the implications for future research, and provide managerial guidelines for practice as well.

Keywords: New entry threats, board independence, board of directors, corporate governance, firm performance, Sarbanes-Oxley Act, text mining

Introduction

The issue of corporate governance has seen much research within the management literature in the last two decades and continues to generate debate among practitioners and re-

searchers alike. Corporate governance received significant attention during the accounting scandals at companies such as Enron and WorldCom in the early 2000s, which prompted the enactment of the Sarbanes-Oxley Act of 2002. Part of the responsibility for these crises was attributed to the boards of directors, ostensibly elected to provide advisory and oversight functions on behalf of shareholders. In the information technology (IT) sector, corporate governance is of particular importance for a number of reasons. First, the IT sector is associated with fast clock-speed and rapid technological change (McAfee and Brynjolfsson 2008), which put pressure

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on firms to continually adapt to changing market conditions. In such contexts, the advisory role of the board is of vital importance. Second, the typical model of entrepreneurship within the IT sector gives rise to many IT firms with powerful founder-CEOs who also serve as the chairman of the board (Wasserman 2008); such CEO–chairman duality is often associated with weak boards in general. The prevalence of these conditions within the IT industry suggests that the firm’s executives can potentially act against the interests of shareholders. For instance, it is well known that IT firms such as Google and Facebook often adopt a dual-class share structure, effectively ensuring that the firm’s founders and top executives maintain control of the company with the ownership of only a small fraction of outstanding shares (Gompers et al. 2010). Such tight control can sometimes evoke dissidence from shareholders and governance activists in the form of complaints or demands for reform; consider, for instance, the recent lawsuit against Facebook’s board of directors by a shareholder, alleging excessive director compensation, breach of fiduciary duty, and unjust enrichment (Stempel 2014). The board of directors is thus of significant importance in managing agency issues that can affect the long-term viability of the firm.

At the heart of the debate surrounding corporate governance lies the unresolved question of the relationship between the independence of the board—the degree to which the board consists of outside directors who are not affiliated with the company—and firm performance. Despite many years of research, this relationship remains theoretically and empirically ambiguous. Some scholars maintain that from an agency perspective, the board should include a majority of outside directors since insiders lack objectivity in decision making and may support CEOs out of their own career considerations (Ellstrand et al. 2002). On the other hand, some researchers note that independent directors may lack industry- or firm-specific knowledge that is required to make well-informed decisions (Baysinger and Hoskisson 1990), whereas insider representation on the board leads to greater management commitment (Baysinger et al. 1991) and more effective monitoring of top managers due to superior information (Eisenhardt 1989). Interestingly, this lack of theoretical agreement is reflected in empirical findings as well (Wagner et al. 1998); prior research has reported a positive correlation (Baysinger and Butler 1985; Pearce and Zahra 1992), a negative correlation (Bhagat and Black 2001; Vintila et al. 2015), as well as no correlation (Dalton et al. 1998; Park and Shin 2004). To reconcile these contradictory findings, Pearce and Zahra (1992) proposed a contingency perspective of corporate governance, arguing that there is no perfect, one-size-fits-all corporate governance approach. Rather, the effectiveness of governance mechanisms depends on the organizational envi-

ronment and other contextual factors about the focal firm (Gani and Jermias 2006).

Building on this contingency view of corporate governance, we argue that the presence of constant new entry threats (hereafter, NET), a unique feature that sets the IT industry apart from others such as the airline or auto sectors, is one critical contextual variable that moderates the relationship between board independence and financial performance. NET is a disruptive force that often challenges incumbents in the marketplace, as highlighted by Porter’s (1979) five competitive forces model. Its influence has become particularly salient in recent years as the pace of digital innovations is altering the nature of competition, and developments in crowdfunding platforms, startup accelerators, and entrepreneurial ecosystems have further lowered barriers to entry within the high-tech industry, making it easier for new ventures to acquire financial resources via channels beyond the model of venture-capital funding (Aggarwal and Singh 2013; Kim and Hann 2014). Indeed, prior research reports that among the top 15 industries with the highest values of NET, with the exception of pharmaceuticals and biotechnology, all are associated with the IT industry broadly (Pan et al. 2015). With high levels of NET, incumbents in the IT industry must spot these threats quickly and adjust their strategies accordingly, since the associated turbulent environment can lead to considerable observed entry into the incumbent’s product markets, and therefore heightened contemporaneous competition in the foreseeable future (Goolsbee and Syverson 2008).

Many examples of such quick responses on the part of incumbents can be found within the IT industry. Consider, for instance, Instagram, a mobile photo-sharing app developer. As Instagram steadily gained popularity within the social media ecosystem and positioned itself as a social network in its own right, it was perceived as a potential threat by Facebook, which ended up acquiring the firm in 2012. Yet another example pertains to the response by Intel when it faced the entry of ARM processors into the mobile computing market. Intel initially underestimated the mobile processor markets and the value provided by the RISC (reduced instruction set computing) architecture-based ARM processors, which have lower costs, use less power, generate less heat, and are ideal for portable, battery-operated devices. These features led ARM to be licensed by firms like Apple, Marvell, Broadcom, and Samsung. Arguably, the late response by Intel cost it the leadership in the mobile market, where ARM processors became the preferred technology (Ganapati 2009). These examples show how important it is for incumbents to be able to respond swiftly and decisively to turbulent environments with high NET emerging from the entrepreneurial ecosystem.

The presence of outside, independent directors on the board is likely to play a more critical role under turbulent environments, such as when a firm faces high NET. Under such contexts, independent members on the board are more conducive to explorative organizational learning and the initiation of strategic changes (Van Den Bosch et al. 1999), which are often necessary in response to NET. In addition, the benefits of independent board members are amplified under turbulent environments via the two functions that boards are meant to provide: First, they strengthen internal monitoring and oversight functions, acting on behalf of shareholders to resolve agency issues and cut management slack (Ryan and Wiggins 2004). Second, they provide knowledge and resources that may not be easily available within the organization to aid decision making on strategic issues (Hillman et al. 2000). In this paper, we therefore investigate how the degree of new entry threats faced by an incumbent moderates the relationship between board independence and firm performance, thereby adding to the contingency perspective of corporate governance.

Empirically establishing the moderating effect of NET on the relationship between board independence and performance is challenging for two reasons. First, threats from new entries represent forward-looking estimations of the extent to which the potential future competition may influence firm profit or product market performance, which are yet to be fully materialized at the current moment; thus they are difficult to observe and measure (Hoberg et al. 2014). Unlike established firms, there are no ready-to-use and accepted industry classifications for startup firms, causing difficulties for the incumbents to identify startups that are threatening their product markets. Second, to the extent that a firm makes board member appointment decisions partly in response to its competitive environment, board independence may be correlated with a variety of unobserved variables that influence firm performance, therefore causing endogeneity concerns (Boone et al. 2007; Hermalin and Weisbach 2003). The presence of these confounds makes it difficult to disentangle the true effect of board independence on firm performance.

To overcome the first challenge, we adopt a novel, text-based measure of new entry threats introduced by Pan et al. (2015). The unique text-based measure of NET overcomes the limitations of static industry classifications that lack longitudinal variation and provides the basis for us to empirically examine the specific research questions of interest here. We address the second challenge—the endogeneity of board independence—by leveraging the enactment of the Sarbanes-Oxley Act and subsequent changes to the NYSE/NASDAQ listing rules (collectively referred to as SOX hereafter) as a natural experiment that exogenously shifts board independence for a subset of public firms in the United States. These changes

provide an ideal identification strategy, since they create differential shocks to board independence of compliant firms (those with boards that included more than the required ratio of independent directors prior to SOX) and to that of non-compliant firms (those with boards that included less than the required ratio of independent directors prior to SOX), and also ensure that such changes are independent of the unobserved firm-specific variables that are correlated with firm performance.

We estimate our models by applying panel data methods to a sample of incumbent firms in the IT hardware and software industries over the period 1997–2013; these years are selected based on joint data availability on board characteristics, new entry threats, and firm-level data on financial performance. Consistent with prior literature (Bhagat and Black 2001), our results show that a higher level of board independence is *not* significantly associated with superior firm performance. More importantly, we consistently find a moderating effect of NET: facing greater new entry threats, firms with a higher proportion of independent board members systematically outperform those with insider-dominated boards. These findings are robust to the use of instrumental variables estimations and a variety of alternative measures of firm performance. We also show our findings are generalizable to other industry segments that share the propensity of facing high NET, including the IT services and pharmaceutical industries. However, these effects do not extend to industries characterized by relatively stable market structure, and the associated low levels of NET, such as oil and natural gas, or agricultural manufacturing sectors.

Theory and Hypothesis

Board Independence and Firm Performance

Corporate governance involves a set of rules, mechanisms, and processes by which corporations are controlled and directed. The primary objective of corporate governance is to provide corporate oversight such that upper management's actions will be aligned with the interest of shareholders (Pearce and Zahra 1992). The board of directors is a central mechanism by which a large part of corporate oversight is carried out. The board also plays an important role in aiding strategic decision making within the firm (Carpenter and Westphal 2001; Judge and Zeithaml 1992). The positive impact of informed board members on decisions made by the firm has been documented in prior research (Hermalin 2005). By providing robust support in the forms of oversight and advice, the board can enable the focal firm to make better decisions and overcome challenges, thereby enhancing the

firm's position in the marketplace. Researchers and policy-makers have advocated for governance reform that focuses on enhancing the abilities of the board, such as through regulating the selection of directors and the separation of the roles of CEO and chairman of the board (Black 1992).² Among these initiatives, one has been particularly noteworthy since it directly influences the extent to which the board is able to exert oversight and provide advice: board independence (Bhagat and Black 2001). However, the empirical evidence on this relationship is largely inconclusive and often contradictory (Bhagat and Black 2001; Dalton et al. 1998): researchers have failed to find systematic evidence that firms with predominantly non-executive boards achieve superior financial performance (Donaldson and Davis 1994).

There are alternative theoretical perspectives that shed light on how board independence may affect firm performance. The dominant view held by practitioners, grounded in agency theory (Jensen and Meckling 1976), maintains that the primary duty of the corporate board is to serve as a monitoring mechanism that helps protect shareholders from opportunistic behavior by managers. Therefore, independent directors are believed to be more effective at carrying out the monitoring functions and reducing agency costs, leading to superior firm performance. This view has found some empirical support in the literature; for example, Baysinger and Butler (1985) found that a greater proportion of outside independent directors had a mild and lagged effect on firm performance, but they also noted that firms with the best performance records did not have the greatest change in board independence. In an alternative setting, Pearce and Zahra (1992) found that board size as well as representation by outsiders had a positive association with the firm's financial performance. Thus, some empirical validation of the agency theory perspective on board independence does exist.

An alternative perspective emerges from arguments based on stewardship theory. It suggests that managers are good stewards instead of opportunistic agents, that they are inherently trustworthy, and act in the best interest of the owners (Davis et al. 1997; Donaldson and Davis 1991). In contrast to the postulates of agency theory, scholars argue that corporate boards with a preponderance of *inside* board members lead to higher firm performance because such practices add to the available expertise of the board, provide unified leadership that removes ambiguity with regard to responsibilities, and give status reward to executives (Dalton et al. 1998; Donaldson 1990). Others have noted the potential benefits of inside directors as well, such as more effective

evaluation of top managers due to superior context-specific information (Baysinger and Hoskisson 1990), and greater R&D spending on the part of the firm (Baysinger et al. 1991). Removing inside directors may also lead to the negative consequences of depriving the firm of important firm- and industry-specific knowledge which, in the longer term, will hurt firm performance (Baysinger and Hoskisson 1990). Therefore, these arguments lead to the testable hypothesis that board independence is negatively associated with firm performance. Empirical evidence consistent with this hypothesis can also be found in the literature. For example, Kesner (1987) reported a positive association between the proportion of *inside* directors and the return to investors while Bhagat and Black (2001), studying 934 large U.S. firms, showed that firms with a greater proportion of *outside* directors were associated with significantly lower financial and stock market performance in the following 3 years. Similar conclusions are reported in a more recent study of a sample of high-tech firms by Vintila et al. (2015).

Adding to the complexity of the issue are a significant number of studies that intriguingly find no direct relationship between board independence and firm performance (Park and Shin 2004; Singh and Davidson 2003). In fact, multiple meta-analyses have concluded that there is no systematic evidence to suggest that an increase in the percentage of outside directors enhances firm performance (Dalton et al. 1998; Finegold et al. 2007). It is possible that methodological limitations, or differences, may in part drive these diverging results; the studies on board independence across sectors and time periods are not easily replicable, nor are they comparable in a straightforward manner (Young 2003). However, a more compelling explanation for these diverging results arises from a contingency perspective of governance proposed by Pearce and Zahra, who argue that the relationship between governance and firm performance is complex, and likely to be contingent on a series of contextual variables and organizational factors that influence the extent to which oversight may be needed or that emphasize the environment in which the firm operates. Contingency variables consistent with this perspective include the firm's growth opportunities (Hutchinson and Gul 2004), its overall strategy (Gani and Jermias 2006), and whether the firm is operating in heavily institutionalized environments (Peng 2004). We propose that one such environmental factor that is particularly relevant to the IT industry is if the firm operates in a dynamic context where there is considerable *new entry threat*, which is described next.

The Moderating Role of New Entry Threats

Building on the contingency perspective of corporate governance (Pearce and Zahra 1992), we argue that the dynamic

² See, for example, *TIAA-CREF Policy Statement on Corporate Governance* (6th ed.) (available online at https://www.tiaa.org/public/pdf/pubs/pdf/governance_policy.pdf).

environment under which a firm operates forms an important boundary condition that moderates the relationship between board independence and firm performance. The disruptive influence of new ventures in the IT industry has been noted in prior research (Kim et al. 2016) and represents a credible source of environmental volatility for incumbents (Samila and Sorenson 2011). While contemporaneous competition from other incumbents is also a source of environmental volatility (Hoberg et al. 2014), NET is inherently different due to its forward-looking nature and its potential for creative destruction (Aghion and Howitt 1992). Under the conditions of dynamism and environmental turbulence, we argue that maintaining a board with a high proportion of independent directors is particularly valuable, with implications for firm performance, for several reasons.

First, new entry threats, particularly from startups, are often associated with the introduction stage of a new, superior technology or a fundamentally different business model, and embody systematic shifts in the technological landscape or changes in the assumptions and routines upon which the incumbents operate (Christensen et al. 1998). Under such conditions, the contribution of inside, executive directors may be limited from an organizational learning perspective (March 1991). Prior research on organizational learning suggests that, in stable knowledge environments, the focus of learning and knowledge absorption is on *exploitation*. In contrast, in a turbulent knowledge environment, the focus should be, and is optimally deployed, on *exploration* instead (Van Den Bosch et al. 1999). As exploitation builds on the value inherent in existing knowledge, inside directors, with greater firm knowledge and industry-specific expertise, may contribute more to firm performance through efficiency, routinization, refinement, and execution under stable environments (Westphal 1999). However, when there are greater learning opportunities from the external environment, such as when a firm faces new entry threats and when new technologies and business models are being introduced, outside (independent) directors are likely to be more open to exploring new opportunities, acquiring new capabilities and adapting to the changing environment through variation, flexibility, risk taking, and experimentation (Greve 2007). Thus, in the presence of environmental volatility and a concomitant emphasis on exploration, a greater proportion of independent board members should lead to better firm performance.

Second, when facing high levels of new entry threats, incumbents need to respond through rethinking their existing strategic orientations, consider resource reconfigurations, and identify appropriate responses to the possibilities of emerging competition in their product market (Hillman et al. 2000). In such contexts, independent board members are significant

reservoirs of information and other resources; they represent valuable stores of knowledge, networks, and capabilities that are available to the firm (Kesner 1988) and not easily replicated from within the firm (Hillman and Dalziel 2003). For example, the networks and information provided by outside directors could help the incumbent firm pursue opportunities in new markets and industries, while also helping the firm advance through the formation of strategic alliances (Pearce and Zahra 1992), all of which are likely to help the firm respond effectively to environmental volatility. Inside directors, with their concentrated exposure to existing strategies within the firm, are less likely on the margin to notice or consider alternative approaches (Carpenter and Westphal 2001). Indeed, prior research indicates that while internal board members may have greater proximal knowledge about the firm and its workings, the perspective brought in by independent members is particularly influential during times of strategic change and turbulence (Forbes and Milliken 1999; Rosenstein and Wyatt 1997). Beyond providing new knowledge and perspective, independent board members may help firms unlearn entrenched organizational habits that are obsolete or no longer functional (Nystrom and Starbuck 1984). The presence of independent board members can also ameliorate the negative effects of “groupthink” visible in embedded group members, thereby questioning taken-for-granted elements of strategy (Forbes and Milliken 1999). Thus, from a resource dependence perspective (Hillman and Dalziel 2003), firms that face turbulence in their product markets are likely to benefit more from the presence of independent board members than firms in a stable environment.

Third, the value of independent board members in the presence of new entry threats is also consistent with the agency view of corporate governance (Hillman and Dalziel 2003). The board is responsible for monitoring the executives on behalf of the shareholders (Hermalin and Weisbach 2003). Prior research shows that the role of governance and oversight is more likely with independent board members rather than insiders who are associated with the firm (Hermalin 2005; Westphal 1999). Consistent with this reasoning, Boone et al. (2007) and Baker and Gompers (2003) find that independent boards reduce the bargaining power of the CEO and incentives of empire-building, thereby ensuring that managerial decisions are long-term optimal for the firm. During the turbulent periods characterized by high levels of new entry threats, this monitoring capability is essential to ensure that the firm’s executives take the appropriate strategic action to improve the firm’s long-term viability, instead of short-term myopic decision making that may provide personal benefits to the manager but will affect the firm negatively in the long run (Guo and Masulis 2015). Prior research also shows that under turbulent environment, boards with heterogeneous external ties are better able to carry out the monitoring func-

tion due to their broad knowledge structures (Carpenter and Westphal 2001). The monitoring function also helps the firm to cut management slack and improve efficiency during the period of turbulence (e.g., cutting unnecessary expenses and scaling back highly risky projects).

Finally, prior research shows that the level of board involvement in strategic decision making increases with more independent board members (Judge and Zeithaml 1992). For instance, Johnson et al. (1993) find that boards dominated by outside directors are more likely to initiate corporate restructuring and strategic change. Inside directors are usually reluctant to voice different opinions during strategic decision making because they are worried about challenging the authority of the CEO (Westphal 1998). Therefore, firms with more inside directors tend to be inertial to strategic changes, making them less adaptable to changing environments that are often associated with new entry threats. In summary, multiple theoretical perspectives on corporate boards (organizational learning, agency theory and resource dependency) suggest that volatile environments characterized by high NET play an important role in moderating the relationship between board independence and the firm's operating performance. Therefore, we propose

Hypothesis 1: *Under high levels of new entry threats, firms with a higher proportion of independent board members perform better than those with a lower proportion of independent board members.*

Data and Variables

Sample and Data Sources

The dataset we use to conduct our empirical tests is constructed from multiple sources. We focus on firms in the IT software, hardware, and Telecom industries identified by 18 four-digit NAICS industry codes (Kim et al. 2016).³ Financial data and other firm characteristics are obtained from Compustat. To measure board independence, we obtain data on board members of U.S.-based public firms from RiskMetrics (formerly Investor Responsibility Research Center), whose coverage is primarily on the S&P 1500 firms. Our variable of new entry threats is adopted from Pan et al. (2015), who describe such threats as emerging from venture-funded startup firms and measure them using a text-mining approach that compares the product descriptions of the

incumbents with those of the new entrepreneurial startups. Our primary sample consists of 583 publicly-traded firms over the period 1997–2013 with 4,175 firm-year observations, representing an unbalanced panel. The sample period includes years when there was considerable turbulence in the IT sector (e.g., the Internet boom and bubble burst), the period of the global financial crisis in 2008 and the recovery afterward, as well as other less volatile years. Together, the dataset provides considerable longitudinal variation in the measures of new entry threats and board independence that allows us to use firm-level fixed effects panel data models to control for many unobserved firm heterogeneities. We describe the key variables in our analyses below, while a summary of variable definitions can be found in Table 1.

It should be noted that in the unbalanced panel dataset, most of the missing observations are due to delayed arrival (i.e., firms entering the dataset as a public firm subsequent to the start of our observation time-period) or early exit (firms were de-listed from the marketplace due to mergers, acquisitions, bankruptcy, privatization, and so on). As long as the missing data is caused by reasons not systematically correlated with the error terms of the estimated equations, the estimation remains unbiased and consistent (Baltagi 2008). Therefore, in our case, the presence of missing observations leading to an unbalanced panel is unlikely to cause significant biases in estimation.

Variables

New Entry Threats (NET). We adopt a novel measure, derived from text mining techniques that are increasingly gaining favor in IS research (Ghose et al. 2012; Li et al. 2014), to capture the threats emerging from startups, introduced by Pan et al. (2015). While the full details on the construction and validation of the NET measure are available in Pan et al., we briefly discuss the intuition behind this measure here. New entry threats are calculated as the cosine similarity between the product description of an incumbent firm and the aggregated product descriptions from startups that received first-round venture capital funding in a specific year. The product descriptions of established firms are obtained from annual reports (10-Ks) that are updated as required by financial market regulations (Hoberg and Phillips 2016; Tetlock 2011; Tetlock et al. 2008). The product descriptions of startups are obtained from the VentureXpert dataset, commonly used in entrepreneurship research (Aggarwal et al. 2012). The VC-backed entrepreneurial firms have baseline quality and therefore represent credible threats of entry to incumbents (Aggarwal et al. 2015). Conceptually, this measure captures how the text of an established firm's product description is similar to the text of product descriptions from the technology-

³Our IT sample is defined by 18 four-digit NAICS codes: 2211, 3332, 3333, 3336, 3339, 3341, 3342, 3343, 3344, 3345, 3346, 5112, 5171, 5172, 5173, 5174, 5179, and 5181.

Table 1. Variable Definitions and Data Sources

Main Interest Variables	Definition
ROA_{it}	Operating income before depreciation divided by total assets of firm i in year t
ROA_{it} (Alternative)	Net income divided by total assets of firm i in year t
ROE_{it}	Net income divided by common shareholders' equity of firm i in year t
NET_{it}	New entry threat measured by cosine similarity between product description of firm i and the aggregated product description of startups in year t
$Board\ of\ Independence_{it}$	Ratio of independent board members over total board members of firm i in year t
Board Characteristic Controls (Source: Risk Metrics)	
$CEO_Duality_{it}$	Firm's CEO also holds the position of the chairman of the board for firm i in year t
$Board\ Size_{it}$	Number of board members of firm i in year t
$Board\ Tenure_{it}$	The average tenure of board members of firm i in year t
$Board\ Age_{it}$	The average age of board members of firm i in year t
$Interlocks_{it}$	Number of interlock directors of firm i in year t
Firm Characteristic Controls (Source: Compustat)	
$Assets_{it}$	Total assets of firm i in year t (in \$ Billion)
$Asset-tangibility_{it}$	Net property, plants, and equipment divided by total assets of firm i in year t
$Leverage_{it}$	Total debt of firm i in year t divided by its total assets
$CapExp/Assets_{it}$	Capital expenditure divided by total assets of firm i in year t
$TNIC_HHI_{it}$	Herfindahl-Hirschman Index of firm i in year t based on text-based network industry classifications (TNIC) (Hoberg et al. 2014).
$R\&D\ Intensity_{it}$	R&D expenditure divided by total assets of firm i in year t
$Tobin's\ Q_{it}$	Market to book ratio of firm i in year t as defined in Brown and Caylor (2006)

based startup ecosystem. Intuitively, the cosine similarity-based NET measure is bounded between 0 and 1, with higher values representing greater threats of new entry.

Board Independence. Following prior work (Knyazeva et al. 2013), we define board independence as the fraction of the board represented by independent (non-gray outside) directors. We exclude gray directors, who are outside board members with familial or business ties to the firm or its senior management, or have conflicts of interests that can compromise a board's major functions. The average firm in our sample has a board comprising nine directors, of whom 73% are independent and 27% are gray directors or internal officers (including the CEO). We report average board independence by year in Table 2. The statistics indicate that average board independence significantly changed over the period 2002–2007 after SOX and other related regulatory changes, and the general trend is increasing over time.

Firm Performance. We start by measuring firm performance using return on assets (ROA), defined as operating income before depreciation and amortization (OIBDA) divided by total assets (AT). This measure captures overall operating

performance of a firm and is a commonly used firm profitability measure in finance and IS (Anderson and Reeb 2003; Bharadwaj 2000). We also consider an alternative definition of ROA, measured as net income over total assets. Prior research has also used return on equity (ROE) as an alternative measure of operational performance (Allen and Gale 2000); we use this measure in our analysis as well. The summary statistics for the dataset are displayed in Table 3, indicating mean ROA is 11.1% (1.9%) using OIBDA (using net income), while mean ROE for the sample is 11.5%.

Control Variables. Following prior literature (Anderson and Reeb 2003; Giroud and Mueller 2011), we control for a vector of firm characteristics that may affect a firm's performance, including firm size, asset tangibility, leverage, capital expenditure, and product market competition. We control for contemporaneous competition by calculating the Herfindahl-Hirschman index based on market shares, where competitors are identified by the increasingly popular text-based network industry classification (TNIC) scheme created by Hoberg and Phillips (2016). Unlike the traditional NAICS classification, TNIC classifications are updated every year as firms file 10-K

Table 2. NET and Board Independence by Year

Year	Obs.	New Entry Threat (<i>t</i>)			Board Independence (<i>t</i>)			Δ Board_Indp
		Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	
1997	174	0.056	0.043	0.046	0.651	0.680	0.184	
1998	206	0.053	0.040	0.041	0.653	0.667	0.183	0.002
1999	239	0.049	0.035	0.040	0.636	0.667	0.199	-0.017
2000	236	0.073	0.056	0.052	0.643	0.667	0.186	0.007
2001	274	0.078	0.072	0.053	0.655	0.696	0.173	0.012
2002	261	0.071	0.064	0.046	0.682	0.700	0.153	0.027
2003	276	0.074	0.067	0.049	0.704	0.714	0.144	0.022
2004	280	0.074	0.070	0.046	0.721	0.750	0.131	0.017
2005	265	0.067	0.062	0.040	0.732	0.750	0.126	0.011
2006	244	0.060	0.053	0.043	0.746	0.760	0.130	0.014
2007	200	0.058	0.048	0.047	0.785	0.800	0.109	0.039
2008	210	0.057	0.050	0.044	0.785	0.800	0.108	0.000
2009	254	0.056	0.050	0.039	0.795	0.833	0.112	0.010
2010	264	0.058	0.051	0.044	0.808	0.833	0.098	0.013
2011	254	0.055	0.047	0.047	0.807	0.833	0.097	-0.001
2012	264	0.055	0.047	0.046	0.809	0.833	0.094	0.002
2013	270	0.057	0.049	0.046	0.817	0.852	0.090	0.008

Note: We define Δ Board_Indp = Mean Board_Independence (*t*) – Mean Board_Independence (*t*-1).

reports, allowing for a more accurate measure of contemporaneous competition. We control for firm size using the natural log of total assets. In addition, following previous studies of corporate boards of directors (Triana et al. 2013; Zona et al. 2018), we control for a set of board structure variables that may influence firm performance, including CEO duality, board size, average age of board members, average tenure of board members, and number of board interlocks. In our sample, the CEO also holds the position of the chairman of the board in approximately 65% of the firms. On average, a firm in our sample has a board of 9 directors with an average age of 60 and tenure of 9 years with the focal company, while 5 of them also sit on the boards of other companies.

Results

We discuss the results of our analysis in stages, starting with firm-level fixed-effects models. We then provide additional analyses where we address the endogeneity of board independence, use alternative samples and alternative measures of the moderator variable, and show that the results are robust to each of these specifications. Beyond considering these rela-

tionships within the focal IT industry, we also estimate similar models for other industry sectors that may not be as technology-intensive for two reasons. First, examining the results from other industries that are less volatile and dynamic than the IT industry helps establish the boundary conditions of the effects we postulate; to the extent that NET is less of a problem in other industries, the relationship between board independence and performance may be less nuanced. Second, if the role of NET is indeed important, as we argue, testing these relationships in industries which experience low levels of NET provides a test of falsifiability. Comparisons between the IT industry, on the one hand, and other industries with lower average levels of NET, on the other, allow us to establish the robustness of our arguments. We describe the obtained results in more detail below.

Results from Panel Data Models with Fixed Effects

In order to evaluate the moderating effect of *NET* on the relationship between *board independence* and corporate operating *performance*, we estimate a panel data model of the following form:

Table 3. Summary Statistics and Correlation Coefficients

Variable	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. ROA	11.129	8.341	1															
2. ROA alternative	1.945	15.992	0.597*	1														
3. ROE	11.505	205.879	0.013	0.036*	1													
4. New Entry Threats	0.062	0.046	-0.061*	-0.105*	-0.01	1												
5. Board Independence	0.733	0.154	0.027	0.063*	-0.03	-0.119*	1											
6. CEO Duality	0.655	0.475	-0.007	-0.014	0.023	-0.049*	0.005	1										
7. Board Size	8.738	2.343	0.127*	0.081*	0.022	-0.209*	0.187*	0.078*	1									
8. Board Tenure	9.383	3.668	0.111*	0.118*	-0.012	-0.112*	-0.241*	-0.036*	-0.082*	1								
9. Board Age	60.028	4.443	0.054*	0.117*	-0.011	-0.281*	0.214*	-0.049*	0.181*	0.426*	1							
10. Interlocks	4.840	5.054	0.149*	0.055*	0.042*	-0.028	0.148*	0.168*	0.564*	-0.143*	0.092*	1						
11. Assets (Billions)	8.109	21.004	0.094*	0.058*	0.013	0.083*	0.140*	0.081*	0.415*	-0.067*	0.129*	0.409*	1					
12. Asset Tangibility (%)	23.701	21.153	0.019	-0.017	0.031*	-0.432*	0.062*	0.131*	0.431*	-0.039*	0.111*	0.169*	0.218*	1				
13. Leverage (%)	16.071	16.307	-0.045*	-0.084*	0.062*	-0.244*	0.079*	0.107*	0.320*	-0.098*	0.076*	0.166*	0.139*	0.507*	1			
14. Cap Exp/Asset (%)	4.402	3.631	0.156*	-0.019	0.061*	-0.109*	-0.148*	0.095*	0.160*	-0.017	-0.079*	0.149*	0.123*	0.576*	0.209*	1		
15. HHI TNIC	0.167	0.165	0.049*	0.015	-0.011	-0.024	0.002	-0.021	-0.060*	0.028	0.037*	0.050*	-0.098*	-0.275*	-0.078*	-0.131*	1	
16. R&D Intensity (%)	8.160	6.009	-0.186*	-0.241*	0.009	0.320*	-0.158*	-0.097*	-0.329*	-0.062*	-0.206*	-0.173*	-0.176*	-0.273*	-0.293*	-0.029	-0.095*	1
17. Tobin's Q	1.956	1.368	0.366*	0.199*	0.012	0.237*	-0.144*	-0.015	-0.188*	0.000	-0.213*	-0.017	-0.079*	-0.288*	-0.281*	-0.001	0.019	0.161*

Notes: This table reports the summary statistics for primary variables constructed based on the sample of U.S. S&P 1500 firms in the IT Industries from 1997 to 2013. See Table 1 for the description of the variables.

We include IT software and hardware Industries, which is defined by 4-digit NAICS codes: 2211, 3332, 3333, 3336, 3339, 3341, 3342, 3343, 3344, 3345, 3346, 5112, 5171, 5172, 5173, 5174, 5179, and 5181.

*p < 0.05.

$$Performance_{i,t+1} = \lambda_i + \phi_t + \beta_1 \times BoardIndp_{i,t} + \beta_2 \times NET_{i,t} + \beta_3 \times BoardIndp_{i,t} \times NET_{i,t} + X_{i,t} \theta + \varepsilon_{i,t} \quad (1)$$

where *i* indexes the firms, and *t* indexes the time periods. In the baseline model we use ROA as the dependent variable. The variable *NET_{i,t}* is the text-based measure of new entry threats. *BoardIndp_{i,t}* denotes the proportion of independent, outside directors. *X_{it}* is a set of firm characteristics that may affect firms' operating performance. We control for time-invariant unobservable firm characteristics by including firm fixed effects λ_i . ϕ_t is a set of year dummies we use to control for economy-wide shocks. We estimate the models using OLS regressions with robust standard clustered at the firm level to control for serial correlation (Wooldridge 2010). ε_{it} represents the idiosyncratic error. To compare our results to prior literature on board independence, we also evaluate the main effect of *BoardIndp_{i,t}* on firm performance by presenting results from a model without the interaction term *BoardIndp_{i,t}* × *NET_{i,t}*.

Table 4 reports the results from our baseline panel data model with firm fixed effects. The dependent variable in Column (1) and Column (2) is ROA, operationalized as OIBDA divided by total assets. Column (1) shows the direct effects of *board independence* on firm performance, and Column (2) adds the interaction with *NET* in the model. We repeated this pattern for other alternative measures of performance in the table. In the models examining direct effects of *board independence* on performance (columns 1, 3, and 5), we find that the coefficients of *BoardIndp_{i,t}*, although positive, are consistently insignificant, suggesting that variations in board independence are, by themselves, not directly associated with firm performance, an observation that is consistent with prior studies (e.g., Bhagat and Black 2001). Interestingly, we also find that *NET* is consistently associated with a decline in firm performance. It is possible that the potential technology changes associated with new entry threats may raise wage levels in the labor market, making it difficult for incumbents to maintain their human capital. In addition, high levels of

Table 4. Board Independence, New Entry Threats, and Firm Performance

	ROA (%) Operationalized as OIBDA/Total Asset		ROA (%) Operationalized as Net Income/Total Asset		ROE (%) Net Income/ Common Shareholders' Equity	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Board Independence</i>	1.019 (1.196)	0.769 (1.178)	1.776 (2.158)	1.406 (2.110)	2.280 (7.126)	1.939 (7.087)
<i>New Entry Threats</i>	-0.550** (0.253)	-4.275*** (0.821)	-1.530*** (0.499)	-7.464*** (2.191)	-2.520** (1.164)	-11.891*** (4.206)
<i>New Entry Threats × Board Independence</i>	–	5.148*** (1.065)	–	8.283*** (2.749)	–	12.965** (5.360)
Board-Related Controls						
<i>CEO Duality</i>	-0.649** (0.297)	-0.601** (0.293)	-1.234* (0.668)	-1.169* (0.662)	-2.398 (1.642)	-2.251 (1.619)
<i>Board Size</i>	0.039 (0.091)	0.028 (0.090)	0.240 (0.188)	0.217 (0.186)	0.708* (0.428)	0.681 (0.427)
<i>Board Tenure</i>	-0.045 (0.066)	-0.047 (0.066)	0.034 (0.124)	0.041 (0.125)	0.013 (0.327)	0.031 (0.327)
<i>Board Age</i>	-0.059 (0.068)	-0.052 (0.067)	-0.089 (0.123)	-0.082 (0.123)	-0.107 (0.325)	-0.104 (0.325)
<i>Interlocks</i>	0.005 (0.036)	0.000 (0.036)	-0.019 (0.060)	-0.026 (0.061)	-0.293 (0.199)	-0.312 (0.200)
Firm-Related Controls						
<i>Log (Assets)</i>	-1.391*** (0.356)	-1.530*** (0.350)	-5.842*** (1.137)	-6.013*** (1.135)	-9.896*** (3.554)	-10.293*** (3.535)
<i>PPE/Assets</i>	2.552 (1.995)	2.356 (2.003)	-5.151 (5.201)	-5.473 (5.209)	-26.697** (12.405)	-27.655** (12.407)
<i>Leverage</i>	-0.347 (1.438)	-0.325 (1.436)	5.191 (4.050)	5.226 (4.042)	-12.677 (9.099)	-12.424 (9.080)
<i>Capx/Assets</i>	-3.582 (4.491)	-3.559 (4.474)	-2.899 (9.781)	-2.865 (9.734)	15.824 (25.275)	15.618 (25.243)
<i>R&D Intensity</i>	-0.052 (0.036)	-0.061* (0.036)	-0.116 (0.090)	-0.130 (0.090)	-0.293* (0.178)	-0.318* (0.178)
<i>Tobin's Q</i>	1.007*** (0.147)	1.016*** (0.148)	1.216*** (0.395)	1.246*** (0.400)	1.877*** (0.482)	1.926*** (0.488)
<i>TNIC HHI</i>	-1.538** (0.757)	-1.701** (0.752)	-2.627 (1.718)	-2.886* (1.713)	-10.023** (4.580)	-10.418** (4.583)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of Firms	583	583	587	587	583	583
Observations	4,175	4,175	4,167	4,167	4,195	4,195
R-squared	0.645	0.649	0.564	0.567	0.468	0.470

Notes: This table reports estimates for firm operating performance as dependent variable. All independent variables are lagged one year. The dataset is constructed based on the sample of U.S. S&P 1500 firms in the IT Industries from 1997 to 2013.

Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1

New entry threats are standardized with mean of zero and standard deviation of one.

NET may raise the perception of riskiness of the incumbent in the capital market, making it costlier for the incumbent to raise capital. As a result, rising labor costs, together with the higher cost of capital induced by entry threats, lead to significant increases in operating costs and deteriorating performance (Fallick et al. 2006).

The results pertaining to the moderating effect of *NET* on the relationship between *board independence* and firm performance are reported in columns 2, 4, and 6 of Table 4. We find that the interaction terms of *Board Independence* \times *NET* are significantly positive at the 5% level or lower across all performance measures, confirming our conjecture that *NET* positively moderates the relationship between board independence and firm performance. Effect size calculations based on column (2) suggest that for firms experiencing low levels of *NET* (i.e., one s.d. below mean), a change in *Board Independence* from 0% to 100% leads to a 4.38 percentage point decrease in ROA ($p < 0.01$), equivalent to a reduction of \$335.17 million in operating income before depreciation (OIBDA) when total assets are evaluated at the mean level. In contrast, at high levels of *NET* (i.e., one s.d. above mean), a change in *Board Independence* from 0% to 100% results in a 5.92 percentage point increase in ROA ($p < 0.01$), equivalent to a gain of almost \$480.05 million in OIBDA on average. To illustrate the marginal effects in a more intuitive manner, in Figure 1 we plot the predicted levels of ROA as a function of board independence under high versus low levels of *NET* (using a sample median split), along with 95% confidence intervals. The results support our theoretical argument that a higher percentage of independent board directors, who strengthen the monitoring functions while also providing knowledge resources and independent opinions, are particularly valuable when firm operates under a turbulent environment such as when facing high *NET*. In Figure 2 we plot the average marginal effect of board independence on ROA as a function of *NET*, together with 95% confidence intervals for the marginal effect. The plot shows that the marginal effect of board independence on performance becomes greater as *NET* increases, supporting the hypothesis postulated about the moderating effect of *NET*.

It is arguable that IT firms experiencing high *NET* are likely to be in industries that are more innovative on average; it is this innovativeness that leads to high *NET*, which then influences performance. Therefore, it is important to account for the innovativeness of the firm before we can partial out the influence of *NET*. We perform additional tests to rule out this alternative explanation, which are described in detail in Appendix A. Specifically, we report a set of regressions controlling for the innovation capabilities of incumbent firms, so that the incremental effect of *NET* on performance can be estimated.

Addressing Endogeneity of Board Independence

The baseline analyses assume that board independence is strictly exogenous. However, endogeneity concerns arise when there are unobserved variables that are correlated with both the firm's operating performance and board composition. Corporate governance structures, including the appointment of the board of directors, are endogenous decisions made by firms in response to the environment in which they operate. For example, a growing body of research focuses on optimal board design, including the representation of independent directors on boards (Boone et al. 2007; Raheja 2005). Others suggest that drivers of independent boards may include the private benefits of control and the CEO's influence over director appointments (Hermalin and Weisbach 1998). In yet another context, Luoma and Goodstein (1999) argue that board formation is often a result of institutional pressures experienced by the firm in its environment. In effect, there are reasons to suggest that board formation is endogenous. As a result, the estimated effect of independent board directors on firm performance may be confounded with unobserved heterogeneities.

To address these concerns, we relax the strict exogeneity assumption of board independence by using a quasi-experimental setup—the regulatory changes with regard to board composition—to construct instrumental variables for board independence. During our sample period, an important set of new and tightened corporate governance requirements was introduced with the enactment of Sarbanes-Oxley Act. The main provisions included increased penalties for fraudulent financial activities, independence of audit committees, CEO and CFO certified financial statements, real-time disclosure of equity transactions by corporate insiders, and so on (Chhaochharia et al. 2016). In response to the enactment of SOX, major U.S. stock exchanges required their listed companies to comply with additional corporate governance obligations, such as the requirement for a majority of independent directors on the board, existence or creation of audit, nomination, and compensation committees, and board sessions without insiders (Wintoki 2007; Zhang 2007). These regulatory changes form the basis of our identification strategy.

Specifically, we use the enactment of the Sarbanes-Oxley Act and the subsequent changes in the NYSE/NASDAQ listing rules as an exogenous determinant of our endogenous variable: board independence. One of the key requirements of SOX was that a majority of directors on a firm's board should be outsiders, or independent directors who have "no material relationship" (either directly or as a partner, shareholder, or officer of an organization that has a relationship with the company) with the listed company (Banerjee et al.

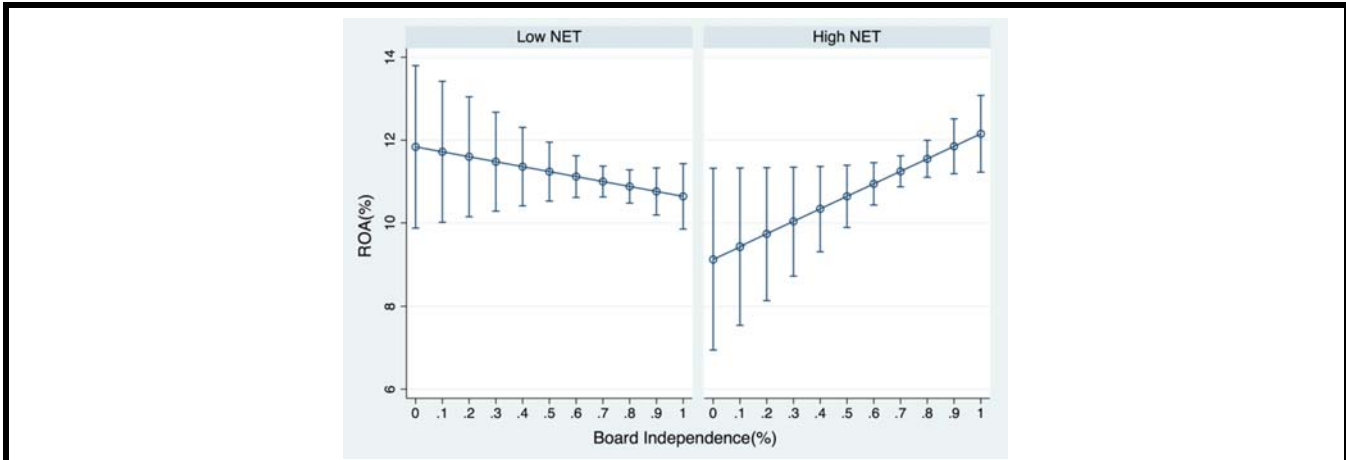


Figure 1. Predicted ROA as a Function of Board Independence, Low and High NET

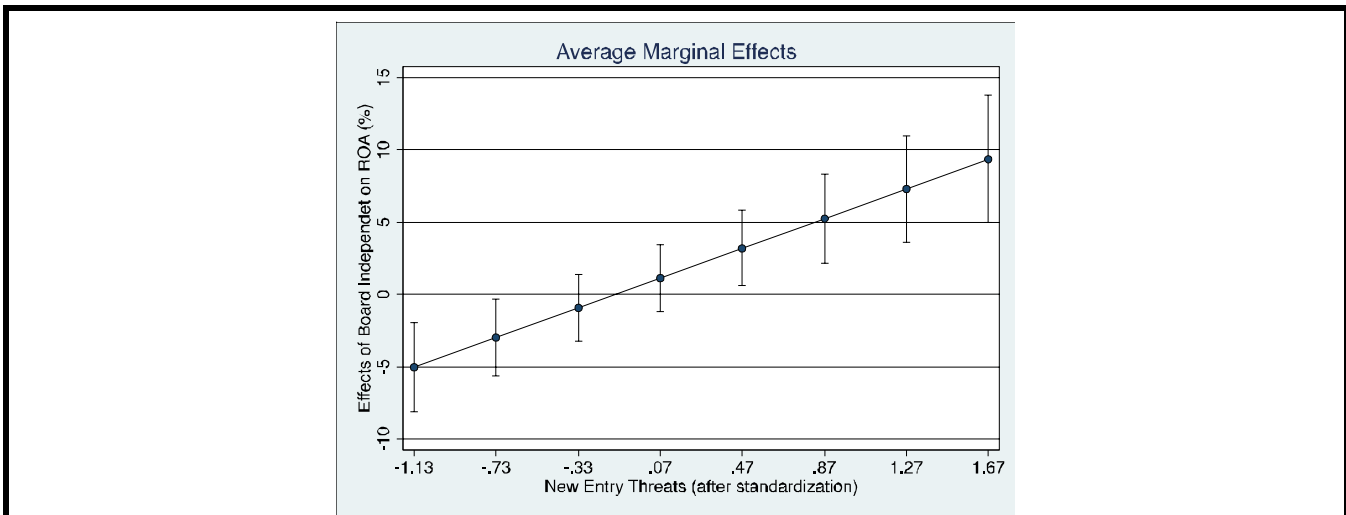


Figure 2. Average Marginal Effect of Board Independence on ROA, Conditional on NET

2015; Chhaochharia et al. 2016). The enactment of SOX was thus associated with a significant, exogenously mandated increase in the number of independent directors for noncompliant firms (i.e., firms with fewer than 50% independent directors prior to SOX), but did not significantly affect the board independence of compliant firms (i.e., firms with greater than 50% independent directors prior to SOX). In addition, there is no reason to believe this exogenous event influences firm performance through any channel other than changing firms' board independence, making it an ideal instrument (Angrist and Pischke 2008, p. 117). Therefore, we use the enactment of SOX to construct an instrument for board independence. Conceptually, our identification strategy is similar to that used in Cohen-Zada and Sander (2011), who examine the effect of religious participation on happiness, and

use the state-level repeal of “blue laws” that prohibit retail activity on Sundays as an exogenous event, to construct an instrument for the endogenous church attendance variable. Figure 3 demonstrates the trends of average board independence for compliant firms and noncompliant firms for the years before and after SOX. Compared to the compliant firms, there is a substantial increase in average board independence for noncompliant firms around the year of SOX enactment in 2002. Thus, model-free evidence shows that the enactment of SOX is indeed associated with significant exogenous shocks to board independence, particularly in non-compliant firms.

To construct the instrument, we assign firms in our sample to one of two groups based on their board composition in the

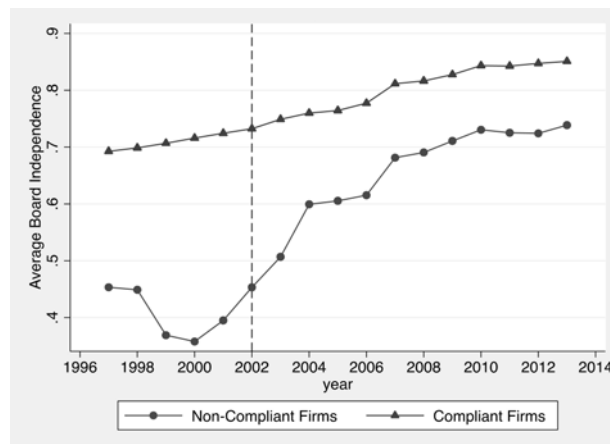


Figure 3. Average Board Independence Over Years

year prior to SOX. The first group (compliant group) consists of firms that had already met the regulatory requirements in the year prior to SOX, that is, they had a majority (more than 50%) of board directors that were independent directors in the year prior to SOX. The second group (noncompliant group) includes the “treated” firms that had not met the requirements with regard to board independence in the year prior to SOX. We create a dummy variable indicating whether a firm belongs to a treated or a control group. We also construct a *post-SOX* timing indicator that equals one if the observation occurs in 2002 or later. As SOX was enacted in mid-2002, we also use an alternative cutoff to construct the timing indicator that equals one if the observation occurs in year 2003 or later as a robustness check (Chhaochharia et al. 2016). The instrumental variable for *Board Independence* is thus defined as the interaction of the *noncompliant group* \times *post-SOX* dummy (Banerjee et al. 2015). For models with interaction $NET \times Board\ Independence$, we further interact this instrument with NET to address the potential endogeneity of $NET \times Board\ Independence$ in the full model.

The results from 2SLS regressions are reported in Table 5 and Table 6. Table 5 presents the results with instrumental variables using 2002 as the cutoff for the *post-SOX* indicator. The first-stage regression results of the IV on *Board Independence* in a model without the interaction term are shown in Column (1). The estimated coefficient of the instrument, *noncompliant firms* \times *post-SOX* (Z_1), is positive and significant at the 1% level, consistent with the expectation that noncompliant firms were indeed adding independent board directors after the enactment of SOX. The first-stage regressions of the IVs on *Board Independence* and $NET \times Board\ Independence$ in the model with the interaction term are reported in Column (3) and Column (4), which show that the coefficients of the

instrument, *noncompliant firms* \times *post-SOX* (Z_1), are broadly consistent with the first stage analysis without the interaction term in Column (1). For all IV regressions, we report the F-statistics for the test of weak instrument (Stock and Yogo 2005). For the main effects model (Column 2), the value of the first stage F-statistic (187.30) is larger than the conventional rule-of-thumb value of 10, as suggested by Staiger and Stock (1997), showing that the instrument is not weak. The F-statistic is also higher than the Stock–Yogo critical value of 16.38 at the 10% maximal IV size (Stock and Yogo 2005). Column (2) and Column (5) show the second stage of the 2SLS regression accounting for the endogeneity of *Board Independence* without and with the interaction term of $NET \times Board\ Independence$, respectively. The second stage results from Column (2) show that board independence is not significantly associated with firm performance even after we correct for its endogeneity. The second stage results in Column (5) are qualitatively similar and in the same direction as in our baseline estimates but render larger coefficient sizes; the larger estimates may reflect the effect of the instruments, which provide conditional marginal effects rather than unconditional marginal effects. The higher estimates could also result from a local average treatment effect. Since it is hard to exactly identify why coefficient estimates are higher, we recommend caution in using point estimates from the analysis for predictions outside the sample. That said, the direction of the effects is estimated reliably, allowing us to conclude that even after accounting for endogeneity, the support for Hypothesis 1 remains robust. Furthermore, we repeat the IV analyses by treating 2003 as the cutoff for the time-period indicator and present the results in Table 6. We observe that the results are highly consistent with Table 5.

While the enactment of SOX is a reasonable instrument in the current context, it is arguable that the law led to regulatory

Table 5. 2SLS Regression with Instruments from Sarbanes-Oxley Act

Dependent Variable	SOX Implementation Year = 2002				
	1 st stage with- out interaction	2 nd stage with- out interaction	1 st stage with interaction	1 st stage with interaction	2 nd stage with interaction
	Board Independence	ROA	Board Independence	NET × Board Independence	ROA
	(1)	(2)	(3)	(4)	(5)
<i>Noncompliant Firms After SOX (z1)</i>	0.137*** (0.014)	–	0.141*** (0.014)	0.049** (0.022)	–
<i>z1 × New Entry Threats (z2)</i>	–	–	-0.016 (0.010)	0.050* (0.027)	–
<i>Board Independence</i>	–	4.697 (5.467)	–	–	-22.642* (11.998)
<i>New Entry Threats</i>	0.001 (0.003)	-0.519** (0.260)	0.002 (0.003)	0.713*** (0.009)	-44.287** (17.802)
<i>New Entry Threats × Board Independence</i>	–	–	–	–	60.860** (24.626)
Board-Related Controls					
<i>CEO Duality</i>	0.019*** (0.005)	-0.731** (0.324)	0.019*** (0.005)	-0.010 (0.007)	0.400 (0.601)
<i>Board Size</i>	-0.000 (0.002)	0.075 (0.094)	-0.000 (0.002)	0.002 (0.002)	-0.032 (0.164)
<i>Board Tenure</i>	-0.011*** (0.001)	0.004 (0.093)	-0.011*** (0.001)	-0.000 (0.002)	-0.303* (0.175)
<i>Board Age</i>	0.007*** (0.001)	-0.037 (0.083)	0.007*** (0.001)	-0.002 (0.001)	0.280* (0.163)
<i>Interlocks</i>	0.001 (0.001)	-0.014 (0.035)	0.001 (0.001)	0.001 (0.001)	-0.057 (0.078)
Firm-Related Controls					
<i>Log (Assets)</i>	0.005 (0.005)	-1.533*** (0.375)	0.006 (0.005)	0.027*** (0.007)	-3.094*** (0.833)
<i>PPE/Assets</i>	-0.096*** (0.033)	3.048 (2.198)	-0.092*** (0.033)	0.021 (0.044)	-1.642 (3.803)
<i>Leverage</i>	-0.024 (0.021)	0.371 (1.594)	-0.024 (0.021)	-0.014 (0.027)	0.547 (2.194)
<i>Capx/Assets</i>	-0.223*** (0.077)	-2.165 (5.135)	-0.219*** (0.077)	-0.040 (0.101)	-6.613 (7.972)
<i>R&D Intensity</i>	-0.000 (0.001)	-0.054 (0.038)	-0.000 (0.001)	0.002*** (0.001)	-0.177** (0.073)
<i>Tobin's Q</i>	-0.001 (0.002)	0.976*** (0.144)	-0.001 (0.002)	-0.003 (0.002)	1.089*** (0.212)
<i>TNIC HHI</i>	-0.017 (0.015)	-2.113*** (0.806)	-0.017 (0.015)	0.027 (0.018)	-4.213*** (1.566)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
First stage F-statistic	–	187.30	–	–	14.94
Stock–Yogo critical value, 10% max IV size	–	16.38	–	–	7.03
No. of Firms	337	337	337	337	337
Observations	3,349	3,349	3,349	3,349	3,349

Notes: This table reports estimates for firm operating performance, ROA operationalized as OIBDA/Total Asset as dependent variable. The instrumental variable is constructed with SOX timing cutoff of year 2002. All independent variables are lagged one year.

Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

New entry threats are standardized with mean of zero and standard deviation of one. The sample is reduced because we only include firms that have data in 2001 (the year before SOX) for constructing the IV.

Table 6. 2SLS Regression with Instruments from SOX, Alternative Cutoff Year

Dependent Variable	SOX Implementation Year = 2003				
	1 st stage without interaction	2 nd stage without interaction	1 st stage with interaction	1 st stage with interaction	2 nd stage with interaction
	Board Independence	ROA	Board Independence	NET × Board Independence	ROA
	(1)	(2)	(3)	(4)	(5)
<i>Non-compliant Firms After SOX (z1)</i>	0.125*** (0.013)	–	0.127*** (0.013)	0.058*** (0.021)	–
<i>z1 × New Entry Threats (z2)</i>	–	–	-0.005 (0.010)	0.069** (0.028)	–
<i>Board Independence</i>	–	3.738 (5.420)	–	–	-20.822** (9.775)
<i>New Entry Threats</i>	0.001 (0.003)	-0.567** (0.253)	0.001 (0.003)	0.717*** (0.009)	-31.034*** (10.140)
<i>New Entry Threats × Board Independence</i>	–	–	–	–	42.153*** (13.946)
Board-Related Controls	Yes	Yes	Yes	Yes	Yes
Firm-Related Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
First stage F-stat.	–	155.48	–	–	19.33
Stock–Yogo critical value, 10% max. IV size	–	16.38	–	–	7.03
No. of Firms	356	356	356	356	356
Observations	3,522	3,522	3,522	3,522	3,522

Notes: This table reports estimates for firm operating performance, ROA operationalized as OIBDA / Total Asset as dependent variable. All independent variables are lagged one year. The instrument variable is constructed with SOX timing cutoff of year 2003.

Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

New entry threats are standardized with mean of zero and standard deviation of one.

changes other than the formation of the board, and therefore the estimated effects on performance may be confounded with other mandated changes within incumbent firms. However, we highlight that our identification strategy is not only based on the timing of SOX, but also on the division of the sample into compliant and non-compliant groups, and therefore takes advantage of the difference-in-difference approach. Nevertheless, we also consider alternative instruments that have been used in prior research. One such instrument pertains to the local supply of directors for the incumbent firm (Knyazeva et al. 2013), under the argument that a higher supply of local directors may increase the likelihood of independent directors being appointed by the focal incumbent firm. In Appendix B, we present the results of 2SLS regressions with this alternative instrument for board independence,⁴ which

show that our findings are robust to the use of this IV. Taken together, they provide strong support for the finding that new entry threats moderate the relationship between board independence and firm operating performance.

Analyses with the Sample Including IT Service Firms

While the main analyses reported above focus on the IT hardware and software sector, it is of particular interest to evaluate if the findings are generalizable to a more inclusive set of IT sectors. Specifically, we expand the sample to include IT services firms that are identified by the following four-digit NAICS industries: data processing, hosting, and related services; computer systems design and related services; and management, scientific, and technical consulting services (Hecker 2005). We replicate the analysis after adding these

⁴We thank the senior editor and an anonymous reviewer for raising these points and the suggestion to consider alternative instrumental variables.

Table 7. Sample Including IT Services Industries

Dependent Variable: ROA	Fixed Effect Model		Fixed Effect with IV (second stage)	
	(1)	(2)	(3)	(4)
<i>Board Independence</i>	0.366 (1.099)	0.187 (1.092)	2.632 (5.191)	-14.710* (8.499)
<i>New Entry Threats</i>	-0.453** (0.231)	-3.640*** (0.806)	-0.479** (0.233)	-29.876*** (11.244)
<i>New Entry Threats × Board Independence</i>	–	4.487*** (1.041)	–	41.454*** (15.741)
Board-Related Controls	Yes	Yes	Yes	Yes
Firm-Related Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
First stage F-stat.	–	–	161.22	16.01
Stock–Yogo critical value, 10% max. IV size	–	–	16.38	7.03
No. of Firms	667	667	398	398
Observations	4,751	4,751	3,957	3,957
R-squared	0.661	0.664	–	–

Notes: This table reports the estimates for firm operating performance as dependent variables. All independent variables are lagged one year. Sample is constructed based on U.S. S&P 1500 firms in the full IT Industries (hardware, software, telecom, IT-based services) from 1997 to 2013. IV was constructed based on the cutoff timing of SOX in 2003.

Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

New entry threats are standardized with mean of zero and standard deviation of one. We define IT services industries by 3 four-digit NAICS codes: 5182, 5415, and 5416.

firms to the dataset from above, referring to this as the IT “full sample,” which now includes 667 firms with 4,751 observations. Table 7 shows the results using the IT full sample (which includes IT service firms), with ROA as the dependent variable. Consistent with the results from the baseline analysis, the direct effect of *Board Independence* on performance is positive but not significant. We also find consistent support for the hypothesized moderating effect of *NET*. The coefficient of the interaction term *NET × Board Independence* is positive and significant at the 1% level, showing consistency with the results reported earlier.

Comparison with Level II and III High Tech Industries

In this section, we further examine the generalizability of our findings by extending the analyses to other non-IT high-tech industries. Analyses across industries are useful since they allow us to probe the robustness of our findings in a more generalizable setting, as well as provide opportunities for falsifiability tests and comparisons between industries. To define alternative but relevant industry segments, we use the set of four-digit NAICS codes identified by the Bureau of Labor Statistics (Hecker 2005). In particular, Hecker (2005)

defined 46 four-digit NAICS high-tech industries by their intensity of employment of technology-oriented workers, several of which are in non-IT industries. Within these industries, three levels of technology intensity were defined, from the most technology intensive to the least technology intensive. In order to evaluate the generalizability of our results, we first repeat our analysis on a sample that includes only Level I high-tech industries (including industries such as pharmaceutical and medicine manufacturing, aerospace product and parts manufacturing, etc.) together with all IT industries. We choose these industries because firms within these sectors tend to face significant threats of new entry and fast-changing dynamics. Consider, for instance, the mean NET across the firms in Level I high tech is 0.630, which is very similar to the average NET for the baseline IT sample used above of 0.629. Combining these samples provides an effective dataset of 798 firms with 5,736 observations. The results from the analyses are shown in Table 8, which display the same pattern as in the main analyses reported earlier, indicating that our findings may be generalizable to other industries that experience volatility and relatively higher levels of NET, such as the pharmaceutical industry.

We next run the same analyses using a sample that includes only the Level II and Level III high-tech industries as defined

Table 8. Board Independence, NET, and Firm Performance in IT and Level I High Tech Sample

Dependent Variable: ROA	Fixed Effect Model		Fixed Effect with IV (second stage)	
	(1)	(2)	(3)	(4)
<i>Board Independence</i>	-0.735 (1.097)	-0.930 (1.094)	0.138 (4.637)	-9.175 (6.766)
<i>New Entry Threats</i>	-0.626*** (0.224)	-3.323*** (0.741)	-0.650*** (0.226)	-28.831** (12.096)
<i>New Entry Threats × Board Independence</i>	–	3.815*** (0.971)	–	39.940** (17.036)
Board-Related Controls	Yes	Yes	Yes	Yes
Firm-Related Controls	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes
First stage F-stat.	–	–	203.69	15.55
Stock–Yogo critical value, 10% max. IV size	–	–	16.38	7.03
No. of Firms	798	798	473	473
Observations	5,736	5,736	4,769	4,769
R-squared	0.682	0.683	–	–

Notes: This table reports estimates for firm operating performance as dependent variable. All independent variables are lagged one year. Sample is constructed based on U.S. S&P 1500 firms in the IT and High-Tech Level I industries⁵ from 1997 to 2013. IV was constructed based on the cutoff timing of SOX in 2003.

Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

New entry threats are standardized with mean of zero and standard deviation of one.

Table 9. Board Independence, NET and Firm Performance in Level II & III High Tech Sample

	ROA (%) Operationalized as OIBDA / Total Asset		ROA (%) Operationalized as Net Income / Total Asset		ROE (%) Net Income/ Common Shareholders' Equity	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Board Independence</i>	-2.089 (1.451)	-2.021 (1.443)	0.735 (1.340)	0.684 (1.345)	4.894 (5.507)	4.469 (5.534)
<i>New Entry Threats</i>	-0.672* (0.399)	-1.525 (0.980)	-1.082** (0.455)	-0.392 (1.279)	-3.090 (1.930)	1.527 (3.980)
<i>New Entry Threats × Board Independence</i>	–	1.036 (1.060)	–	-0.840 (1.536)	–	-5.596 (4.906)
Board-Related Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Related Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of Firms	177	177	176	176	174	174
Observations	1,403	1,403	1,408	1,408	1,408	1,408
R-squared	0.544	0.545	0.532	0.533	0.383	0.383

Notes: This table reports estimates for firm operating performance as dependent variable. All independent variables are lagged one year. Sample is constructed based on U.S. S&P 1500 firms in the Level II & III Non-IT High-Tech industries⁶ from 1997 to 2013.

Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

New entry threats are standardized with mean of zero and standard deviation of one.

⁵Here, the sample is restricted to Hecker (2005) Level I high-tech industries (including industries such as pharmaceutical and medicine manufacturing, aerospace product, and parts manufacturing, etc.) and all IT industries.

⁶The sample includes all Level II and Level III Non-IT industries (Hecker 2005), such as basic chemical manufacturing, oil and gas extraction, pesticide, fertilizer, and other agricultural chemical manufacturing, etc. Specifically, the four-digit NAICS codes are 2111, 3241, 3251, 3252, 3253, 3255, 3259, 3369, 4234, 4862, 5232, and 5612.

in Hecker. These firms are associated with 12 four-digit NAICS code industries, and typical firms in this group belong to sectors such as basic chemical manufacturing, oil and gas extraction, pesticide, fertilizer, agricultural chemical manufacturing, and so on. We report the results with Level II and Level III high-tech industries in Table 9. Interestingly, the moderating effects of *NET* on the relationship between *board independence* and firm performance are no longer significant (in columns 2, 4, and 6 of Table 9). There are several potential explanations. First, the absence of the moderating effect of *NET* might be a result of the low and relatively homogeneous levels of *NET* in these industries; the mean of *NET* in Level II and Level III high-tech is 0.25, compared to 0.629 in IT industries and 0.630 in Level I high-tech. Therefore, the contribution of independent boards of directors under stable environments may not be as significant in terms of firm performance as they would be in more turbulent environments, even though they are required to be present from a regulatory perspective. It is also arguable that firms in these industries are relatively less sensitive to *NET* due to higher entry barriers: the presence of potential new entrants does not change market structure in a significant way, thereby reducing the value of strategic advice and counsel that independent board members may provide. While the true mechanism cannot be identified clearly here, our results do highlight the notion that *NET* has different implications for corporate governance in relatively stable industries versus industries that are highly dynamic and experience rapid change, such as the IT and Level I high-tech industries.

Discussion and Conclusion

In this study we examine how threats emerging from entrepreneurial ventures moderate the much-debated relationship between the independence of incumbent firms' boards of directors and their operational performances in the IT sector. Using data on a panel of 583 firms in the IT hardware, software and telecom industries over the period of 1997–2013, we find that board independence has a positive but nonsignificant association with operating performance, consistent with prior literature (Bhagat and Black 2001). More importantly, we show that under high *NET*, IT firms with boards including a large proportion of independent directors, who arguably contribute to explorative organizational learning and more effective monitoring, outperform firms with boards that retain a larger proportion of insiders, a finding that is consistent with prior work suggesting that corporate governance need not be treated as a one-size-fits-all solution but is contingent on the environmental context. The results are robust to alternative regression specifications, as well as the endogeneity of board independence, addressed through multiple IV strategies based

on the enactment of the Sarbanes–Oxley Act as well as local supply of directors. Further, we show that our results appear generalizable to some other industry contexts, such as IT services and the Level I high-tech sectors, where new entry threats and board independence remain relevant.

Our work makes several important contributions to research and managerial practice. First, we contribute to the literature on corporate governance (e.g., Coles et al. 2008; Hillman and Dalziel 2003) by examining how contextual factors, such as the level of new entry threats, moderate the relationship between board characteristics and firm performance. Prior literature has provided equivocal guidance on whether there is a definitive relationship between board independence and improvement in firm performance (Bhagat and Black 2001; Coles et al. 2008), often leading to divergent policy advice. By showing how the nature of this relationship varies in response to the degree of *NET*, we illustrate the role of a critical boundary condition and provide a possible explanation for the ambiguous findings in prior literature. Board independence may not matter—or even be undesirable—if industry structure is stable and experiences limited turbulence; in such contexts, the knowledge resources and monitoring that external board members provide may not be as important as those involving routinization and efficiency that are better provided by insiders. It is in turbulent environments that independent board members provide value that cannot be substituted by insiders. This effect is especially salient in IT and Level I high-tech industries where a significant part of the fast-moving dynamic and turbulence is fed by the high rate of new entry in the form of entrepreneurial ventures.

Second, we add to extant IS literature on competitive dynamics in the IT industry by drawing attention to an important but understudied construct that has tremendous implications in the IT sector: new entry threats. Since the IT sector is particularly associated with hyper-competition, fast clock-speed, and rapid technological changes (McAfee and Brynjolfsson 2008), being able to identify and measure new entry threats from the startup ecosystems has become increasingly vital. New entry threat, as a conceptual entity, has existed in the literature since the early days of strategy and industrial organization (Porter 2008). However, because the threat from the individual entrepreneurial startups is difficult to observe, and no existing measure of the threats at aggregated levels has been developed, there is little empirical work that investigates how new entry threats change the competitive dynamics. For example, prior work has focused mostly on competition and turbulence arising from peer incumbents or from actual observed entry of competitors, rather than the threat of new entry from the entrepreneurial ecosystem (Hoberg et al. 2014). In this paper, we contribute beyond just the validation of this measure to also showing how it helps capture nuances

and shed light on existing academic debates about important constructs and relationships such as those involving corporate governance. Indirectly, we believe our work here also helps showcase the value of this new measure of NET, with a special focus on the value of adopting machine learning/text-mining techniques in studying questions of relevance to governance and firm strategy. For IS strategy researchers, our study highlights the need to study boards and other corporate governance mechanisms as a source of strategic value within the fast-moving IT industry. Fast clock-speed and hyper-competition are the norm in technology markets, and as markets impose stress and uncertainty on incumbents, it is up to the governance regime within the firm to help create effective responses to these imperatives. Governance can strengthen or weaken a firm's ability and effectiveness in its response to turbulent environments such as one that is constantly under the pressure of new entry threats. Boards represent one of such governance mechanisms, and inasmuch as the IT industry continues to be characterized by turbulence and hyper-competition, further work is needed within the IS community to fully explicate the role of governance.

A potential limitation of this work is that by focusing on new entry threats emerging from very early-stage entrepreneurs receiving first-stage funding, we do not fully capture the more imminent threats from mature entrepreneurial firms that are either in later stages of funding or close to offering an IPO. However, we want to stress that these firms, often with mature products and established business models, resemble more closely the observed entry instead of threats of entry, with the latter associated with greater uncertainty and variation. Because observed entries are relatively easy for the incumbent firms to identify, it is our intention to use a measure of NET that only includes threats that emerge from entrepreneurial firms at their early stages of development when they are still experimenting with product prototypes and the viability of their business models are far from proven.

Our work here also points the way for future research in this area. First, we recognize that governance is a multifaceted construct and we only capture one aspect of it through our focus on the board. There are other forms in which firms govern their constituents, such as through design of compensation mechanisms, board interlocks, the presence of checks and balances on executives (as measured by the G-index, for instance; Gompers et al. 2003), and so on. We see limited research on these constructs within the IS literature, arguably where much more work is needed. Second, we characterize board members broadly as independent or not, but this characterization masks considerable heterogeneity in the skills, experience, and social capital they bring to the table. Unfortunately, this level of granularity of data is difficult to gather for large samples, but nevertheless represents an interesting

extension of our work. Finally, new entry threats emerging from entrepreneurs represent one source of turbulence for incumbents; other sources include threats from foreign technology firms, threats from the open source market (e.g., in the new Big Data ecosystem where most products are open source; Madden 2012), and threats from rapid technological change per se. We believe there is considerable opportunity for future work that enhances our understanding of how these forces affect the viability, and the performance, of incumbents in the IT industry. We also show how recent advances in machine learning and text mining can be used to address these questions of economic interest, thus responding to recent calls for incorporating machine learning in business research (Athey 2015).

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