USING WEB IMAGES AS A MEASURE FOR NEW VENTURE TECHNOLOGY STRATEGY

A DISSERTATION SUBMITTED TO THE GRADUATE
DIVISION OF THE UNIVERISTY OF HAWAI‘I AT MĀNOA IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF

DOCTOR OF PHILOSOPHY

IN

BUSINESS ADMINISTRATION

MAY 2016

By

Todd M. Inouye

Dissertation Committee:

Kiyohiko Ito, Chairperson
John Butler
Tung Bui
Elizabeth Davidson
Ronald Heck

Keywords: context, knowledge, new ventures, technology strategy,
image ratio

ACKNOWLEDGMENTS

Looking back at the journey I have taken these past four years, I am simply amazed at the transformation. None of this would have been possible without the help and support of so many people. I would like to acknowledge them now.

Professor Kiyohiko Ito, thank you for agreeing to be my committee chairperson and for all the guidance you have provided along the way. I hope that I have and will continue to meet your high standards of excellence in academia. Thank you also to the rest of my committee for providing your varied expertise. I knew that I was able to count on your support through this process and I truly value your help in writing this dissertation. To Professor Amol Joshi and family, I am so fortunate to have had the chance to work with all of you. I hope that I will be able to repay all of the generosity you have shown me throughout the years. I am so honored to have had the opportunity to work with such distinguished scholars. These are experiences that I will always carry with me.

Thank you to all of my fellow PhD students. Our many conversations have enlightened me in so many ways. Without your help, I would not have been able to efficiently plan my course of study. I will always remember the support you all have provided and in that spirit, I will continue to give back to future students as much as I can. I also would like to thank both Kathryn Anbe and Raegene Nakamura. As administrators you always looked out for me and I want you to know that I sincerely appreciate everything you did to make the process easier.

Lastly, thank you to my family for all of your support and patience. Without your help, I would not have been able to push through those late nights and meet those many deadlines. To my lovely wife Jennifer, you are everything to me. You have always supported me and I will always cherish your dedication to our family. Our family is my inspiration and I hope to repay you with a lifetime of love and happiness.

ABSTRACT

The knowledge-based literature highlights the importance of external knowledge sources in the recognition and exploitation of technology-based opportunities by new ventures. However, previous literature has had difficulty describing how external knowledge is integrated and then deployed to gain competitive advantage. In addition, the primary insight into this phenomenon is managerial perception which, while valuable, has limitations due to the inherent cognitive biases associated with survey and interview methodology. Therefore, I introduce a novel content analysis variable called image ratio, which complements managerial perception data. Image ratio interprets website images to demonstrate how new venture technology strategy interacts with the context in which these ventures are embedded. I find that technology strategy alone is not a significant factor in new venture product introduction, but it does become significant when interacting with a related institutional context. I use logistic panel regression techniques to analyze 138 new robotics ventures between 2007–2012. I find that militarization as the institutional context of interest is negatively related to product introduction and that militarization also positively moderates the relationship between technology strategy and product introduction. These findings bridge the gap between micro strategy research and macro organization theory by empirically investigating the interaction between context and the strategy of embedded new technology ventures.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The quest for knowledge by new technology ventures is ongoing and while context is an afterthought for most studies (Zahra & Bogner, 2000), contextual knowledge (held by institutions) can be a significant source of competitive advantage. The resource-based literature regarding new technology ventures suggests that available resources determine the distribution of strategic options (Bogner & Thomas, 1996; Zahra & Bogner, 2000). At the same time, the knowledge-based literature highlights the importance of external knowledge sources in the exploration (West & Bogers, 2014) and exploitation (Foss, Lyngsie, & Zahra, 2013; Zahra & Nielsen, 2002) of technology-based opportunities. These findings imply that new technology ventures integrate accessible sources of internal and external knowledge when formulating and evaluating technology strategy. This integration is defined as the sum of a venture's choices for exploiting its technological resources (Zahra & Bogner, 2000). In essence, the literature states that managers of new ventures consider context; however, studies have been limited in describing exactly how new ventures deploy technology strategy and how it may be a source of competitive advantage.

The limiting factors in answering these "how" questions have been the availability of data and the inherent cognitive biases (of management) associated with current research methodology (Zahra & Bogner, 2000). Managerial perception of context is extremely valuable, as management often formulates and then drives firm strategy. Survey and interview techniques currently used to collect primary data are best suited for the task and have found interesting results.

Thornhill (2006) uses survey data and finds a strong influence of the competitive context on the relationship between innovation and firm performance amongst Canadian manufacturing firms. Larrañeta, Zahra, and Gonzalez (2012) conduct a series of interviews and find that management's understanding of their local context is critical to the capture and integration of knowledge resources across firms in Spain. Additional research is needed to better understand how managerial perception interacts with context. Additional methods also are needed to capture the importance of context from sources other than management.

I provide a complementary methodological option by developing a new variable (*image ratio*) as a measure for technology strategy. Each image on a website represents how the new venture visualizes the use of its technology in the market. Berinstein (1997) finds that images document and preserve facts that clarify related text. For example, an image of a soldier in fatigues holding a weapon likely would not appear on the website of a venture selling harvesters to farmers, whereas it might be found on a website selling robots for landmine removal. The images selected by the venture represent how it intends to exploit its technological resources (see Appendices A and B for examples). I introduce image ratio to capture this firm-level data on technology strategy. In doing so, I broaden the data repository for scholars and answer the call for insight into how ventures integrate contextual knowledge in the deployment of technology strategy (Zahra & Bogner, 2000).

Identifying a suitable measure is not enough, because a technology strategy is only as effective as the context in which it is deployed (Foss et al., 2013); therefore, it cannot be the lone precursor to competitive advantage. The context of interest in my study is country-level militarization, which is defined by the level of resources that are allocated to civilian and military sectors of a country. A highly militarized country (e.g., Israel, Russia) has a disproportionate allocation of military resources, while a less militarized country (e.g., Japan) may allocate more resources towards healthcare.

Continuing with the previous example, a venture with a military-focused technology strategy would likely perform better than a farm-focused venture in a highly militarized context and vice versa. Indeed, the results of my research show that militarization (as the institutional context of interest) has a negative direct relationship with the product introduction of new technology ventures. I also find that militarization has a positive moderating effect on the relationship between a military-focused technology strategy and product introduction. This means that new ventures that align themselves more closely with their context can improve prospects for product introduction and identify potential sources of competitive advantage.

By focusing on technology strategy and performance in a specific context (i.e., militarization), I contribute to contextual research on venture performance (Miller, 1988; Zahra, 1996b) and build upon the micro–macro link (Peng, 2002), as called for in the management literature. These findings support the notion that context matters and that it should be considered whenever there is reason to believe that sample ventures' contextual alignments might provide a competitive advantage.

The remainder of the manuscript consists of five sections. First, a broad range of literatures on new venture technology strategy and context are discussed. In the second section, I develop the hypotheses by incorporating both the knowledge-based view (KBV) to relate technology strategy to performance and institutional theory to describe the relationship between context, technology strategy, and product introduction. The third section reviews my research methodology, sample data, and introduces the variables included in my statistical models. The fourth section reviews the results of the analysis and whether those results support the developed hypotheses. The final section discusses the theoretical, policy, and practical contributions of my study as well as the limitations of my research design and areas for future research.

LITERATURE REVIEW

Perspectives on New Venture Technology Strategy

New venture technology strategy has been a veritable "black box" with sole insight originating from the management or founding team. This literature review discusses the KBV-related research on technology strategy (see Appendix C), the extant literature regarding contextual perspectives on knowledge, and the potential for complementarity between the two. By encouraging a multi-disciplinary approach, the literature suggests that a more balanced perspective (between management and context) could shed light on the influences of context on new venture technology strategy.

Current methodological limitations. While insights from management and founders are of great value to strategy scholars, it has been acknowledged that there are significant limitations (e.g., cognitive biases, managerial hubris, law of small numbers) to survey and interview-based data collection (Simon, Houghton, & Aquino, 2000; Zahra & Bogner, 2000). These collection methods dominate the entrepreneurship literature (Coviello & Jones, 2004), likely due to the lack of other viable data sources. Along with that, there is also the tendency to offer such detailed and specific slices of reality that generalization becomes difficult (Suddaby, Seidl, & Lê, 2013). This skews the theoretical perspective derived from these results to that of the managers' point of view. Several calls for additional research on contextual factors have been made in an attempt to balance this one-sided perspective on technology strategy (Foss et al., 2013; Zahra & Bogner, 2000; Zahra & Nielsen, 2002). This balance is critical, because a strategy can have no merit without context to derive its validity.

Knowledge-based perspectives. Technology strategy first appeared as a variable of interest in the 1980s and was tied to the variation in acquiring technology through R&D, alliances, or acquisition (Friar & Horwitch, 1985). Large multinational corporations like General Motors and IBM (e.g., Argyres, 1995) often served as case examples, because unlike new ventures, these organizations had the resources to develop and then exploit technology. Additionally, current vehicles to access capital for R&D, such as the Small Business Innovation Research (SBIR) program and Small Business Technology Transfer program, were still in their initial stages (Audretsch, 2003). Since then, the introduction of the KBV has allowed researchers to develop a more appropriate perspective on new venture strategy, because knowledge is often the most abundant resource (Chrisman, 1999).

KBV has seen widespread use in both the strategic management (Eisenhardt & Santos, 2002) and entrepreneurship literatures (Zahra, 1996b; Zahra & Bogner, 2000). This is likely due to the value attributed to knowledge by both managers (Thornhill, 2006) and scholars alike (Kogut & Zander, 1996). For new technology ventures, knowledge is unequivocally the most valuable resource. Knowledge stocks are acquired by individuals via experience (Grant, 1996); therefore, new ventures are typically knowledge heavy and (tangible) resource poor (Brush, Greene, & Hart, 2001). Thus, scholars have naturally turned to KBV to provide the theoretical foundation for new venture technology strategy.

Technology strategy is defined as the sum of a venture's choices on how to exploit its technological resources (Zahra & Bogner, 2000). These choices could include the level of product radicality, intensity of product upgrades, use of external technologies, and so on. Each strategy moderates management's perceptions of the external environment (Zahra & Bogner, 2000); therefore, each deals with varying levels of contextual knowledge integration. Technology strategy is found to positively relate to venture performance (i.e., return on equity and growth of market share), but Zahra and Bogner (2000) note that those ventures that align technology strategy with their external environment are better positioned to gain a competitive advantage.

Another study on small- or medium-sized Canadian manufacturers finds that technology strategy varies according to industry characteristics. Managers reported that innovative technologies had the greatest effect on revenue growth for ventures in high-technology industries with high knowledge assets. Yet, in low-technology industries, innovative technologies have the greatest effect on revenue growth when combined with investments in workforce training (Thornhill, 2006). This study implies that contextual knowledge of the industry could be taken into account when management considers hiring technical staff (knowledge assets) or develops budgets for employee training.

Later, Kraaijenbrink and Wijnhoven (2008) introduce a prescriptive theory of external knowledge integration to explain how ventures should deal with knowledge outside organizational boundaries. They build upon the findings of Grant (1996), because up to that point, KBV explains only how ventures deploy internal knowledge. They propose strategies for managers to balance the exploration and exploitation of heterogeneous external (contextual) knowledge but fail to provide any recommendation. They also do not include examples of how (technology) strategy can be adjusted given varying types of contextual knowledge. They posit that the integration of knowledge is important and that the development of superior integration capabilities can be a source of competitive advantage, similar to the findings of Zahra and Bogner (2000).

Commonalities of the knowledge-based view. These aforementioned studies have common threads. The first is that the empirical studies (i.e., Thornhill, 2006; Zahra & Bogner, 2000) are based on survey or interview data.

New venture strategy research uses these data sources for good reason. The development and deployment of strategy are led by the management or founding team, and it is frequently these parties who are surveyed. Other research examples share this common thread. For example, Larrañeta, Zahra, and González (2012) find that new ventures in Spain improve their strategic repertoires by exposure to contextual knowledge. Zhang and Li (2010) find that new ventures in China improve product innovation when accessing the networks of service intermediaries like law or accounting firms. These studies all contribute to KBV by demonstrating that externally sourced knowledge is valuable to new venture management in strategic decision-making (for more, see Appendix D). Yet, all of these studies suffer from the same limitations associated with survey and interview research, namely management hubris (Zahra & Bogner, 2000) and cognitive biases like optimism (Hmieleski & Baron, 2009) or the law of small numbers (March, Sproull, & Tamuz, 1991; Simon et al., 2000). So while these results are valuable, they may also be limited in the perspective they take on new venture strategy. Therefore, the theoretical foundations built upon these findings are also limited and may continue to be until new sources of data can support the claims made thus far.

Another common thread is that a strategy is only as valuable as the context in which it is deployed. These studies include a contextual element to ground the results. Thornhill (2006) finds that management considers the industry context when hiring technical personnel or investing in training. Even in a purely theoretical study, Kraaijenbrink and Wijnhoven (2008) acknowledge that external knowledge integration can be a source of competitive advantage. Zahra and Bogner (2000) use dynamism, non-price hostility, and heterogeneity as factors of the competitive environment in their study. They find that the effect of technology strategy on new venture performance is moderated by management's perception of these factors. They further state that alignment between technology strategy and the external environment allows new ventures to achieve superior performance (i.e., competitive advantage).

Overall, the KBV literature has demonstrated the importance of context and contextual alignment from a managerial or founder perspective. However, the methodological limitations associated with the body of literature thus far indicates that this perspective might be based on incomplete information. If context is important, then a contextual perspective is needed to balance and validate the perceptions of management.

The Contextual Knowledge Perspective

New venture strategy (e.g., product upgrades, hiring) and individual characteristics (e.g., psychological profile) are the main drivers for new venture performance (Sandberg & Hofer, 1988; Zahra, 1996b). Researchers have often used the industrial economics (Porter, 1980, 1981) or resource-based views (Barney, 1991; Penrose, 1959; Wernerfelt, 1984) to identify some of these drivers. However, as previously discussed, context and contextual alignment are also key drivers that have been identified from the KBV literature, which is considered an offshoot of the resource-based literature. A concern for the KBV is that the value of context is attributed purely from a managerial or founder perspective. So the question remains, is context or contextual knowledge valuable for other perspectives?

Contextual value has been established in other management literatures like entrepreneurial innovation (Autio, Kenney, Mustar, Siegel, & Wright, 2014b), the national systems of innovation (Freeman, 1987; Lundvall, 1988), institutional theory (Peng, 2002), and international new ventures (Fernhaber, Gilbert, & McDougall, 2008). These literatures provide a more top-down (context-manager) perspective of value versus the bottom-up (manager-context) perspective of KBV. The balancing of perspectives is necessary, but a top-down perspective also has limitations. Context is inherently complex, which motivates these studies to describe the whole phenomenon with less specificity as might be expected from the KBV (Suddaby et al., 2013). Moreover, much of this research is conducted via surveys or interviews, which carry the same limitations as new venture research.

Entrepreneurial innovation. In the entrepreneurial innovation literature, Autio et al. (2014a) emphasizes the importance of context and goes further to categorize the innovation research space according to context. Their survey of the literature demonstrates that entrepreneurial ventures do not simply compete against other ventures, they also in some cases compete for government funding. These ventures also have to navigate informal institutions like culture which determine legitimacy, which then impacts sales, and ventures are further impacted by respective industry effects. The entrepreneurial innovation space has so many organizations that studies thus far have been able to focus only on one to two different contextual components at a time. These identified components are briefly discussed.

The “industry/technology context” includes studies that consider patterns of behavior across industry lifecycles (Abernathy & Utterback, 1978; Acs & Audretsch, 1988) or that investigate how the attributes of the technology or technology platform shape the innovative activities of various stakeholders (Garud, Jain, & Tuertscher, 2008). The “organizational context” primarily captures the effects of culture or individual work experience and knowledge on entrepreneurial action (Nanda & Sørensen, 2010). For example, Nelson (2014) finds that the same individuals adopt different behaviors given different contexts, and thus misalignment between organizational context and expectations can occur.

“Institutional/policy contexts” influence economic outcomes and the legitimacy of new ventures. Examples include intellectual property regime (Autio & Acs, 2010), the rule of law (Djankov, La Porta, Lopez-de-Silanes, & Shleifer, 2002; Levie & Autio, 2011), and culture (Stephan & Uhlaner, 2010). The “social context” (e.g., the network of financiers, partners, incumbents) also influences venture behavior. Kenney and Patton (2005) find that contextual knowledge sources (support networks) influence the spatial distributions of high-technology industries differently. These aforementioned contexts evolve over time, which implies that “temporal context” matters. Garud, Gehman, and Giuliani (2014) propose that entrepreneurial innovation is an interdependent process involving organizations embedded in changing contexts. These contexts further change depending upon the performance of those organizations. The "spatial context" deals with the geographic locus of ventures (Welter, 2011). Drori, Honig, and Wright (2009) find that transnational entrepreneurs move from different geographical areas to those with different institutional mixes and that this affects their ability to innovate. It is difficult if not impossible to build a complete taxonomy for context. Autio et al. (2014b) adequately categorize the existing entrepreneurial innovation literature but have thus far been unable to provide a more generalized understanding at higher levels of aggregation.

National innovation systems. The national innovation systems (NIS) literature (e.g., Freeman, 1987; Lundvall, 1988) has been one of the most cited concepts in innovation-related studies with observations generally made at the country or nation-state level. NIS is defined as the network of institutions that create, modify, and diffuse new technologies (Freeman, 1995) or as the elements that interact in the production of knowledge and are located within a nation-state (Lundvall, 1992). A major influence of this research stream is that it has effectively convinced policy-makers that innovation is an interactive process rather than a linear one (Lundvall, 2007). This is because NIS recognizes that there are many organizations and that these entities interact and co-evolve over time. Both internal and contextual knowledge sources contribute to and interact within the innovation system.

The NIS literature describes contextual value as well as the complexity involved in contextual studies ex post. Yet, scholars have been unable to reach consensus with regards to the ex ante boundary conditions required for successful innovation to occur. The prescriptive ability of NIS is limited, because the literature has been primarily used to describe historical innovation systems (e.g., Freeman, 1987). Another related limitation is that individuals and new ventures are often included as part of a network with variation in strategy not specifically considered. This is because an NIS perspective does not expect that an element transplanted from one system to another to have a consistent effect (Lundvall, 2007). Fundamentally, the literature expects innovation outcomes to be unique to each system, even though new ventures in different countries have the same technology strategy. Although NIS takes an aggregated approach to contextual value and the entrepreneurial innovation literature does not, the complexity of what occurs is too great to generalize ex ante.

Institutional theory. The inclusion of institutions is a basic premise for NIS, and it has added both value and limitations to the systems perspective. Institutional theory argues that organizations reflect the "myths" or beliefs of their environment rather than just the demands of work activities (DiMaggio & Powell, 1991; Meyer & Rowan, 1977). Institutional environments are heterogeneous compositions of both formal institutions (e.g., level of militarization, rule of law), which influence economic outcomes and opportunity costs for firms, and informal institutions (e.g., culture, social norms), which influence perceptions of legitimacy and social acceptance (North, 1990). Both sub-types are important, because their tacit knowledge (Polanyi, 1962) is acquired by new ventures to reduce uncertainty in strategic decision-making. Therefore, ventures within different institutional settings develop different strategies to comply with or take advantage of the knowledge base of its particular society (Drori et al., 2009). Identification of specific institutional frameworks like national environments (Peng, 2002) help to provide insight as to why new ventures in different geographic areas acquire unique knowledge and behave differently with regards to new venture strategy.

Institutional theory is suitable for most contextual research, because it accounts for the dynamic interaction between institutions and organizations, along with new venture strategy, as the outcomes from that interaction (Peng, 2002). Despite these characteristics, the challenge for institutional theory is the same as that for NIS. The literature has had difficulty providing concrete links between the macro characteristics of institutions and how those relate to the micro and meso actions required of strategy research (an exception to this is Peng & Luo, 2000). Although Thornton, Ocasio, and Lounsbury (2012) attempt to develop a metatheory of institutional logics that views society as a multilevel interinstitutional system, the varying strengths and levels of institutions still require a more detailed explanation of the boundary conditions for differing institutional effects. This is a common limitation for macro-level studies. Thus, there have been several calls for research that bridges the micro-macro literature (Peng, 2002; Suddaby et al., 2013). After all, new ventures are always embedded in some context, even though institutions may or may not be present to guide them.

A Balanced Approach to Innovation Performance

International entrepreneurship. Switching from the more context-focused NIS and institutional theory perspectives to international entrepreneurship, which has a more balanced approach to context and new venture strategy, is a positive step towards establishing the micro-macro link. Some international entrepreneurship research has examined the exploration and exploitation of opportunities across national borders (Oviatt & McDougall, 2005). For new ventures to internationalize, they must have a competitive advantage to overcome the transaction costs associated with cross-border activity (Hymer, 1960) and the liability of newness or foreignness (Zaheer, 1995). Fernhaber et al. (2008) finds that externally sourced international knowledge serves as a competitive advantage for new ventures that internationalize. Moreover, new ventures with minimal internationalization experience benefit more from externally sourced knowledge than firms with extensive experience. This implies that new ventures looking to expand internationally can compensate for internal deficiencies with externally sourced knowledge (Fernhaber et al., 2008).

Fernhaber et al. (2008) did not explore the performance of internationalization nor did they examine the location decisions of the new ventures. This leaves several questions regarding the actual benefit of the strategy. Nevertheless, they lay the foundation for further studies on how new venture strategy can differ with regards to context, namely the desire to exploit cross-border opportunities. Building upon this would require further analysis on country-level differences to tease out the contextual effects on performance, but the international entrepreneurship literature has effectively linked the micro-macro perspectives. This linkage is also partly attributable to the cross-disciplinary nature of international business research, which expects a certain level of theoretical exchange and balance (Dunning, 1989).

Overall, the literature reviewed suggests that both new venture technology strategy and context are critical components in innovation performance. Additionally, the need for a balanced research perspective necessitates the use of cross-disciplinary methods. KBV has the potential to bridge the micro-macro chasm (e.g., Fernhaber et al., 2008) with a concrete focus on performance, and an institutional framework (Peng, 2002) supports the dynamic interplay between context and new venture technology strategy.

HYPOTHESIS DEVELOPMENT

High-technology firms are fast becoming a dominant driver of the global economy. According to the World Bank, high-technology exports increased from $987 billion in 1999 to $2.34 trillion in 2014. Charges for the use of intellectual property (IP) increased from $53 billion in 1999 to $327 billion in 2014. Patent applications have doubled since 2000 to more than 1.7 million in 2014[1]. Robotics is at the forefront of the high-technology sector (see Appendix E for a chart on robotics industry growth). Autonomous and semi-autonomous robotics is a relatively new field, but media coverage suggests the importance of this field today and in the near future. An example of this is the recent fatal crash involving

[1] http://data.worldbank.org/topic/science-and-technology

the Tesla Motors autopilot system with the headline, “Fatal Tesla crash shows limits of self-driving technology.”[2] Another example is how Toyota plans to make automatic braking technology standard across its entire fleet by 2017.

The previous examples are commercial endeavors, but the military also has been integral to the evolution of high technology. The internet, mass air transport, and nuclear power all have roots in military R&D. While autonomous and semi-autonomous vehicles remain in development commercially, the military currently uses autonomous air drones[3], submarines[4], and land rovers[5]. In many instances, military R&D has spilled over to the commercial sector, which is not surprising given the typical large R&D budget allocated for military use. It is in many ways, more efficient to borrow or copy technology rather than develop it from scratch. Building upon military technology spillovers saves commercial investors costs for R&D.

The requested federal budget for R&D put forth by President Obama for FY2013 equaled $140.82 billion, of which $71.2 billion or 50.6 percent was slated for the Department of Defense (DOD)[6]. Although the United States outspends other countries by a large margin, the military is a significant consumer of technology in any country, regardless of militarization (Malecki, 1984). The military is also a legitimate financial stakeholder in both developed (Kentor &

[2] http://phys.org/news/2016-07-fatal-telsa-limits-self-driving-technology.html
[3] http://www.militaryfactory.com/aircraft/unmanned-aerial-vehicle-uav.asp
[4] http://www.livescience.com/53678-darpa-designing-robot-battle-managers.html
[5] http://www.globalsecurity.org/military/systems/ground/ugv.htm
[6] https://www.fas.org/sgp/crs/misc/R42410.pdf

Kick, 2015) and emerging markets (Looney, 1986), because the military is often the organization with the largest R&D budget.

Therefore, the institutional context of interest is country-level militarization, which is defined by the continuum of resources (e.g., human, financial, knowledge capital) allocated across civilian and military sectors in a country[7]. In general, resources allocated to the military sector are externally focused, thereby supporting the overall defense of the country (Bowman, 2010). Resources allocated to the civilian sector include everything else (e.g., healthcare, education) and have an internal focus. Highly militarized countries have disproportionate resource flows going towards their departments of defense or national equivalents. This benefits the defense agencies and not the economy, as studies (e.g., Kentor & Kick, 2015) have shown that economic growth is stifled by adverse impacts on capital formation and resource allocation caused by increased military spending (Knight, Loayza, & Villanueva, 1996). If resources are directed inward nationally (e.g., to agriculture or transportation) the economy benefits. If resources are directed outward (e.g., to national defense, war), non-manufacturing industries (e.g. education) may suffer due to large investments in technology and decreases in labor force (Kentor & Kick, 2015).

The political science literature has also generally found a negative impact on economic growth with regards to higher militarization (e.g., Bowman, 2010; Cappelen, Gleditsch, & Bjerkholt, 1984; Ward & Davis, 1992). Mintz and Huang

[7] The definition of militarization is derived from a study on the detrimental impacts of the growth in military resources. Scanlan, S. J. & Jenkins, J. C. 2001. Military Power and Food Security: A Cross- National Analysis of Less- Developed Countries, 1970–1990. ***International Studies Quarterly***, 45(1): 159-187.

(1991) find that although no short-term trade-offs between arms and education expenditures are identified, there are significant long-term trade-offs that support the long-standing “guns versus butter” debate[8] (Apostolakis, 1992) in the literature. Over longer periods of time, extensive arms expenditures are related to decreases in education spending. Moreover, military spending was found to have a negative effect on investment (Cappelen et al., 1984). Therefore, higher defense spending results in less commercial investment, which leads to less available capital for R&D. This is a critical implication for new technology ventures that are “knowledge heavy,” resource poor, and require outside investment for product introduction (Brush et al., 2001; Kropp & Zolin, 2005; Miles, Preece, & Baetz, 1999). These studies indicate that the pool of resources is finite and that the allocation of capital is an expanding sum game where more resources are budgeted for defense than for other sectors (Apostolakis, 1992). Increased militarization appears to have an overall negative impact on the economy. This may manifest itself as a direct relationship with firm-level product introduction if R&D investment is also negatively impacted.

According to the institutional theory literature, formal institutions like militarization influence the opportunity costs within a society (North, 1990). For example, militarization as an institutional context adjusts the relative degree of the information asymmetries between stakeholders by influencing information flows and knowledge transfer. A recent survey of the literature reveals that defense-specific R&D offers lower returns due to secrecy and restrictions on the

[8] The “guns versus butter” debate refers to the economic trade-offs governments deal with when significant resources are allocated to the military.

dissemination of knowledge (Hartley, 2006). This is significant because increasing information asymmetries created from high levels of militarization weaken the legitimacy of the entrepreneur and technology. Potential financiers are less able to understand the nature of the new venture, and the entrepreneurs' conformity to established institutional rules remain in question (Aldrich & Fiol, 1994). The wider the information asymmetries between ventures and potential financial stakeholders, the more difficult it is to finance R&D and eventually introduce a product. Higher militarization results in increased secrecy, which increases the opportunity cost for commercial investments in radical new technology. Therefore, I expect

> H1 – Country-level militarization has a negative direct relationship with the product introduction of new technology ventures over time.

Zahra (1996b) finds that technology strategy (product pioneering, a focus on applied versus basic R&D, and the extensive use of internally sourced R&D) positively relates to performance (increase return on equity, market and sales growth, and net profit margin) for new biotechnology ventures. This study (Zahra, 1996b) uses both objective financial statistics as well as managerial satisfaction with those statistics to balance the perspective on venture performance (Tsai, MacMillan, & Low, 1991) and overcome the limitations associated with previously used subjective measures. In a similar study, Dowling and McGee (1994) use investments in R&D to measure technology strategy and find that telecommunications ventures also benefit in terms of performance when higher R&D investments are made. The overall indication is that managers who implement a formal technology strategy can expect to see positive results.

Technology strategy is the sum of a venture's choices on how to exploit its technological resources (Zahra & Bogner, 2000). As such, a technology strategy includes a choice of target markets in which to exploit those resources. Gruber, MacMillan, and Thompson (2008) find that entrepreneurs explore a set of market opportunities prior to choosing one on which to found their new venture. Given that militarization is the context of interest, I choose the military as the target market to test whether a military-focused technology strategy on its own (not accounting for context) is positively related to new venture performance (i.e., product introduction). This is likely because defense segments tend to outperform non-defense segments over time (Bowlin, 2000). Given support for positive relationships between technology strategy and performance, as well as defense segments and performance, I expect that

> H2 – A military-focused technology strategy by new technology ventures is positively related to product introduction.

The military provides new ventures with a large market opportunity (for a table on military spending by sample country, see Appendix F). As previously mentioned, the military is often the largest technology consumer. In addition, programs like SBIR in the United States and Vinnova in Sweden are examples of formal institutions established by governments to foster innovation through public-private partnerships. This dual role of both financier/developer and consumer offers unique benefits like alternative supply sources (Kropp & Zolin, 2005). However, information asymmetries occur while functioning on both sides of the “transaction”. The military understands what technology is desirable for national defense, so naturally this prior knowledge affects which proposed technologies get financed. This behavior is both legal and legitimate. Agencies are in fact mandated to support R&D that aligns with their interests[9]. Therefore, compared to less militarized countries, highly militarized countries should have larger amounts of financing for new products and the military markets for those products should be larger. Militarization as an institutional context provides the mechanism (i.e., public policy) to enable the interaction between internal and external resources in firm strategy. In turn, it explains the success of programs like SBIR.

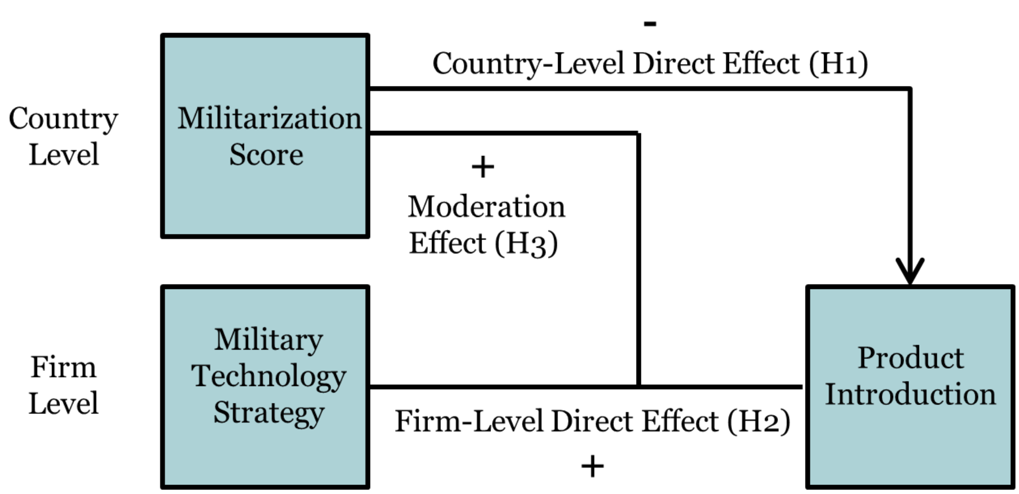
The KBV literature demonstrates the importance of context from the managerial perspective (Thornhill, 2006) and suggests that ventures which align their technology strategy with their context are better able to achieve superior performance (Kraaijenbrink & Wijnhoven, 2008; Zahra & Bogner, 2000). If militarization as an institutional context enables private R&D to align with defense development and if managers understand the value of context, then these factors should translate to variation in product introduction between firms that

[9] https://www.sbir.gov/about/about-sbir

choose to develop military versus civilian products, with respect to the level of militarization. Therefore, I expect

> H3 – Country-level militarization has a positive moderating effect on the relationship between a military-focused technology strategy and new venture product introduction such that, as militarization increases, so does the effect of a military-focused technology strategy on product introduction.

Figure 1. A Micro-Macro Model of New Venture Technology Strategy



METHOD AND DATA

Sampling Frame

The dataset was created by hand-collecting archival data from individual firm websites identified from a robotics industry listing[10] and combining it with additional archival data from external public data sources (discussed in the next

[10] www.therobotreport.com

section). The sampling frame consisted of 186 ventures identified from the list of startups on the industry website[11] plus 14 additional ventures from secondary internet searches. The additional 14 were added because the industry website did not appear representative in terms of country. For example, the United Kingdom was not represented at all. Therefore, ventures from Japan, the United Kingdom, and Ireland were added to supplement the dataset. At this point, the dataset included 200 ventures across 30 countries. Only new ventures in the robotics industry were sampled to control for environmental conditions that can vary significantly from one industry to another (Dess & Beard, 1984). By focusing on a single industry, I controlled for industry effects similar to Zahra and Bogner (2000), who limit their sampling frame to new ventures in the software industry.

Some ventures were then excluded for several reasons. First, ventures in operation for less than one year at the time of data collection (2013–2015) were excluded, because they would not have had sufficient time to develop and introduce a product. Service-only ventures, such as consulting firms, were excluded, because this study focuses on product introduction. Ventures that were acquired or went public were excluded to ensure that the final sample did not have resources endowed by any corporate parents or by issuing stock publicly. Lastly, ventures that took down their websites during the data collection phase were also excluded due to incomplete data. The final dataset included 138 ventures that had been in operation across 26 countries for 1–15 years at the time of data collection. It consisted of venture data between 2007–2012. Not all ventures were in

[11] https://www.therobotreport.com/directory/start-up-companies

operation from 2007, so the final number of observations was 596, which averages to just over four years of data per venture.

Dependent Variable

The binary dependent variable is *any product introduction*. The data were hand-collected from firm websites, press releases, and secondary internet searches. In this study, a product introduction was defined as a product released for sale or a product that shows evidence of generating sales revenue. Each observation year was coded "1" if a product was introduced and coded "0" if no product was introduced. This variable served as a proxy for new venture performance, because Schoonhoven, Eisenhardt, & Lyman (1990) have shown that new ventures which can develop and ship their first products improve their financial performance. For a table of all variables and their definitions, see Appendix G.

Independent Variables

Militarization is an example of an institutional context. To proxy for *country-level militarization*, I used the Global Militarization Index (GMI), which allows the model to be more parsimonious. This is an important factor, as the sample size required a relatively simple model to preserve statistical power. In addition, militarization as an institutional context is incredibly complex. Using an index to proxy for this complex phenomenon was better than simply using military spending, which would not be an accurate representation.

GMI data were collected from the Bonn International Center for Conversion (BICC) website[12]. The BICC gathers data from the Stockholm International Peace Research Institute, International Monetary Fund, World Health Organization, International Institute for Strategic Studies, and its own internal reports. This index compares military expenditures by country with GDP and health expenditures, so countries with high GDP (like the United States) do not overpower the index. It also includes the ratio of heavy weapons to total population of a given country and compares the number of military personnel with the number of physicians in the population. Both health expenditures and the number of physicians are pertinent to militarization, as war and its effects on the civilian population are reflected in the public health arena (Zwi, 1991). The German Federal Ministry for Economic Cooperation and Development finances the maintenance of this index, which ranges from 2007 to the present. In the final regression analysis, country-level militarization (measured by militarization score) is mean-centered to account for multicollinearity.

The image ratio variable is used as a measure for new venture technology strategy. A high image ratio indicates a strategy that focuses on the military (*military technology strategy*). I derive this newly constructed content analysis variable from the photovoice methodology used in sociology. Originally, Wang and Burris (1997) developed the photovoice method to allow marginalized participants to express themselves through participant photography[13]. The images

[12] https://www.bicc.de/

[13] Participant photography refers to instances where sample subjects were provided cameras and the freedom to take pictures of anything of interest.

are collectively interpreted by researchers to highlight common research themes, such as community assets or needs (Catalani & Minkler, 2010). The use of photovoice relies on images to communicate information to the observer. Similar processes have been used by business professionals, as described in Berinstein's (1997) multimedia research. Her examples include a digital image consultant in San Francisco, who reports that images are visual assets used by corporations to document their business and technical histories, and an advertising agency librarian, who assesses product images on competitors' websites in case her client wants to design a similar looking product (Berinstein, 1997). These examples are evidence of the relationship between images, information, and firm strategy.

I adapted this novel method from photovoice to new venture websites because websites have become a vehicle for expression in the business world, much like the photovoice concept has accomplished for rural populations. For example, website "personality" is a common term in the marketing literature (Shobeiri, Laroche, & Mazaheri, 2013). One study even develops a website personality scale (Chen & Rodgers, 2006). Using photovoice methodology, I substitute website images for photographs to determine what ventures want to develop, manufacture, and sell to the public. Collectively, these images express the sum of a venture's choices regarding how to exploit its technological resources (Zahra & Bogner, 2000). Using this image collection, I calculate the ratio of contextually relevant images to the total image count. As such, this image ratio is a valid representation of technology strategy.

To build this variable, all images were scraped from firm websites and then categorized into military, non-military, or unrelated images. A military image was defined as any image related to defense (particularly external defense), national security, or a military agency. Examples included armed drones, military personnel, or logos from defense agencies. Only explicit military images were categorized as such. A non-military image was defined as any image related to commercial goods or symbols (e.g., business people, hobbyists, toys). Unrelated images were defined as any other non-categorized images, such as blank shapes, undiscernible symbols, and text-only logos. For images containing symbols and text, I disregarded the text and categorized the image based only on the image portion. In the rare cases when a symbol was discernable but unknown to me, I attempted to define the images based on secondary internet searches. If I could not locate a similar image, I categorized these as unrelated so that they did not affect the resulting ratio. To take the most conservative approach, because even one military image could result in a non-zero image ratio for the venture, images that could be interpreted as both military and non-military (e.g., a drone without armaments) were categorized as non-military.

The simple ratio of military to commercial images within a new venture website provides insight into its technology strategy. High ratios (closer to 1.0) indicate a military technology strategy. Ratios equal to zero indicate an intent to exploit resources in a commercial market. Image ratio reflects a venture's technology strategy by measuring the kinds of images it uses to portray itself online. This variable is also mean-centered in the final analysis due to high variance inflation factors in the non-mean-centered analysis when the interaction term is introduced.

The data collection for the image ratio measure was enabled by scraping each of the new technology ventures' websites. A website crawler was developed by writing the base code and then testing it on a subset of the sample (for a walkthrough on the web crawling process, see Appendix H). Several rounds of development ensued until the crawler scraped all the images from every site with a delay built in to avoid blocking by the site. After that, another untested subset was crawled and several more rounds of development occurred until both subsets were scraped properly. In total, 18 sites were tested before final data collection began. For sites that could not be crawled because of incompatible formats (e.g., AJAX, blocking, robot exclusion protocol), I hand-collected and categorized the images. The crawler is currently hosted on a cloud server that is password protected to avoid misuse and corruption of the code.

Control Variables

European union is a binary country-level variable constructed from the European Union website[14] to control for the effects related to law and economic policy. A country was coded "1" if it belongs to the European Union and coded "0" if not. As a formal institution, the European Union systematically interacts with ventures in member and non-member countries.

[14] http://europa.eu/about-eu/countries/index_en.htm

Cultural distance is a country control variable adapted from Kogut and Singh's (1988) cultural distance index. Because the original cultural distance score was calculated from a focal country (the United States) and its cultural distance from other countries, it had to be adapted to my research design, as there were no focal countries and all countries were equally weighted. Cultural distance was included to control for the effects related to differences in national culture. For example, Japan was very low on individualism, which may contribute to a larger difference in cultural distance from the sample mean. Weak individualism may lead new technology ventures in Japan to seek higher levels of validation from peers or mentors before introducing the product, compared to ventures in other cultures.

The cultural distance score is calculated based on the deviation along each of Hofstede’s indices (i.e., power distance, uncertainty avoidance, masculinity/femininity, and individualism) from the sample mean. The index is displayed below algebraically:

$$CD_j = \sum_{i=1}^{4} \left(\left(I_{ij} - I_{iu} \right)^2 / V_i \right) / 4$$

where I_{ij} stands for the index for the *i*th cultural dimension and the *j*th country, *u* indicates the sample mean, V_i is the variance of the index of the *i*th cultural dimension, and CD_j is the cultural difference of the *j*th country from the sample mean.

IP rights is constructed by the Property Rights Alliance and Americans for Tax Reform. It is a country-level variable that is one of three components of the

International Property Rights Index[15]. IP rights score is determined from the country-grouped survey assessment of protection of IP rights, patent protection, and copyright piracy. The data originates from the World Economic Forum's Global Competitiveness Index, the Ginarte-Park Index of Patent Rights, the International IP Alliance Special 301 Report, and the Ninth Annual BSA and IDC Global Software Piracy study. The IP rights score is intended for use as a broad control variable for effects related to intellectual property regime (Autio & Acs, 2010). This is especially critical, because the sample consists of technology firms with R&D requirements. IP is likely one of the most valuable resources for the sampled ventures.

Ease of startup scores comes from a publicly available dataset published yearly by the World Bank Group[16]. The country-level scores are an average of the distance-to-frontier scores for the following country indicators: number of business registration procedures, paid-in minimum capital as a percentage of income per capita, number of days to complete procedures, and cost to complete procedures as a percentage of income per capita. The distance-to-frontier score is the distance of an economy to the highest score received for each indicator. The ease of startup score is a relevant proxy to control for country-level economic development, and it directly applies to the sample, because all ventures had only recently begun operations.

Years in operation was constructed by collecting the founding year from firm websites and secondary news sources and subtracting that year from the year

[15] www.internationalproperty-rightsindex.org
[16] http://www.doingbusiness.org/methodology/starting-a-business

of observation. This was firm-level data collected at the same time as the dependent variables. It is an important control variable for product introduction, because firms with more years in operation have more time to secure funding and perform R&D.

Spinoff status is controlled for by using a binary variable coded “1” if a company was a spinoff and coded “0” if a company was a new venture. Spinoffs from universities, corporations, or government laboratories may have advantages when compared to de novo firms with no previous ties (Ito & Rose, 1994; Walter, Auer, & Ritter, 2006). This may lead to shorter product development periods and faster product introduction.

Statistical Method and Analysis

Table 1 displays the intercorrelations for the study’s relevant variables (see Appendix I for the sample descriptive statistics). Table 2 displays the intercorrelations between the same variables except that country-level militarization, military technology strategy, and the interaction of the two are mean-centered to account for multicollinearity (Robinson & Schumacker, 2009). Country-level militarization is not highly correlated with any other variables, but in Table 1, military technology strategy has a high correlation of 0.985 with the introduced interaction term (militarization technology strategy * country-level militarization), which indicates possible multicollinearity. This is not surprising as Aiken, West, and Reno (1991) find that introducing an interaction term also introduces multicollinearity when the variable means are not centered. To contrast, in Table 2, the correlation between military technology strategy and military technology strategy * country-level militarization remains significant but changes sign and drops to -0.268 when both variables are mean-centered. The sign change and the large change in magnitude of the coefficient are also indications of multicollinearity affecting the results in Table 1. I follow the recommendations of Robinson and Schumacker (2009) and mean-center country-level militarization, military technology strategy, and the interaction term between the two to account for possible multicollinearity.

Image ratio is a measure for a military-focused technology strategy. In Tables 1 and 2, it is negatively correlated with EU affiliation. This means that as military technology strategy increases, EU affiliation decreases. This is expected because EU-affiliated countries are generally lower in militarization ranking (per the GMI) and ventures located in these countries will have less institutional pressure to introduce military products. The highest-ranked country with a sample venture in 2015[17] is Finland at 21. Those countries ranked higher that also have sample ventures include Israel, Russia, and Singapore, none of which belong to the European Union.

Country-level militarization is negative and significantly correlated with any product introduced by new robotics ventures in both Tables 1 and 2. These correlation results support H1. Both military technology strategy and the interaction term are not significantly correlated with any product introduced, so H2 and H3 are not supported by the correlation results.

[17] http://gmi.bicc.de/index.php?page=ranking-table?year=2014&sort=rank_asc

Table 1. Correlation Matrix

	0	1	2	3	4	5	6	7	8	9
0. Any Product Introduced	1.000									
1. European Union	-0.008	1.000								
2. Cultural Distance	-0.045	0.025	1.000							
3. IP Rights	0.030	-0.018	-0.096*	1.000						
4. Ease of Startup	-0.007	0.034	-0.058	0.692**	1.000					
5. Years in Operation	0.046	-0.140**	0.143**	0.044	0.095*	1.000				
6. Spinoff	0.018	-0.033	-0.196**	0.222**	0.165**	-0.014	1.000			
7. Country-Level Militarization	-0.101*	-0.365**	-0.026	-0.012	0.234**	0.088*	-0.012	1.000		
8. Military Technology Strategy	0.012	-0.106**	0.006	-0.010	0.105*	-0.061	0.075	0.040	1.000	
9. Military Technology Strategy * Country-Level Militarization	0.015	-0.112**	0.018	-0.026	0.099*	-0.068	0.055	0.098*	0.985**	1.000

Significance levels: * $p<0.05$, ** $p<0.01$

Table 2. Correlation Matrix

	0	1	2	3	4	5	6	7	8	9
0. Any Product Introduced	1.000									
1. European Union	-0.008	1.000								
2. Cultural Distance	-0.045	0.025	1.000							
3. IP Rights	0.030	-0.018	-0.096*	1.000						
4. Ease of Startup	-0.007	0.034	-0.058	0.692**	1.000					
5. Years in Operation	0.046	-0.140**	0.143**	0.044	0.095*	1.000				
6. Spinoff	0.018	-0.033	-0.196**	0.222**	0.165**	-0.014	1.000			
7. Country-Level Militarization (mean-centered)	-0.101*	-0.365**	-0.026	-0.012	0.234**	0.088*	-0.012	1.000		
8. Military Technology Strategy (mean-centered)	0.012	-0.106**	0.006	-0.010	0.105*	-0.061	0.075	0.040	1.000	
9. Military Technology Strategy * Country-Level Militarization (mean-centered)	0.036	0.047	0.071	-0.088*	-0.094*	-0.048	-0.130**	0.146**	-0.268**	1.000

Significance levels: * $p<0.05$, ** $p<0.01$

Due to the binary dependent variable (any product introduction) and the six years of observations, a logistic panel regression was used to analyze the data. Some variables such as cultural distance, EU affiliation, and spinoff, did not vary over time, so a random effects model was used versus a fixed effects model. I used a stepwise entry of the independent variables into the regression models and began with a base model that included only the country- and firm-level control variables. Country-level militarization was added for Model 2 but removed for Model 3 when military technology strategy was added. Model 4 included both country-level militarization and military technology strategy, and Model 5 kept the same variables but with the addition of the interaction term. There were two sets of regression results. Table 3 includes the non-mean-centered results, and Table 4 includes the mean-centered results.

Multicollinearity was a concern for the results in Tables 1 and 3. As previously discussed, the high correlation of 0.985 in Table 1 between the interaction term and military technology strategy is a concern. To check for multicollinearity, a variance inflation factor (VIF) analysis was done. Acceptable upper limits for VIF scores vary. Menard (2002) suggests that any VIF under 5 is acceptable, whereas Belsley, Kuh, and Welsch (1980) suggest that any VIF less than 10 is not a multicollinearity concern. The VIF for image ratio is 38.935, and the VIF for the interaction term is 38.964; therefore, it is highly likely that multicollinearity affected the results. Due to the concerns for multicollinearity in Table 3 (non-mean-centered), only the results for Table 4 are discussed in the following section. The interaction-related variables in Table 4 were mean-centered, as recommended by Robinson and Schumacker (2009).

Table 3. Random Effects Logistic Panel Regression Analysis

Dependent Variable: Any Product Introduced	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Constant	-1.468	0.466	-1.429	0.473	0.882
	(1.348)	(1.544)	(1.345)	(1.541)	(1.581)
Country-Level Control Variables:					
European Union	0.034	-0.319	0.057	-0.303	-0.348
	(0.307)	(0.331)	(0.310)	(0.335)	(0.336)
Cultural Distance	-0.458	-0.587	-0.468	-0.592	-0.676
	(0.379)	(0.370)	(0.380)	(0.371)	(0.376)
IP Rights	0.228	0.144	0.246	0.154	0.171
	(0.203)	(0.209)	(0.208)	(0.213)	(0.218)
Ease of Startup	-0.023	-0.005	-0.025	-0.006	-0.005
	(0.021)	(0.022)	(0.021)	(0.022)	(0.022)
Firm-Level Control Variables:					
Years in Operation	0.056	0.059	0.059	0.061	0.068
	(0.040)	(0.041)	(0.041)	(0.041)	(0.041)
Spinoff	0.028	0.014	0.015	0.004	0.043
	(0.264)	(0.267)	(0.266)	(0.269)	(0.270)
Variables of Interest:					
Country-Level Militarization (H1)		-0.005**		-0.005**	-0.006**
		(0.002)		(0.002)	(0.002)
Military Technology Strategy (H2)			0.834	0.445	-15.67*
			(1.365)	(1.336)	(7.946)
Military Technology Strategy*Country-Level Militarization (H3)					0.032*
					(0.015)
Total Observations	596	596	596	596	596
Number of Firms	138	138	138	138	138
McFadden's R^2	0.010	0.026	0.010	0.026	0.034

Significance levels for two-tailed tests:
* p<0.05, ** p<0.01

Table 4. Random Effects Logistic Panel Regression Analysis					
Dependent Variable: Any Product Introduced	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Constant	-1.468	-2.275	-1.414	-2.230	-2.434
	(1.348)	(1.406)	(1.346)	(1.408)	(1.437)
Country-Level Control Variables:					
European Union	0.034	-0.319	0.057	-0.303	-0.348
	(0.307)	(0.331)	(0.310)	0.335)	(0.336)
Cultural Distance	-0.458	-0.587	-0.468	-0.592	-0.676
	(0.379)	(0.370)	(0.380)	(0.371)	(0.376)
IP Rights	0.228	0.144	0.246	0.154	0.171
	(0.203)	(0.209)	(0.208)	(0.213)	(0.218)
Ease of Startup	-0.023	-0.005	-0.025	-0.006	-0.005
	(0.021)	(0.022)	(0.021)	(0.022)	(0.022)
Firm-Level Control Variables:					
Years in Operation	0.056	0.059	0.059	0.061	0.068
	(0.040)	(0.041)	(0.041)	(0.041)	(0.041)
Spinoff	0.028	0.014	0.015	0.004	0.043
	(0.264)	(0.267)	(0.266)	(0.269)	(0.270)
Variables of Interest:					
Country-Level Militarization (H1)		-0.005**		-0.005**	-0.006**
(mean-centered)		(0.002)		(0.002)	(0.002)
Military Technology Strategy (H2)			0.834	0.445	1.511
(mean-centered)			(1.365)	(1.336)	(1.468)
Military Technology Strategy*Country-Level Militarization (H3)					0.032*
(mean-centered)					(0.015)
Total Observations	596	596	596	596	596
Number of Firms	138	138	138	138	138
McFadden's R^2	0.010	0.026	0.010	0.026	0.034

Significance levels for two-tailed tests:
* p<0.05, ** p<0.01

RESULTS

All models in Table 4 include controls for EU affiliation, cultural distance, IP regime, ease of startup, years in operation, and spinoff status. Model 1, which is the base model with only controls, has no significant coefficients. The independent variables are mean-centered (i.e., country-level militarization, military technology strategy, and their interaction term) and then added in using a stepwise method. Coefficients are reported with standard errors in parentheses below each estimate. The independent VIF scores (ranging from 1.072–2.378) do not indicate high multicollinearity in the results (Table 4) for the random effects logistic panel regression analysis (Menard, 2002).

None of the country-level control variables are significant in Table 3 or Table 4. EU is not significant. Cultural distance is not significant, possibly because the sample mean is the focal statistic for measuring the distance or because the effects of the cultural indices, which are not tested individually, cancel each other. Use of cultural distance may be more useful in future research that focuses more on the effects of culture on commercialization. IP rights is not significant because intellectual property is not explicitly studied. The IP regime may indeed be significant for the production of intellectual property, but this is not the focus of my research and no data on intellectual property is used. Ease of startup may be influential in determining which ventures share certain characteristics, but in this study, these qualities may not make a difference at the more advanced stages of product introduction.

None of the firm-level control variables are significant. Years in operation is surprisingly not significant, as a positive relationship is expected where firms with more time in operations would also have more time to develop and then introduce a product. It may be that years in operation cancels itself out over time for new technology ventures. Young ventures may be at a disadvantage due to lack of experience. Firms that are in operations too long without introducing a product may also be at a disadvantage, because they cannot build or perhaps lose their established legitimacy. These negative effects may be enough to counteract the positive effects, resulting in no significant findings. Spinoff status may not be significant because there may be little to no advantages for new spinoffs. Corporate parent firms may choose to not support spinoffs until later stages, when the new venture can provide proof of sales.

McFadden's R-squared is calculated for each model. Models 1 and 3 each have a value of 0.01, Models 2 and 4 each have a value of 0.026, and Model 5 has a value of 0.034. These values are relatively small, but this is not surprising because militarization as a contextual feature cannot be expected to be the main driver for product introduction. Moreover, numerous other institutional contexts (e.g., market efficiency, level of corruption) may play a role in product introduction. Context is a small factor, but as demonstrated throughout the analysis, militarization is consistently significant and McFadden's increases each time I include country-level militarization in the model. Importantly, Model 5 has the highest score for McFadden's R-squared, which is critical because it includes both country-level militarization as the context and its interaction with military technology strategy. Including the interaction term improves the model fit.

Tests of the Hypotheses

Consistent with H1, Model 2 shows that country-level militarization has a significant, negative direct relationship (ß = -0.005, $p < 0.01$) with the introduction of a product by new ventures in robotics. This result indicates that as country-level militarization increases, the ability for new ventures to introduce a product decreases. This negative relationship suggests that a “guns versus butter” tradeoff does exist, as described in the political science literature (Apostolakis, 1992; Mintz & Huang, 1991). This also supports the institutional theory literature with an empirical result demonstrating that formal institutional contexts have direct impacts on the ventures embedded in them.

H2, which predicted that a military technology strategy has a positive relationship with product introduction, is not supported. The coefficient for military technology strategy is not significant in Models 3, 4, or 5. This is likely due to the importance of context for the sample. Although previous studies (i.e., Bowlin, 2000) have demonstrated that defense segments outperform non-defense business segments, this was done on a limited (N = 18) sample using the top 100 defense contractors as the sampling frame. Compared to small ventures, large corporations are less subject to resource constraints and less likely to rely upon external knowledge integration (from their context) for resource exploitation. Model 4 controls for country-level militarization and includes military technology strategy, but again it is not significant and country-level militarization remains significant (at $p < 0.01$). It is plausible that technology strategy for new ventures can be important for product introduction only when combined with context. For example, a military-focused technology strategy may be inefficient in introducing a military product, given a non-militarized context.

The KBV literature indicates that a focused technology strategy is positively related to performance (Dowling & McGee, 1994; Zahra, 1996b). However, the results for Models 3 and 4 do not support these findings. This is likely due to the differences in perspective and in data collection methods. Zahra (1996b) uses a mail survey and finds that technology strategy is critical to enhancing new venture performance. The perspective is from the managers' point of view, and technology strategy is a significant factor for them. My study uses image ratios and does not include managerial perception; therefore, the non-significant results indicate a potentially partial view of management. This supports the concern by Zahra and Bogner (2000) that managerial perceptions do not always reflect the objective attributes of their contexts and that cognitive biases or managerial hubris can lead to ineffective technology strategy. Based on the results from Models 3 and 4, military technology strategy in and of itself does not appear to be valuable. It is likely that combining it with an objective contextual measure is necessary to measure performance.

H3 hypothesizes that ventures whose technological choices align with their contexts are better positioned for success (Zahra & Bogner, 2000). This is supported by a positive and significant coefficient estimate ($p < 0.05$) for the interaction term between military technology strategy and country-level militarization. Country-level militarization remains significant and negative (ß = -0.006, $p < 0.01$). Therefore, militarization does have a positive moderating effect on the relationship between a military-focused technology strategy and product introduction by new ventures. As country-level militarization increases, so does the effect of a military-focused technology strategy on new venture product introduction. This indicates that technology strategy is valuable, but technology strategy also should align with the context of interest for managers to reap the benefits. The KBV literature (Zahra, 1996b; Zahra & Bogner, 2000) has been limited by surveys as the main source of data. The results from Model 5 lend support to studying technology strategy in context and not in isolation.

CONCLUDING DISCUSSION

Contributions to Theory

The KBV literature has contributed much in terms of how accessing of external knowledge resources (e.g., customer, suppliers, competitive environment) impacts innovative performance (Cohen & Levinthal, 1990; Foss, Laursen, & Pedersen, 2011; Zahra & Bogner, 2000; Zahra & George, 2002). That said, there is more than one perspective to consider. A limitation for this literature stream is that the majority of research focuses on the managers and founders via data collection from surveys. This perspective is valuable, given the scarcity of data on new ventures; nevertheless, managers are notoriously biased in their perceptions regarding strategy (Hmieleski & Baron, 2009; Simon et al., 2000).

This bias creates a limited theoretical foundation on which to build on technology strategy research. As a result, several calls for a balanced perspective on external knowledge, technology strategy, and the interaction between them have been made (Foss et al., 2013; Zahra & Bogner, 2000). I try to address these calls by demonstrating that technology strategy is not the sole precursor to product introduction, but that the institutional context moderates the relationship between technology strategy and product introduction. By not incorporating managerial perception (bottom-up), I offer a more contextual view (top-down) of firm-level strategy, which provides the complementary perspective that is called for in the literature.

Furthermore, Zahra and Bogner (2000) call for additional research into the mechanisms that new ventures use to interact with their contexts. Until now, little was known about how new ventures deploy technology strategy. My study describes one such mechanism, the websites of the new ventures. Every image on a website represents a choice, and the sum of these choices (image ratio) provides researchers with insight into how new ventures access external institutional knowledge, integrate it with product R&D, and then deploy it as technology strategy. Image ratio is a novel content analysis variable that has the potential to provide an additional source of data (due to the proliferation of websites) and to balance the managerial perspective, which currently dominates the entrepreneurship and strategy literature.

I also contribute to institutional theory. Historically, macro-level researchers have had difficulty empirically describing phenomena with enough detail to satisfy micro-level researchers. This has resulted in calls to bridge the micro-macro link between institutions and venture strategy (Peng, 2002; Peng & Luo, 2000; Suddaby et al., 2013). My study accomplishes this by incorporating country-level militarization as an institutional context that positively moderates the relationship between military technology strategy and product introduction. This finding indicates that institutional context does matter and that in-depth knowledge of institutions can be a source of competitive advantage for ventures.

The political science literature has long debated the economic tradeoff between "guns versus butter" (Apostolakis, 1992; Mintz & Huang, 1991), producing conflicting results (Bullock & Firebaugh, 1990). Thus far, several tradeoffs have been established, including expenditures and education (Mintz & Huang, 1991), military spending and public welfare (Apostolakis, 1992), and military expenditures and per capita GDP (Kentor & Kick, 2015). However, to the best of my knowledge, no research has demonstrated a tradeoff between militarization as a context and new venture product introduction. I explicitly include country-level militarization in my study, and I find a negative direct relationship between militarization and firm-level product introduction. These results suggest that an economic tradeoff may exist between these constructs and that further research is required to determine the directionality and timing of this relationship. Additionally, the potential economic value of this negative relationship has yet to be determined. This could be another interesting line of research in political science going forward.

My study makes two main contributions to the political science literature. First, I proxy for militarization using an index versus a single factor, like military spending or arms expenditures. GMI better captures the complexity of a country-level construct like institutional context (i.e., militarization) because it includes several factors related to the military from multiple sources of data. Second, I provide a granular perspective to the tradeoff where previous researchers have taken a macro perspective to explain the phenomenon. My results pertain directly to new robotics ventures embedded across a variety of militarized contexts. The macro explanations of tradeoffs with education spending or per capita GDP are not as prescriptive in nature for specific business groups and therefore are limited in practical application.

Contributions to Policy

There are policy implications resulting from my study. For example, federal policy initiatives like the SBIR Program are being tasked to increase innovation. However, SBIR receives a large portion (more than 50 percent) of funding from the same entity (the military) that I find confines innovation by negatively relating to product introduction. By inhibiting the overall introduction of products and by increasing the effect of a military-focused technology strategy on product introduction by new ventures, militarization may narrow innovation scope outside of the military technology market. This is a critical implication for those who have the authority to investigate the military’s dual-role as financier and consumer of technology.

While programs like SBIR are necessary for public R&D and job creation, a concerted effort must be made to evaluate these programs in terms of their indirect contextual effects, like the narrowing of innovation scope. This study brings attention to this issue, and hopefully it will spark discussion as to whether existing policy reinforces expected venture behavior. It would be a mistake for policy-makers to believe that programs like SBIR have no effect on job creation and patent counts.

Contributions to Practice

The value of my research to practice is twofold. First, it can help improve managers' and founders' understanding of how context affects their ventures. Rather than ignoring the institutional context, they will gain a better awareness of how external knowledge sources influence strategic decisions. New ventures that better align technology strategy with context are more likely to introduce a product to the market. This is critical because prior research has shown improved financial performance for ventures that ship their first products to market faster (Schoonhoven et al., 1990).

For example, consider two United States-based rivals in the robotics industry with dual-use drone technology (i.e., technology that could be used in the military or configured to assist in research) that has yet to be commercialized. Both ventures suffer from the liability of newness, and both ventures are resource constrained. If one venture applies for SBIR funding from the DOD and the other applies for SBIR under the National Science Foundation, the DOD-funded venture is more likely to introduce a product than the non-DOD venture. Although the level of militarization is held constant between the two competitors (they are both in the United States), the former venture has the advantage of contextual alignment, whereas the latter competitor does not. The United States has been a powerhouse in military technology for some time. Partially due to this, the DOD currently has much more funding and awards more grants than the National Science Foundation (or any other federal agency[18]). This increases the opportunity for defense-related ventures to be awarded SBIR grants, which in turn speeds up R&D and decreases time to market.

Another contribution to practice is that managers and founders can consider the results of my study when deciding how to compete with rivals in different countries. By considering the respective contexts for both their own venture and their competitors', they may find sustainable competitive advantages because country-level institutions generally do not change at the same rate (Roland, 2004) as new venture strategy. By looking at each ventures' respective home country, managers may be able to leverage unique mechanisms to secure both tangible and intangible resources and introduce products more quickly than competitors.

The SBIR program mentioned previously is an example of a policy mechanism that has distributed more than $27 billion in R&D grants for private small businesses. In addition to this capital, this program offers the external knowledge of its administrative staff, such as how to efficiently garner higher

[18] https://www.sbir.gov/analytics-dashboard?view_by=Agency

levels of funding or progress through the program more quickly. The extensive knowledge base of this and similar programs (e.g., Vinnova in Sweden, FIRST) have profound effects on eligible ventures. Consider two rivals in the robotics industry. One rival is in the United States, and the other is in Japan. Both competitors have military-focused technology strategies for products that have yet to be commercialized. The United States rival is more likely to introduce a product because of the alignment between its technology strategy and context. It has competitive advantages associated with access to the SBIR program, whereas its rival in Japan (which happens to have the lowest militarization score for any developed country) does not. Even if Japan has similar programs to SBIR, such as FIRST, these programs do not have the level of SBIR's military-related knowledge base to transfer over to the new venture. New venture technology strategy that aligns with the contextual knowledge base will generally outperform technology strategy that does not.

Limitations

The results of my study must be considered in light of its limitations. First, the generalizability of the results extends only to new ventures in the robotics industry because I controlled for industry effects using one industry. Empirical research in other industries, such as biotechnology and software are needed to generalize the contextual relationship to other new technology ventures. Additionally, only a single context (country-level militarization) was used to demonstrate the relationship; therefore, further research should incorporate other contexts like market efficiency or political corruption. Nevertheless, the robotics industry includes several product categories (e.g., education, medical devices, toys, farming devices, and telepresence), which helps to broaden the reach of this study to new ventures that are developing products in these areas.

Self-selection bias may occur in my study, because the primary source of sample identification is an industry listing in which new ventures must apply to get listed. A systematic factor may preclude some ventures from listing while encouraging others to apply for listing. It is possible that new ventures with less marketing capital are more apt to apply for listing than new ventures with sufficient capital. In this situation, the resource base of the listed versus non-listed ventures may significantly differ and affect the results of the study. This is a plausible limitation, but prior research (Brush et al., 2001; Kropp & Zolin, 2005; Miles et al., 1999) indicates that new technology ventures typically have few tangible resources, so a systematic difference in resource base is unlikely.

Data collection for the dependent variable (any product introduction) required the use of translation software (Google Translate) to code non-English websites. This tool has the potential to mistranslate text systematically, which may affect the results. Due to the country-level nature of the study, this was the only feasible way to translate the broad range of languages displayed in new venture websites.

My analysis includes only new ventures that have a publicly hosted website. This is a limitation because some new robotics ventures may not have a website and therefore would not be accurately represented. In addition, there is survivor bias taking place because the websites need to be publicly hosted to be coded. If a new venture failed and went out of business, that venture would likely take down its website. Some websites were no longer accessible to me, so I excluded those ventures from the final sample. Although this was a rare occurrence (approximately 10 ventures), my study analyzed only ventures that survived. Those surviving ventures had commonalities that were overrepresented, whereas failed ventures were underrepresented. This is a common but noteworthy limitation in the entrepreneurship literature (e.g., Fernhaber et al., 2008; Zahra & Neubaum, 1998).

Another limitation is that data collection for image ratio assumes that the ventures' websites reflect their technology strategies. This assumption is logical, because a venture should display images related to what, where, and to whom it sells. It is also logical that a new venture wants to connect with its potential market via the website. For this to occur, a new venture must assign someone to build and maintain its website. This could be the CEO or founder, but it also could be outsourced or assigned to an employee. Regardless of who maintains the website, I assume that management and founders understand their venture's website content. This may not be a safe assumption for a multinational corporation (with hundreds or thousands of employees), but I believe that it is acceptable for a sample of new ventures. Entrepreneurs tend to prefer autonomy and rely less on support, which often leads to resistance in delegation (Sexton & Bowman, 1986). Because entrepreneurs tend to be labeled as "control freaks" or micro-managers, there is little concern that managers or founders of new ventures would be unaware of what content is uploaded to their websites. Therefore, any concern that a website may not reflect the desired technology strategy is mitigated.

The image ratio measure is a new variable and as such, there are concerns for reliability of its measurement. The interpretation of images is subjective, since individuals recall different experiences when attempting to interpret an image. This subjectivity is mitigated as much as possible by providing detailed and conservative instructions for image categorization. Military images are categorized as such only when there is no doubt it is military related. If any image is considered dual-use, then it is coded as non-military. If any image is unknown, then it is coded as unrelated so that it is excluded from the ratio. Given these instructions, a false-positive military code is unlikely. It is more likely that a military image be coded as non-military or unrelated. Future research incorporating image ratio should conduct inter-rater reliability tests on subsamples to ensure that the measure is reliable. Future research also should consider the demographic and experiential backgrounds of coders, as these factors may affect image interpretation.

I make the assumption that image ratio as a proxy for military technology strategy does not change during the early stages of new venture operations. This limitation undermines image ratio’s usefulness as a measure. If military technology strategy becomes more non-military focused over time, then future research will need to collect time-varying image ratio data to support the claims I make in this study. I find it unlikely that new ventures with limited tangible resources would have the assets needed to pivot so early on in their development[19]. That said, I cannot account for this possibility due to the limitations of my data, and therefore it remains a concern. In addition, image ratio on its own is not significant (H2), and its significance in the interaction term (H3) may be driven by country-level militarization (H1). Again, future research will need to collect periodic image ratio data at the same time as product introduction data to better justify the significance of the variable.

Future research is needed with regards to how image ratio is implemented. I categorize images as military or non-military only. There may be a need to subcategorize images further to better specify firm strategy. In addition, weighted ratios of images according to image size and placement may better describe the perceived value of an image. Large images are often thought to be more valuable than smaller images, and images may have differing values based on the location of the image on the screen, even if size is constant. I do not take these attributes into consideration for my study, but it may benefit future research to do so.

Finally, the availability of only six years of data is a limitation to my study. The context of interest is militarization, and I use an index score (GMI) as a proxy. The BICC began publishing the GMI in 2007. Therefore, I am limited in the number of years of data collected. More years might be better, but given the radical nature of technology industries, it may not make much of a difference. For many new ventures, six years could very well be sufficient for testing the interaction between context and technology strategy.

[19] I reran the analysis using a temporal subset of the data (the most recent two years). The results are very similar with no changes in directionality.

Conclusion

New ventures have long been considered a “black box” in strategy research due to the relative scarcity of data. The primary source of insight into new venture strategy has been the surveying of management. Although valuable, survey data inherently contain cognitive biases. I circumvent these biases by introducing a new content analysis measure called image ratio, which excludes managerial perception and instead describes how contextual knowledge is captured in the image choices by new ventures and then deployed as technology strategy in their websites. This knowledge-based approach introduces a new source of data and describes how new ventures use contextual knowledge bases to gain a competitive advantage in product introduction.

Competitive advantage is not solely based upon the technology strategy of new ventures. The results of my study indicate that technology strategy in isolation is not a significant factor in product introduction. It becomes a factor only as an interaction term with an institutional context. I find that country-level militarization positively moderates the relationship between military technology strategy and product introduction for new ventures in robotics. Therefore, context matters, and technology strategy should not be considered without accounting for contextual alignment. I hope that these results will encourage more contextual research using image ratio in new and novel ways. After all, image ratio is the embodiment of the idiom “a picture is worth a thousand words” when contextualized in new venture strategy research.

APPENDIX A. Construct Validity for Military-Focused Strategy

Firm ID	Venture Name	Country	Image Ratio	Validation of Strategy from Venture Website
49	Marathon Targets	Australia	0.745	"Documented tests and evaluations carried out by the US Marine Corps determined that soldiers developed a 104% increase in combat accuracy within a 24 hour period through use of our robotic targets. In addition, the US Army's Research Institute measured a 3.7 times increase in range throughput compared to traditional training methods."
115	Roboteam Ltd.	Israel	0.284	"Among our customers one can find top units within the US Military, Special Forces, EOD units and SWAT teams as well as other elite units around the globe."
178	ProxDynamics	Norway	0.25	"Combat-proven in Afghanistan by NATO-forces and with a range exceeding 1.6 km, the PD-100 PRS represents an operational capability available to military units."
78	American Unmanned Systems LLC	US	0.143	Attended event - SOFIC (Special Operations Forces Industry Conference), May 20-22, 2014 in Tampa, FL
24	Hstar Technologies	US	0.109	"Our team has successfully completed a range of technology development programs including the following: Advanced Medical Robotic System (U.S. Army), An Integrated Rehabilitation Robotic System (U.S. Army), Robotic Noninvasive Neck/ Spinal Injury Assessment Devices (U.S. Army), An Advanced Intelligent Robotic Pallet System for Cargo-Handling and Aircraft-Loading Efficiency (U.S. Air Force)"

* above are subsamples representing the highest image ratios and the lowest (i.e., zero)
* 100% of all image ratio scores in the subsample were validated with text taken from the venture websites

[20] [21] [22] [23] [24]

[20] http://marathon-targets.com/capabilities/
[21] http://www.robo-team.com/company/about-us
[22] http://www.proxdynamics.com/home#millitaryandspecialforces
[23] http://www.americanunmannedsystems.com/events.html
[24] http://www.hstartech.com/index.php/2012-07-03-15-22-47/capabilities.html

APPENDIX B. Construct Validity for Non-Military-Focused Strategy

Firm ID	Venture Name	Country	Image Ratio	Validation of Strategy from Venture Website
175	ZenRobotics Ltd.	Finland	0	"Right now we are focused on Next Generation Recycling – we like to solve one major world problem at a time. Our product, the ZenRobotics Recycler, is the first commercially available robotic waste sorting system. It reclaims chosen fractions from solid waste with industrial robots and smart machine learning technology."
151	You Rehab Ltd.	Switzerla	0	"YouRehab's passion for innovative rehabilitation devices offers the possibility of more attractive, more intensive and more successful therapy."
174	Vishwa Robotics	US	0	"Better than Biology is our motto to design and develop robots that can outperform biological counterparts in many niche applications. The result of such aggressive design goals is development of energy efficient machines, increased safety while operating close to, within or attached to humans and high reliability."
150	Virtual Incision	US	0	"Virtual Incision Corporation is a privately-held medical device company focused on developing an advanced, miniaturized robot for general surgery abdominal procedures, such as colon resections."
126	Vehicle Technologies Inc.	US	0	"Specializing in the design and manufacture of Omni-Directional Vehicles for Robotic Mobility, Entertainment, Assembly and Process, Logistics and Materials Handling"

* above are subsamples representing the highest image ratios and the lowest (i.e., zero)
* 100% of all image ratio scores in the subsample were validated with text taken from the venture websites

[25] [26] [27] [28] [29]

[25] http://zenrobotics.com/about-us/company/
[26] http://yourehab.com/about-yourehab/
[27] http://vishwarobotics.com/
[28] https://www.virtualincision.com/
[29] http://www.vetexinc.com/

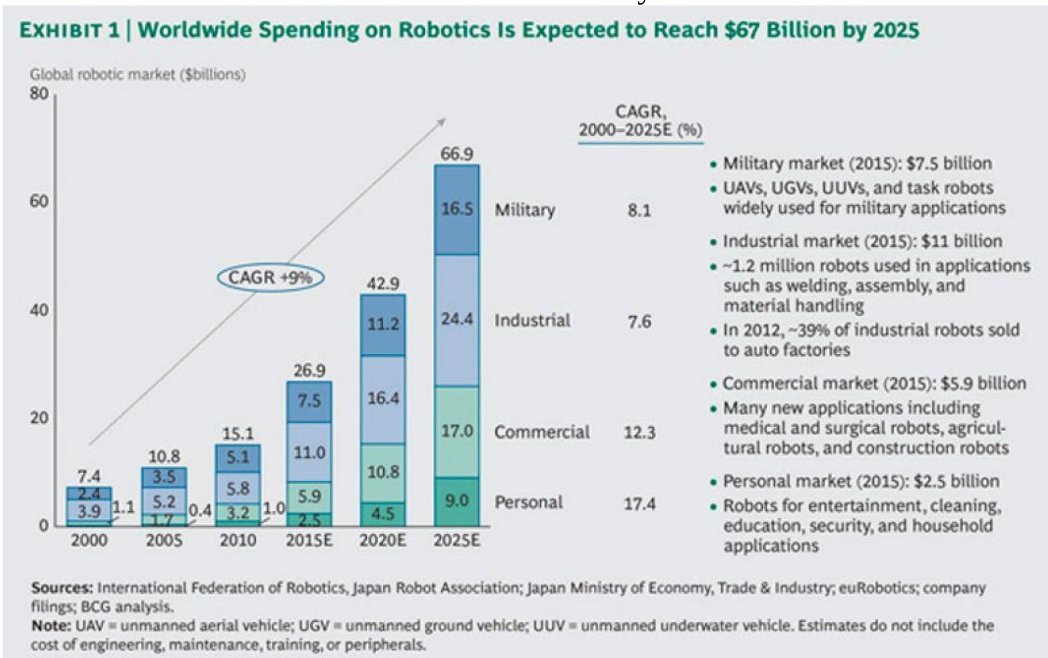
APPENDIX C. Literature Summary and Technology Strategy

Authors	**Data and Method**	**Related Findings**
Zahra, 1996a	Mail survey to highest ranking executive, N=176	Pursuing a technology strategy in manufacturing is positively related to financial performance. There is an indirect effect between the competitve environment and the technology strategy-performance relationship.
Zahra, 1996b	Mail survey to highest ranking executive, N=112	Technology strategy is important for enhancing performance of new ventures in biotechnology. Corporate ventures and independent ventures gained competitive advantages from different technology strategies.
Zahra and Bogner, 1999	Mail survey to senior manager, N=116	The industry context moderates the relationship between technology strategy and the performance of new ventures in software. Ventures that match their technology strategy are better positioned for superior performace. Environmental conditions leading to ineractions between variables are inevitable.
Zahra and Covin, 2007	Cluster Analysis, N=180	The technology strategy of United States-based electronics firms differs with regards to the combination of domestic and international competition.
Dowling and McGee, 1994	Archival data using IPO documents, N=52	Relative R&D expenditures are positively related to performance for new ventures in telecommunications. Significant indirect effects exist between investments in innovation, competitive strategies, and performance.

APPENDIX D. Literature Summary and External Knowledge Resources

Authors	**Data and Method**	**Related Findings**
Larrañeta, Zahra, and González, 2012	Face-to-face interviews with senior company officials, N=140	New ventures in Spain remain competitive by accessing diverse sources of external knowledge. Most ventures have limited knowledge bases, which prompts them to seek external sources.
Thornhill, 2006	Survey data from operations manager, N=845	Firm knowledge, industry context, and innovation influence performance of Canadian manufacturing firms.
Vega-Jurado, Gutiérrez-Gracia and Fernández-de-Lucio, 2009	Survey data, N=1329	The effects of external (e.g. industrial and scientific parties) knowledge sourcing strategies (e.g. buying and cooperating) differ with regards to whether the innovation is product or process innovation.
Kraaijenbrink and Wijnhoven, 2008	Theory paper, literature review and synthesis	By developing better external knowledge integration processes than their competitors, firms can gain competitive advantages. Firms are open systems that deal with knowledge heterogeneity originating from other firms or individuals.
Fernhaber, McDougall-Covin, and Shepherd, 2009	Archival data using IPO documents, N=206	International knowledge (e.g., information, beliefs, and skills that firms can apply to international activities) can be sourced externally. This external knowledge can compensate for internal resource deficiencies.
Foss, Lyngsie, and Zahra, 2013	Mail survey to HR managers and highest ranking executive, N=536	The use of external knowledge sources is positively related to opportunity exploitation. The strength of this relationship is positively influenced by organizational designs, which enable firms to access external knowledge.

APPENDIX E. Robotics Industry Growth Chart



[30]

[30] https://www.therobotreport.com/news/latest-research-report-shows-xx-cagr-for-robotics-to-2025

APPENDIX F. Military Spending Statistics

Military Spending by Sample Country					
	Country Name	**2012**	**2013**	**2014**	**2015**
1	Canada	$20,452	$18,516	$17,854	$15,031
2	USA	$684,780	$639,704	$609,914	$596,024
3	China	$157,446	$177,848	$199,651	$214,787
4	Japan	$60,012	$49,024	$45,867	$40,885
5	South Korea	$31,952	$34,354	$37,286	$36,435
6	Taiwan	$10,497	$9,964	$10,240	$9,803
7	India	$47,217	$47,404	$50,914	$51,257
8	Singapore	$9,172	$9,346	$9,668	$9,417
9	Thailand	$5,492	$5,901	$5,730	$5,737
10	Australia	$26,217	$24,825	$25,784	$23,588
11	Russia	$81,469	$88,353	$84,697	$66,421
12	Belgium	$5,169	$5,230	$5,192	$4,168
13	Finland	$3,603	$3,787	$3,599	$2,979
14	France	$60,035	$62,417	$63,614	$50,860
15	Germany	$46,471	$45,931	$46,103	$39,393
16	Ireland	$1,158	$1,196	$1,191	$995
17	Italy	$33,733	$33,892	$31,571	$23,840
18	Netherlands	$10,365	$10,226	$10,333	$8,873
19	Norway	$7,144	$7,392	$7,334	$5,898
20	Portugal	$4,137	$4,724	$4,112	$3,684
21	Spain	$18,861	$17,243	$17,051	$14,104
22	Sweden	$6,244	$6,529	$6,556	$5,377
23	Switzerland	$4,592	$5,033	$4,613	$4,770
24	United Kingdom	$58,496	$56,862	$59,183	$55,460
25	Israel	$14,742	$16,874	$18,106	$16,101
26	Turkey	$17,958	$18,615	$17,770	$15,275
*	Figures are in US $M				
*	Figures converted at the exchange rate for the given year				

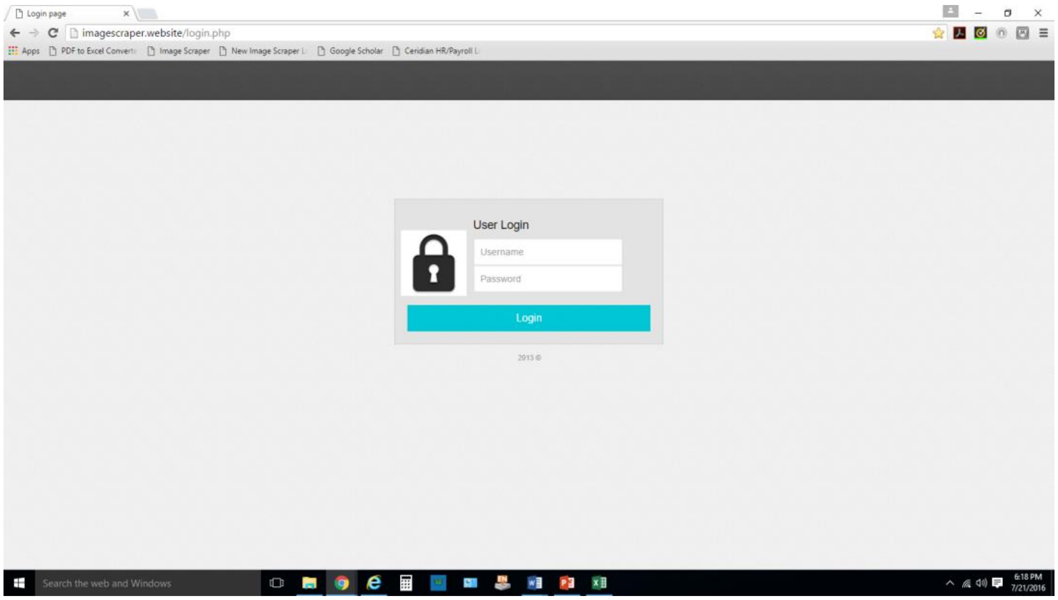
[31]

[31] https://www.sipri.org/databases/milex

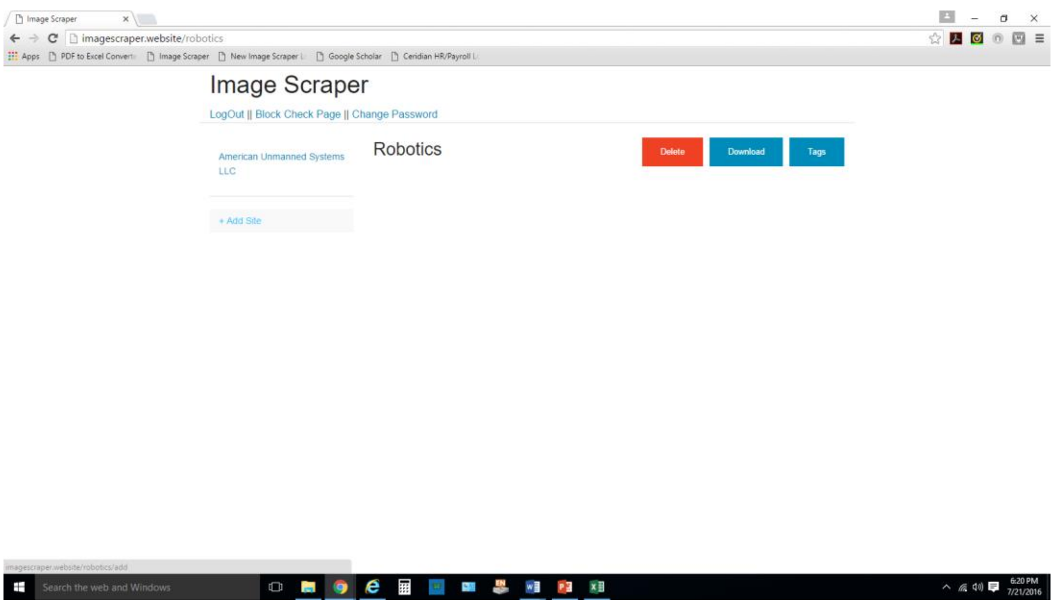
APPENDIX G. Variable Descriptions

Variable Name	**Definition**
Any Product Introduced	A product released for sale in a given year by sample firms
European Union	Country belongs to the European Union
Cultural Distance	Deviation by a country along Hofstede's cultural indices from the sample mean of countries
IP Rights	Index score based on a grouped survey assessment of intellectual property rights, patent protection, and copyright piracy at the country level
Ease of Startup	Average distance-to-frontier scores for the following country indicators: number of business registrations, paid-in minimum capital as a percentage of income per capita, number of days to complete registration procedures, and cost to complete those procedures as a percentage of income per capita
Years in Operation	Number of years a firm has been in operations as of the year of observation
Spinoff	A firm is a spinoff or a de novo firm
Country-Level Militarization (measured by GMI score)	Level of militarization at the country level, based on the following country indicators: GDP, health expenditures, military expenditures, heavy weaponry, total population, military personnel, and healthcare personnel
Military Technology Strategy (measured by image ratio)	Ratio of military web images to non-military images in sample firms' websites

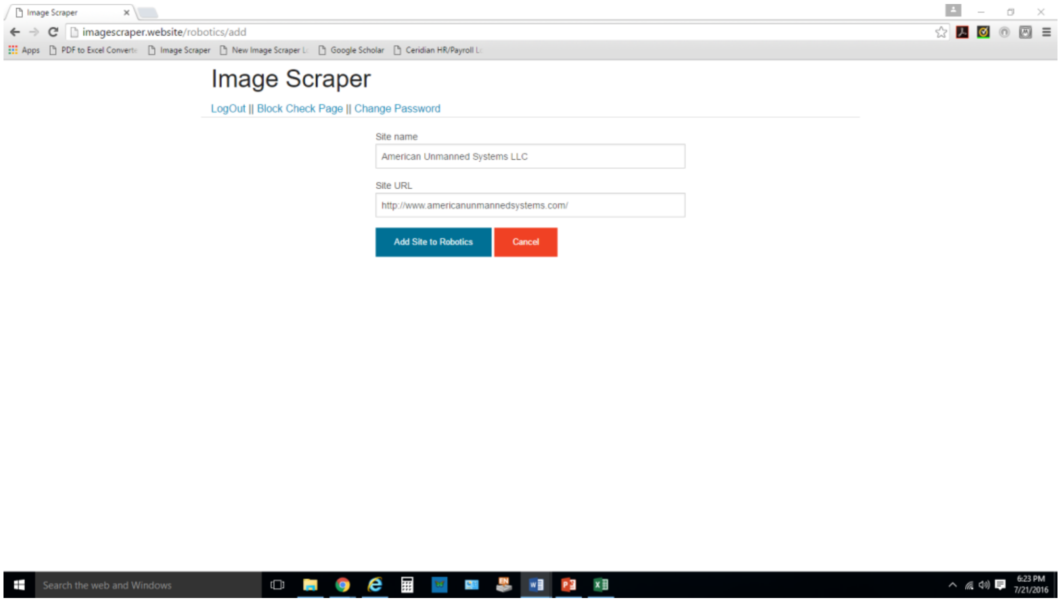
APPENDIX H. Image Scraper Walkthrough



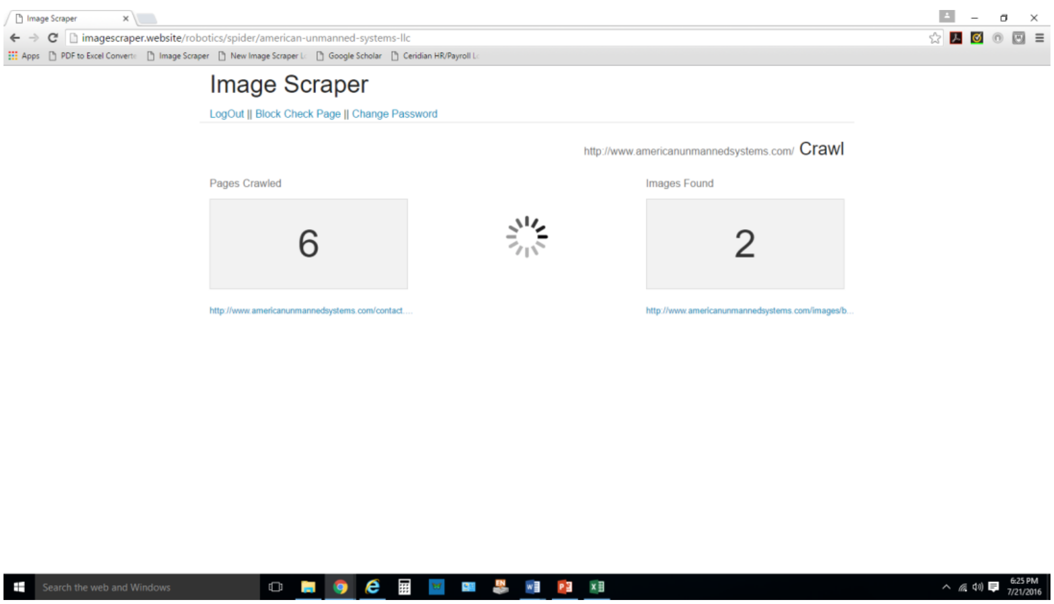
Go to the login screen and crawler website address.



Click "+ Add Site".

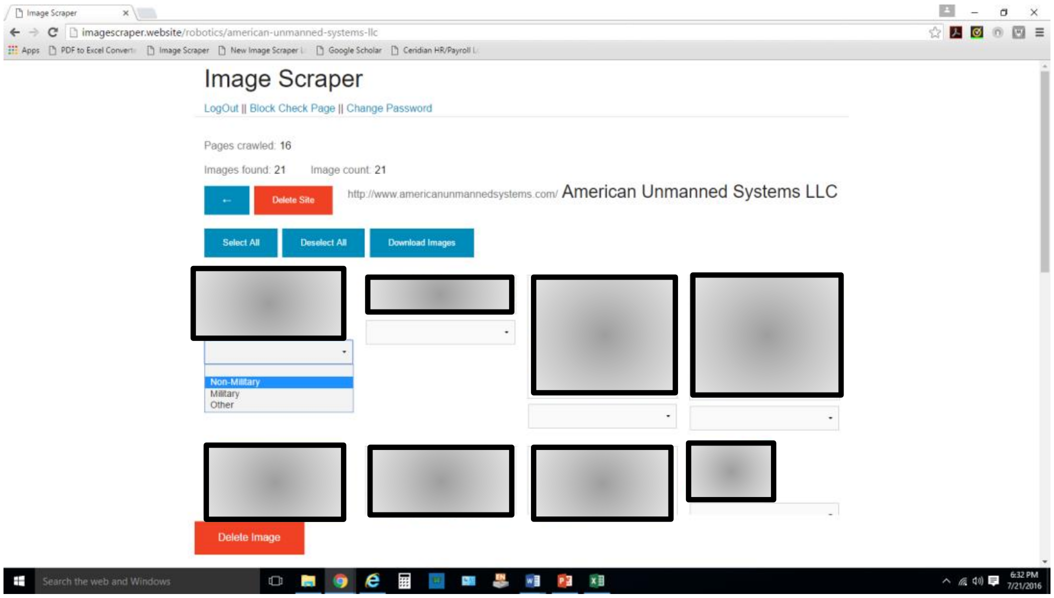


Type in venture name and homepage address.
Then click "Add Site to …"



The crawler counts the number of pages in the site and the number of images found. It notifies the user when the crawl is completed.

Small pauses are built into the download to limit any burden on the hosting server. Also, each site is checked for the presence of a robots.txt files prior to initiating the crawl. If robots.txt is present, then a hand collection is done instead.



The crawler then allows for categorization of images by hand. For this study, “Non-Military”, “Military”, and “Other” are the categories. (Images in this screen capture are blurred to protect any copyrighted works.)

Image ratio is calculated by subtracting “Other” images from the total images collected, then dividing the number of “Military” images by that number to get a score that falls between 1 and 0. The higher the score, the higher the amount of military images in relation to non-military images.

APPENDIX I. Descriptive Statistics

Table 5. Descriptive Statistics						
Variable Name	**Mean**	**Std. Dev.**	**Min**	**Max**	**Skewness**	**Kurtosis**
Any Product Introduced	0.131	0.338	0.000	1.000	2.189	5.792
European Union	0.213	0.410	0.000	1.000	1.401	2.964
Cultural Distance	0.885	0.363	0.300	2.143	1.323	4.365
IP Rights	7.887	0.970	3.500	8.700	-2.418	8.255
Ease of Startup	88.539	8.254	43.480	97.220	-3.330	14.890
Years in Operation	3.245	3.017	0.000	15.000	1.134	3.883
Spinoff	0.337	0.473	0.000	1.000	0.689	1.474
Militarization Score	538.067	79.477	342.800	840.930	0.214	4.777
Image Ratio	0.017	0.083	0.000	0.745	7.269	60.889

REFERENCES

Abernathy, W. J. & Utterback, J. M. 1978. Patterns of industrial innovation. ***Technology Review.*** 64: 254-228.

Acs, Z. J. & Audretsch, D. B. 1988. Innovation in large and small firms: an empirical analysis. ***The American Economic Review***, 678-690.

Aiken, L. S., West, S. G., & Reno, R. R. 1991. ***Multiple Regression: Testing and Interpreting Interactions***: Sage.

Aldrich, H. E. & Fiol, C. M. 1994. Fools rush in? The institutional context of industry creation. ***Academy of Management Review***, 19(4): 645-670.

Apostolakis, B. E. 1992. Warfare-welfare expenditure substitutions in Latin America, 1953-87. ***Journal of Peace Research***, 29(1): 85-98.

Argyres, N. S. 1995. Technology strategy, governance structure and interdivisional coordination. ***Journal of Economic Behavior & Organization***, 28(3): 337-358.

Audretsch, D. B. 2003. Standing on the shoulders of midgets: The US Small Business Innovation Research program (SBIR). ***Small Business Economics***, 20(2): 129-135.

Autio, E. & Acs, Z. 2010. Intellectual property protection and the formation of entrepreneurial growth aspirations. ***Strategic Entrepreneurship Journal***, 4(3): 234-251.

Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. 2014. Entrepreneurial innovation: The importance of context. ***Research Policy***, 43(7): 1097-1108.

Barney, J. 1991. Firm resources and sustained competitive advantage. ***Journal of Management***, 17(1): 99-120.

Belsley, D. A., Kuh, E., & Welsch, R. E. 1980. Detecting and assessing collinearity. ***Regression Diagnostics: Identifying Influential Data and Sources of Collinearity***: 85-191.

Berinstein, P. 1997. Moving Multimedia: The Information Value in Images. ***Searcher***, 5(8).

Bogner, W. C. & Thomas, H. 1996. From Skills to Competencies: The "Play-Out" of Resource Bundles Across Firms. In R. Sanchez, A. Heene, & H. Thomas (Eds.), ***Dynamics of Competence-Based Competition***: 101-117. London, UK: Pergamon.

Bowlin, W. F. 2000. An analysis of the financial performance of defense business segments using data envelopment analysis. ***Journal of Accounting and Public Policy***, 18(4): 287-310.

Bowman, K. S. 2010. ***Militarization, Democracy, and Development: The Perils of Praetorianism in Latin America***: Penn State Press.

Brush, C. G., Greene, P. G., & Hart, M. M. 2001. From initial idea to unique advantage: The entrepreneurial challenge of constructing a resource base. ***The Academy of Management Executive***, 15(1): 64-78.

Bullock, B. & Firebaugh, G. 1990. Guns and butter? The effect of military on economic and social development in the third world. ***JPMS: Journal of Political and Military Sociology***, 18(2): 231.

Cappelen, Å., Gleditsch, N. P., & Bjerkholt, O. 1984. Military spending and economic growth in the OECD countries. ***Journal of Peace Research***, 21(4): 361-373.

Catalani, C. & Minkler, M. 2010. Photovoice: A review of the literature in health and public health. ***Health Education & Behavior***, 37(3): 424-451.

Chen, Q. & Rodgers, S. 2006. Development of an instrument to measure web site personality. ***Journal of Interactive Advertising***, 7(1): 4-46.

Chrisman, J. J. 1999. The influence of outsider-generated knowledge resources on venture creation. ***Journal of Small Business Management***, 37(4): 42.

Cohen, W. M. & Levinthal, D. A. 1990. Absorptive capacity: A new perspective on learning and innovation. ***Administrative Science Quarterly***, 35(1).

Coviello, N. E. & Jones, M. V. 2004. Methodological issues in international entrepreneurship research. ***Journal of Business Venturing***, 19(4): 485-508.

Dess, G. G. & Beard, D. W. 1984. Dimensions of organizational task environments. ***Administrative Science Quarterly,*** 52-73.

DiMaggio, P. J. & Powell, W. W. 1991. ***The New Institutionalism in Organizational Analysis***. Chicago: University of Chicago Press.

Djankov, S., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. 2002. The regulation of entry. ***Quarterly Journal of Economics***, 1-37.

Dowling, M. J. & McGee, J. E. 1994. Business and technology strategies and new venture performance: a study of the telecommunications equipment industry. ***Management Science***, 40(12): 1663-1677.

Drori, I., Honig, B., & Wright, M. 2009. Transnational entrepreneurship: An emergent field of study. ***Entrepreneurship Theory and Practice***, 33(5): 1001-1022.

Dunning, J. H. 1989. The study of international business: A plea for a more interdisciplinary approach. ***Journal of International Business Studies***, 411-436.

Eisenhardt, K. M. & Santos, F. M. 2002. Knowledge-based view: A new theory of strategy. ***Handbook of Strategy and Management***, 1: 139-164.

Fernhaber, S. A., Gilbert, B. A., & McDougall, P. P. 2008. International entrepreneurship and geographic location: an empirical examination of new venture internationalization. ***Journal of International Business Studies***, 39(2): 267-290.

Foss, N. J., Laursen, K., & Pedersen, T. 2011. Linking customer interaction and innovation: The mediating role of new organizational practices. ***Organization Science***, 22(4): 980-999.

Foss, N. J., Lyngsie, J., & Zahra, S. A. 2013. The role of external knowledge sources and organizational design in the process of opportunity exploitation. ***Strategic Management Journal***, 34(12): 1453-1471.

Freeman, C. 1987. Technology policy and economic policy: Lessons from Japan. London: Pinter.

Freeman, C. 1995. The National System of Innovation in Historical Perspective. ***Cambridge Journal of Economics***, 19(1): 5-24.

Friar, J. & Horwitch, M. 1985. The emergence of technology strategy: A new dimension of strategic management. ***Technology in Society***, 7(2): 143-178.

Garud, R., Jain, S., & Tuertscher, P. 2008. Incomplete by design and designing for incompleteness. ***Organization Studies***, 29(3): 351-371.

Garud, R., Gehman, J., & Giuliani, A. P. 2014. Contextualizing entrepreneurial innovation: A narrative perspective. ***Research Policy***.

Grant, R. M. 1996. Toward a Knowledge-Based Theory of the firm. ***Strategic Management Journal***, 17(S2): 109-122.

Gruber, M., MacMillan, I. C., & Thompson, J. D. 2008. Look before you leap: Market opportunity identification in emerging technology firms. ***Management Science***, 54(9): 1652-1665.

Hartley, K. 2006. ***Defense Spending and its Impact on the National Economy: A Review of the Literature and Research Issues***. University of York: Mimeo, Centre for Defense Economics.

Hmieleski, K. M. & Baron, R. A. 2009. Entrepreneurs' optimism and new venture performance: A social cognitive perspective. ***Academy of Management Journal***, 52(3): 473-488.

Hymer, S. 1960. The international operations of international firms: A study of direct investment. Unpublished Ph. D. dissertation, Massachusetts Institute of Technology, Cambridge, MA.

Ito, K. & Rose, E. L. 1994. The genealogical structure of Japanese firms: Parent-subsidiary relationships. ***Strategic Management Journal***, 15(S2): 35-51.

Kenney, M. & Patton, D. 2005. Entrepreneurial geographies: support networks in three high-technology industries. ***Economic Geography***, 81(2): 201-228.

Kentor, J. & Kick, E. 2015. Bringing the military back in: Military expenditures and economic growth 1990 to 2003. ***Journal of World-Systems Research***, 14(2): 142-172.

Knight, M., Loayza, N., & Villanueva, D. 1996. The peace dividend: military spending cuts and economic growth. ***IMF Staff Papers***, 43(1): 1-37.

Kogut, B. & Singh, H. 1988. The effect of national culture on the choice of entry mode. ***Journal of International Business Studies***, 19(3): 411-432.

Kogut, B. & Zander, U. 1996. What firms do? Coordination, identity, and learning. ***Organization Science***, 7(5): 502-518.

Kraaijenbrink, J. & Wijnhoven, F. 2008. Managing heterogeneous knowledge: a theory of external knowledge integration. ***Knowledge Management Research & Practice***, 6(4): 274-286.

Kropp, F. & Zolin, R. 2005. Technological entrepreneurship and small business innovation research programs. ***Academy of Marketing Science Review***, 2005(7).

Larrañeta, B., Zahra, S. A., & González, J. L. G. 2012. Enriching strategic variety in new ventures through external knowledge. ***Journal of Business Venturing***, 27(4): 401-413.

Levie, J. & Autio, E. 2011. Regulatory burden, rule of law, and entry of strategic entrepreneurs: An international panel study. ***Journal of Management Studies***, 48(6): 1392-1419.

Looney, R. E. 1986. Austerity and military expenditures in developing countries: the case of Venezuela. ***Socio-Economic Planning Sciences***, 20(3): 161-164.

Lundvall, B.-A. (Ed.). 1988. ***Innovation as an Interactive Process: User-producer Interaction to the National System of Innovation***. (Vol. 1). London: Pinter Publishers.

Lundvall, B.-A. 1992. User-producer relationships, national systems of innovation and internationalisation. ***National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning***: 45-67.

Lundvall, B. Å. 2007. National innovation systems—analytical concept and development tool. ***Industry and Innovation***, 14(1): 95-119.

Malecki, E. J. 1984. Military spending and the US defense industry: Regional patterns of military contracts and subcontracts. ***Environment and Planning C: Government and Policy***, 2(1): 31-44.

March, J. G., Sproull, L. S., & Tamuz, M. 1991. Learning from samples of one or fewer. ***Organization Science***, 2(1): 1-13.

Menard, S. 2002. ***Applied Logistic Regression Analysis***: Sage.

Meyer, J. W. & Rowan, B. 1977. Institutionalized organizations: Formal structure as myth and ceremony. ***American Journal of Sociology***: 340-363.

Miles, G., Preece, S. B., & Baetz, M. C. 1999. Dangers of dependence: the impact of strategic alliance use by small technology-based firms. ***Journal of Small Business Management***, 37(2): 20.

Miller, A. 1988. A taxonomy of technological settings, with related strategies and performance levels. ***Strategic Management Journal***, 9(3): 239-254.

Mintz, A. & Huang, C. 1991. Guns versus butter: The indirect link. ***American Journal of Political Science***, 738-757.

Nanda, R. & Sørensen, J. B. 2010. Workplace peers and entrepreneurship. ***Management Science***, 56(7): 1116-1126.

Nelson, A. J. 2014. From the ivory tower to the startup garage: Organizational context and commercialization processes. ***Research Policy***.

North, D. C. 1990. ***Institutions, Institutional Change and Economic Performance***: Cambridge University Press.

Oviatt, B. M. & McDougall, P. P. 2005. Defining international entrepreneurship and modeling the speed of internationalization. ***Entrepreneurship Theory and Practice***, 29(5): 537-554.

Peng, M. W. & Luo, Y. 2000. Managerial ties and firm performance in a transition economy: The nature of a micro-macro link. ***Academy of Management Journal***, 43(3): 486-501.

Peng, M. W. 2002. Towards an institution-based view of business strategy. ***Asia Pacific Journal of Management***, 19(2-3): 251-267.

Penrose, E. T. 1959. The theory of the growth of the firm. Sharpe: New York.

Polanyi, M. 1962. ***Personal Knowledge: Towards a Post-critical Philosophy***. Chicago: University of Chicago Press.

Porter, M. E. 1980. ***Competitive Strategy***. New York: The Free Press.

Porter, M. E. 1981. The contributions of industrial organization to strategic management. ***Academy of Management Review***, 6(4): 609-620.

Robinson, C. & Schumacker, R. E. 2009. Interaction effects: centering, variance inflation factor, and interpretation issues. ***Multiple Linear Regression Viewpoints***, 35(1): 6-11.

Roland, G. 2004. Understanding institutional change: fast-moving and slow-moving institutions. ***Studies in Comparative International Development***, 38(4): 109-131.

Sandberg, W. R. & Hofer, C. W. 1988. Improving new venture performance: The role of strategy, industry structure, and the entrepreneur. ***Journal of Business Venturing***, 2(1): 5-28.

Scanlan, S. J. & Jenkins, J. C. 2001. Military Power and Food Security: A Cross-National Analysis of Less-Developed Countries, 1970–1990. ***International Studies Quarterly***, 45(1): 159-187.

Schoonhoven, C. B., Eisenhardt, K. M., & Lyman, K. 1990. Speeding products to market: Waiting time to first product introduction in new firms. ***Administrative Science Quarterly***, 35(1): 177-207.

Sexton, D. L. & Bowman, N. 1986. The entrepreneur: A capable executive and more. ***Journal of Business Venturing***, 1(1): 129-140.

Shobeiri, S., Laroche, M., & Mazaheri, E. 2013. Shaping e-retailer's website personality: The importance of experiential marketing. ***Journal of Retailing and Consumer Services***, 20(1): 102-110.

Simon, M., Houghton, S. M., & Aquino, K. 2000. Cognitive biases, risk perception, and venture formation: How individuals decide to start companies. ***Journal of Business Venturing***, 15(2): 113-134.

Stephan, U. & Uhlaner, L. M. 2010. Performance-based vs socially supportive culture: A cross-national study of descriptive norms and entrepreneurship. ***Journal of International Business Studies***, 41(8): 1347-1364.

Suddaby, R., Seidl, D., & Lê, J. K. 2013. Strategy-as-practice meets neo-institutional theory. ***Strategic Organization***, 11(3): 329-344.

Thornhill, S. 2006. Knowledge, innovation and firm performance in high-and low-technology regimes. ***Journal of Business Venturing***, 21(5): 687-703.

Thornton, P. H., Ocasio, W., & Lounsbury, M. 2012. ***The Institutional Logics Perspective: A New Approach to Culture, Structure, and Process***: Oxford University Press on Demand.

Tsai, W. M.-H., MacMillan, I. C., & Low, M. B. 1991. Effects of strategy and environment on corporate venture success in industrial markets. ***Journal of Business Venturing***, 6(1): 9-28.

Vega-Jurado, J., Gutiérrez-Gracia, A., & Fernández-de-Lucio, I. 2009. Does external knowledge sourcing matter for innovation? Evidence from the Spanish manufacturing industry. ***Industrial and Corporate Change***, 18(4):637-670.

Walter, A., Auer, M., & Ritter, T. 2006. The impact of network capabilities and entrepreneurial orientation on university spin-off performance. ***Journal of Business Venturing***, 21(4): 541-567.

Wang, C. & Burris, M. A. 1997. Photovoice: Concept, methodology, and use for participatory needs assessment. ***Health Education & Behavior***, 24(3): 369-387.

Ward, M. D. & Davis, D. R. 1992. Sizing up the Peace Dividend: Economic Growth and Military Spending in the United States, 1948–1996. ***American Political Science Review***, 86(03): 748-755.

Welter, F. 2011. Contextualizing entrepreneurship—conceptual challenges and ways forward. ***Entrepreneurship Theory and Practice***, 35(1): 165-184.

Wernerfelt, B. 1984. A resource based view of the firm. ***Strategic Management Journal***, 5(2): 171-180.

West, J. & Bogers, M. 2014. Leveraging external sources of innovation: a review of research on open innovation. ***Journal of Product Innovation Management***, 31(4): 814-831.

Zaheer, S. 1995. Overcoming the liability of foreignness. ***Academy of Management journal***, 38(2): 341-363.

Zahra, S. A. 1996a. Technology strategy and financial performance: Examining the moderating role of the firm's competitive environment. ***Journal of Business Venturing***, *11*(3), 189-219.

Zahra, S. A. 1996b. Technology strategy and new venture performance: A study of corporate-sponsored and independent biotechnology ventures. ***Journal of Business Venturing***, 11(4): 289-321.

Zahra, S. A. & Bogner, W. C. 2000. Technology strategy and software new ventures' performance: Exploring the moderating effect of the competitive environment. ***Journal of Business Venturing***, 15(2): 135-173.

Zahra, S. & Covin, J. 2007. Domestic and international competitive focus, technology strategy and company performance: an empirical analysis. ***Technology Analysis & Strategic Management***, 6(1):39-54.

Zahra, S. A. & George, G. 2002. Absorptive capacity: A review, reconceptualization, and extension. ***Academy of Management Review***, 27(2): 185-203.

Zahra, S. A. & Neubaum, D. O. 1998. Environmental adversity and the entrepreneurial activities of new ventures. ***Journal of Developmental Entrepreneurship***, 3(2): 123.

Zahra, S. A. & Nielsen, A. P. 2002. Sources of capabilities, integration and technology commercialization. ***Strategic Management Journal***, 23(5): 377-398.

Zhang, Y. & Li, H. 2010. Innovation search of new ventures in a technology cluster: the role of ties with service intermediaries. ***Strategic Management Journal***, 31(1): 88-109.

Zwi, A. B. 1991. Militarism, militarization, health and the third world. ***Medicine, Conflict and Survival***, 7(4): 262-268.