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The Impact of Home Country Institutions on Corporate Technological Entrepreneurship via R&D Investments and Virtual World Presence*

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In this study, we seek to understand how four dimensions of national business systems surrounding the corporate headquarters of multinational firms influence corporate technological entrepreneurship (CTE). After controlling for fairly well-established antecedents of corporate technological entrepreneurship at the firm and industry levels, we find that national-level predictors explain considerable variance above and beyond our control variables. Furthermore, we find that various national-level dimensions influence different measures of CTE. Overall, our study points to the remarkably strong role of home institutional context for understanding two types of technological entrepreneurship pursued by relatively large, multinational firms based in 24 different economies.

The development of new technologies is often an essential ingredient to entrepreneurial success, economic growth, and firm productivity within our increasingly knowledge-based, global economy (Acs & Audretsch, 2003; Porter, 1990; Shane & Venkataraman, 2003; Siegel, 2006). Technological entrepreneurship exists when developments in science or technology constitute a core element of the opportunity that enables the emergence of a venture, market, cluster, or industry (Beckman, Eisenhardt, Kotha, Meyer, & Rajagopalan, 2012, p. 90). Despite the huge payoffs associated with successful technological entrepreneurship, success is never guaranteed due to the relatively high

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investments required over relatively long periods of time for uncertain outcomes (Phan & Foo, 2004). Therefore, entrepreneurship scholars have long been interested in learning why some firms invest in technological entrepreneurship, while others do not.

There is a rich tradition of research demonstrating that individual entrepreneurs are key contributors to entrepreneurial outcomes. For example, founder and/or chief executive officer (CEO) characteristics have repeatedly shown that these individuals influence the decision to invest in technological entrepreneurship (Terjesen, 2007; Wright, Hmieleski, Siegel, & Ensley, 2007). Similarly, we also know that firm-level characteristics, such as its size, provide slack resources that make investments in technological entrepreneurship a possibility (Chrisman & Patel, 2012). Finally, the technological entrepreneurship literature also recognizes that industry context can influence the degree to which incumbent firms pursue technological entrepreneurship (Kaul, 2012).

Recent research has also shown that national-level factors can influence the extent to which firms pursue technological entrepreneurship. For example, Garud and Karnøe (2003) demonstrated how firms based in Denmark came to dominate wind turbine technologies over firms based in the United States even though much less money was invested by the Danish firms and government. Similarly, Spencer, Murtha, and Lenway (2005) explored how national political institutions interact with entrepreneurial firms to influence the success or failure of technological entrepreneurship investments. More recently, Guillen and Garcia-Canal (2009) reported that multinational firms operating in developing economies are increasingly emphasizing technological entrepreneurship as their labor costs begin to rise and their original source of competitive advantage begins to decline. Overall, the entrepreneurship literature clearly suggests that the factors that influence technological entrepreneurship occur on multiple levels of analysis (Beckman et al., 2012; Hoskisson, Covin, Volberda, & Johnson, 2011; Phan & Foo, 2004).

While the argument that national context influences firm behavior is not particularly new, some observers have asserted that large, multinational firms have transcended their national context and have become "stateless" entities (Economist, 2008). With their access to global flows of capital, human resources, and knowledge, multinational firms are often larger than many nation-states and increasingly conduct "institutional arbitrage." This arbitrage occurs through activities, including such things as: (1) foreign mergers and acquisitions (Schneider, Schulze-Bentrop, & Paunescu, 2010), (2) setting up operations in lightly regulated foreign locations (Murphy, 2005), (3) obtaining financial capital by seeking out favorable interest rates worldwide (Liu & Hsueh, 1993), and (4) through outsourcing and offshoring (Jones, 2006). Most important for this study, multinational firms are increasingly investing in technological entrepreneurship throughout the world (Zhao, 2006). For example, big investments in technological entrepreneurship by Cisco and Google are being made in India—a country with a very different context for entrepreneurship as compared with the United States (Alvares, 2007).

Due to our increasingly interconnected global economy, and the scale and scope available to multinational firms, this leads to our central research question, which is: To what extent are multinational firms embedded in their home country national context with respect to investments in technological entrepreneurship? We ask this question for multinational firms since they are an extreme case of the institutional embeddedness argument. If multinational firms are truly "stateless" in nature, then we would *not* expect their home country context to be systematically related to their pursuit of technological entrepreneurship. However, if even these geographically diverse firms remain institutionally embedded, then their home country context should continue to influence these decisions.

In our pursuit of this question, we contribute to the technological entrepreneurship literature in three ways. First, we build on previous technological entrepreneurship

literature by considering firm- and industry-level antecedents, such as CEO characteristics, firm size, and industry growth rates, and it extends that literature by also exploring the relative influence of the multinational firm's home context. In so doing, we begin to develop a more holistic, multilevel, "meso" understanding of technological entrepreneurship that refines and extends the field of entrepreneurship into a more global perspective. Since technology no longer respects national boundaries, this has important implications for entrepreneurs as well as public policy makers.

Second, we examine technological entrepreneurship within some of the largest firms operating in the global economy. Multinational enterprises (MNEs) are important players in the global economy, and are integral to national competitiveness in general and technological entrepreneurship in particular (Cerrato, 2009; Zander, 1997). Notably, Birkinshaw (1997, 1999) has shown how foreign subsidiaries contribute to entrepreneurial ventures within MNEs, but we have very limited understanding of how the parent MNE influences overall technological entrepreneurship. As such, we extend entrepreneurship theory and research into large, multinational firms to better understand how these types of firms contribute to technological entrepreneurship within national business systems. Interestingly, we find that the national context in which a multinational firm is headquartered explains unique variance in technological entrepreneurship, above and beyond CEO-, firm-, and industry-level predictors. Notably, we demonstrate that "national imprinting" continues to influence even the largest multinational firms in the world (Stinchcombe, 1965), which refines and extends existing institutional theory.

Third, we consider two very different measures of technological entrepreneurship—a general and traditional measure based on overall research and development intensity, and a relatively focused and untraditional measure based on a unique hand-collected data set of technological venturing into an online virtual world. With both general and specific operationalizations, a more complete and robust understanding of technological entrepreneurship for MNEs is advanced.

Theory Development

We begin this section by discussing what technological entrepreneurship is and how it relates to the larger entrepreneurship literature. Then, we discuss how national institutions may influence technological entrepreneurship above and beyond firm- and industry-level antecedents by considering a prominent institutional framework within the national business system literature.

The Nature of Technological Entrepreneurship

The essence of entrepreneurship is "the willingness to pursue opportunity, regardless of the resources under control" (Stephenson & Jarillo, 1990, p. 23). Corporate entrepreneurship refers to "the process of organizational renewal through innovation and corporate venturing, as well as activities that enhance a corporation's ability to compete and take risks, which may or may not involve the addition of new businesses to a corporation" (Phan, Wright, Ucbasaran, & Tan, 2009, pp. 198–199). In essence, corporate entrepreneurship takes place within established organizations while "independent" entrepreneurship takes place within new firms (Sharma & Chrisman, 1999). Because we focus on technological entrepreneurship within established firms, this study will focus on corporate technological entrepreneurship (Antonic & Prodan, 2008; hereafter referred to as "CTE").

CTE is often focused on using technology to differentiate the firm from its competitors (Venkataraman, 2004). Since not all corporate entrepreneurship depends on technology, CTE represents a subset of all corporate entrepreneurial activities (Dodgson, 2009). CTE requires the blending of new technologies with unmet market opportunities (Eisenhardt & Forbes, 1984). Although relatively small and young entrepreneurial firms often pursue high-risk technological entrepreneurship (e.g., Yu, Stough, & Nijkamp, 2009), our focus in this study is on technological entrepreneurship within relatively large, established firms. Due to the high cost, specialized expertise, and long lead times associated with CTE, large and well-established MNEs may be the key business entities that can substantively undertake these types of entrepreneurial ventures (Antonic & Prodan, 2008; Gassman, Widenmayer, & Zeschky, 2012). Unfortunately, we simply do not know to what extent this population of firms' approach to CTE is influenced by its national context. Hence, that is the focus of our next section.

National Business Systems and CTE

There are many ways to conceptualize the national institutional context within which firms operate. One popular and promising theoretical framework for characterizing the institutional context in which MNEs operate is the national business systems approach. Whitley (1992, p. 13) conceptualized a national business system as "the distinctive configurations of hierarchy-market relations which become institutionalized as relatively successful ways of organizing economic activities in different institutional environments." Whitley (1999) identified four institutional subsystems that operate within the national business system: (1) the financial subsystem, (2) the educational and training subsystem, (3) the legal and regulatory subsystem, and (4) the authority and trust subsystem.

In this study, we build our theoretical predications based on Whitley's four subsystems to comprehensively characterize the national business system in which our multinational firms are headquartered. In essence, our central theoretical premise is that the institutional context created by the national business system influences CTE in predictable and systematic ways, even for large multinational firms.

Some might argue that multinational firms transcend their national business system since they operate in international markets. Whitley argues otherwise. He states:

> It is important to recognize that multinational firms develop in particular institutional contexts which condition and guide their growth and structure. Thus, U.S. firms reflect their origins, as do British and Japanese ones, so that their recipes for success and preferred ways of operating follow the dominant pattern in their home economies. (Whitley, 1999, p. 177)

In summary, we argue that multinational firms are heavily imprinted within their national business system, and hence, their home economy and country of origin has a predominant influence on the multinational firm's approach to technological entrepreneurship.

Financial Subsystem. Whitley (1992, 1999) argues that financial subsystems operate differently across national business systems and that these differences have profound influences on how businesses operate. For example, some financial subsystems rely predominantly on family and kinship relations for access to financial resources (e.g., Italy), while other financial subsystems draw from both private, personal sources, and public, impersonal sources (e.g., United Kingdom). Consequently, the range and availability of financial resources can have a major influence on the entrepreneurial norms and practices within a society.

For multinational firms with their access to global financial markets, capital flows into and out of the firm's home country are likely to have little or no influence on the firm if it is truly "stateless." Standard macroeconomic theory argues that capital flow controls make home country firms more dependent on national markets and less dependent on global markets for their capital needs (Arrow & Hahn, 1973; Errunza & Losq, 1989).

However, recent research challenges this perspective since capital appears to flow to countries with relatively low returns and high levels of capital constraints (Ohanian & Wright, 2010). Knyght, Kakabase, Kouzmin, and Kakabase (2011) clarify this new insight by explaining that national capital flows are positively associated with short-term thinking, counter to classical assertions. The upside aspects of increased flows are greater integration of the national economy with the global economy and the facilitation of more sources of capital in a domestic economy (Bird, 2012). The downside aspects of increased capital flows are: (1) the economy is more likely to experience inflation, (2) there is more speculative investment in real estate and asset bubbles, (3) currency appreciation can lead to loss of global competitiveness, and (4) capital surges often follow capital scarcity (Bird). Perhaps because of these new insights, the International Monetary Fund no longer requires all emerging economies to increase their capital flows in all instances.

Acer is a good example of the counterintuitive influence of capital constraints on technological innovation. Acer is the only non-American, non-Japanese manufacturing firm in the top 10 global producers of personal computers (PCs). Among other factors, Acer has been a technology innovator in the global PC market *because* of the capital constraints operating in Taiwan. Hence, Acer has focused on high value-added elements of the PC-value chain with great success, precisely because of Taiwan's capital constraints (Hon, Tarng, & Po-Young, 2000). Thus, Acer's example helps to demonstrate that the restriction of capital flowing in and out of the multinational firm's home country can work to make the firm *more* inclined to invest for the long term while exploiting existing markets. As such, the free flow of capital is likely to *limit* the multinational firm's level of technological entrepreneurship due to the long-term payoff of these investments from a national business systems perspective.

Hypothesis 1: The higher the freedom of capital flows into and out of a national economy, the less likely multinational firms headquartered in that national economy will engage in CTE.

Education and Training Subsystem. Whitley (1992, 1999) also argued that the educational subsystem acts as a series of collective cognitive filters designed to identify and develop the most academically competent, while the training system provides technical and practical skills for implementing new ideas quickly and effectively. For example, the nature of the Australian education and training system limited its ability to develop heavy industry (p. 63). Relatedly, the German educational system influenced the flexibility of its workforce to remain open to new technologies (p. 111). Therefore, the national business system can influence the level and type of expertise available to a national economy, and this expertise both liberates and constrains specific economic activity.

Previous entrepreneurship research supports this notion that investments in education and training are positively related to innovation and entrepreneurship. For example, Finland possesses a national innovation strategy, and heavy investment in a highly educated workforce is central to that strategy (Blau, 2008). Similarly, education expenditures and entrepreneurship are positively correlated in various regions of the United States (Doms, Lewis, & Robb, 2010) and the European Union (Grilo & Irigoyen, 2006).

And recent gains in productivity and entrepreneurship in Ghana have been attributed, in part, to its investments in education (Robson, Haugh, & Obend, 2009). Finally, Dalziel, Gentry, and Bowerman (2011) found that higher educational levels of corporate directors were associated with greater levels of corporate venturing and entrepreneurial activity.

To be successful, technology-based new ventures must generate new and useful technologies and possess the ability to manage the commercialization process (Friar & Balanchandra, 1999). Consequently, the education and training subsystem operating within a nation has been shown to be particularly important to technological entrepreneurship (Rodriguez & Marti, 2006).

For example, Siegel (2006) provides a wealth of research on how academic institutions can be a source of new ideas and technologies through licensing and patenting, partnering with science parks and incubators, and promoting university-based start-ups. Similarly, Venkataraman (2004) argues that while technological entrepreneurship requires concrete tangible resources such as risk capital and appropriate infrastructure, it is the intangible resources enveloping a technology venture that is often the key differentiator as to why some technologies flourish while others do not. Baptista, Lima, and Mendonca (2011) recently documented higher levels of technological entrepreneurship in Portugal after the establishment of a new, science-based university in the region. In sum, the overall quality of the education and training system is expected to influence the propensity to engage in technological entrepreneurship as well.

Hypothesis 2: The higher the quality of education and training within a nation, the more likely multinational firms headquartered in that national economy will engage in CTE.

Legal and Regulatory Subsystem. According to Whitley (1992, 1999), another fundamental subsystem in which corporations are embedded pertains to legal and regulatory institutions that formally legitimize certain behaviors while forbidding others. In a comprehensive research stream, La Porta and associates (e.g., La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1997, 1998; La Porta, Lopez-de-Silanes, & Shleifer, 2008) have explored the relationships between national legal system origins and financial structures and outcomes. This work focuses on the fundamental differences between common-law legal traditions (derived from English law), and civil-law traditions (derived from Roman law). In common-law business systems, the rights of property owners are privileged over other stakeholders. In contrast, corporate executives and directors are expected to consider all stakeholders in civil-law countries, and property rights are not given special privileges.

Executives in common-law countries are therefore legally required to add value to the corporation with fewer regulatory constraints than executives in civil-law countries. Notably, there is some recent literature suggesting that the legal and regulatory subsystem may influence entrepreneurship within a national economy. For example, Puffer, McCarthy, and Peterson (2001) argued that the (civil law) legal system operating in Russia hindered entrepreneurship in that country. Similarly, Troilo (2011) argued that civil-law nations generally require higher numbers of procedures to start a business and enforce a contract, and consequently, the number of days to start a new business is much higher than start-ups in common-law nations. Finally, Visentini and Panzironi (2007) pointed out that the Italian civil-law system operates with excessive regulatory costs without the commensurate benefits.

This relationship between legal systems and entrepreneurship is expected to be particularly strong for firms seeking to be entrepreneurial via new technologies.

Technology entrepreneurs frequently create valuable new intellectual property, and they want this property to be protected from imitators. Indeed, some researchers view the essence of technological entrepreneurship as the commercialization of new intellectual property (Siegel & Wright, 2007). Recent research has suggested that the (civil law) legal systems operating in Eastern Europe may be partially to blame for the lack of technological entrepreneurship in those countries due to the lack of intellectual property protection afforded in those nations (Todorovic & Ma, 2010). As a result, technological entrepreneurship is expected to find a relatively more hospitable environment in common-law than in civil-law countries.

Hypothesis 3: Multinational firms headquartered in nations with a common-law legal system will engage in higher levels of CTE than multinational firms headquartered in nations with civil-law legal systems.

Trust and Authority Subsystem. According to Whitley (1992, 1999), all economic transactions are based on trust, and national business systems vary substantially in the level and types of trust cultivated. The nature of trust therefore affects how authority is operationalized within and between firms. He states:

> All market economies institutionalize particular ways of ensuring trust between exchange partners, coordinating economic activities between firms and organizing work within them. These reflect more general and underlying principles of cooperation, identity, and subordination to authority which have become institutionalized in different societies. (Whitley, 1992, pp. 19–20)

In their meta-analysis of the antecedents and effects of corruption, Judge, McNatt, and Xu (2011) argued that national corruption is an informal institution that greatly influences trust and economic exchange within and between firms. Perhaps this is why Bowen and de Clercq (2008) found that national corruption was negatively associated with entrepreneurial intentions by individuals. Subsequent to that study, Tonoyan, Strohmeyer, Habib, and Perlitz (2010) demonstrated how national corruption limited entrepreneurship within transition economies. And Anokhin and Schulze (2009) argued that corruption reduces trust in economic exchange and increases transaction costs. In their comprehensive study of 64 nations, they also found an inverse relationship between national corruption and the formation of new entrepreneurial ventures.

Hannafey (2003) argues that entrepreneurs face uniquely complex moral problems, and that these problems are accentuated for technological entrepreneurship due to the plethora of opportunities to capitalize on asymmetric information. As such, there is some preliminary literature suggesting a particularly strong link between corruption levels and technological entrepreneurship. For example, Bubou and Okrigwe (2011) argue that Nigeria will never be a source of technological entrepreneurship until corruption levels are reduced. In contrast, Abetti (2004) asserts that Finland has a competitive advantage over other countries in developing new technologies, at least partially due to its relatively low levels of corruption. In sum, national corruption may stifle the creation and/or development of technological entrepreneurship within an economy due to the need for extensive trust and cooperation within and between such ventures.

Hypothesis 4: The higher the perceived corruption operating within a national economy, the less likely multinational firms headquartered in that national economy will engage in CTE.

Research Design

Sample

In order to study a geographically diverse sample of multinational firms, we focused our study on the largest multinational firms in the world—the Global 500 listing in *Fortune* magazine. Specifically, we obtained the Global 500 listing published in *Fortune* in July 2008. These firms are the 500 largest publicly traded firms in the world, based on revenues. They employed over 54 million employees worldwide and represented more than one third (38.7%) of global gross domestic product. Due to missing data, our final sample included 211 multinational firms located in 24 different countries. To verify the representativeness of our subsample, we compared the 211 firms with the rest of the Global 500 firms on firm size (as measured by the number of employees), sales, revenue growth rate, and return on assets. Our *t*-tests showed nonsignificant mean differences on all of these variables, suggesting that the sample firms are generally representative of the Global 500 firms.[1]

Operationalizing CTE

In a recent special issue published in *Strategic Entrepreneurship Journal*, the guest editors argued that technological entrepreneurship exists when: ". . . developments in science or engineering constitute a core element of the opportunity that enables the emergence of a venture, market, cluster, or industry" (Beckman et al., 2012, p. 90). Hence, technological entrepreneurship represents a systematic effort by a corporation to create or utilize new technologies.

General CTE. We considered a wide array of archival measures that have been used for studies of overall CTE. Specifically, the literature has used: (1) research and development (R&D) intensity (Filatotchev & Piesse, 2009), (2) patents (Kotha, Zheng, & George, 2011), (3) new product introductions (Miner, Bassoff, & Moorman, 2001), (4) creation of new technology alliances (Van de Vrande, Vanhaverbeke, & Duysters, 2009), and (5) creation and/or utilization of corporate venture capital units (Gaba & Bhattacharya, 2012). Unfortunately, only R&D expenditure data were available in a reliable and accessible format outside of the United States. Furthermore, due to different laws and intellectual property traditions, patent data and technology-based alliance agreements are unlikely to be comparable across countries. Hence, we chose to focus on R&D intensity for our sample of multinational firms.[2]

R&D investment intensity is arguably the most common measure of the firm's general level of technological entrepreneurship (e.g., Chrisman & Patel, 2012; Kaul, 2012; Shrader, 2001; Zahra, 1996). Hence, we used R&D investment intensity as a measure of the firm's general CTE. Following Ettlie (1998), we operationalized the construct as the ratio of R&D expenditures to total sales. We obtained this measure for 2009 from Thomson One Financial for our sample firms.

Specific CTE. Previous studies that have used R&D intensity have been criticized for being too focused on the inputs to technological entrepreneurship while ignoring the

1. For further details on these tests, please refer to Appendix 1.
2. For further details on previous empirical studies of corporate technological entrepreneurship, please refer to Appendix 2.

outputs (Weiser, 2005). This measure has also been criticized as being too broad and general as it comprises many different forms and projects for entrepreneurial ventures (Gittelman, 2008). As a result, we sought to look at technological entrepreneurship within a specific context to complement our investigation of the R&D intensity measure.

In this study, we operationalized a specific form of CTE as the virtual presence or absence of the MNE in *Second Life*—an emerging "virtual world" technology on the Internet. As such, our measure was more in the spirit of adoption of an emerging new technology, similar to total quality management adoption (Kennedy & Fiss, 2009) or e-banking (Weigelt & Sarkar, 2009). However, entrepreneurship arises primarily from looking forward and experimenting with new technologies, rather than looking backward at adoption of established technologies (Miller, 2007).

Second Life by Linden Labs is a richly detailed three-dimensional virtual world and functions as one of the many massive multiplayer virtual communities on the Internet. As of July 2012, *Second Life* boasts more than 30 million "residents" (Voyager, 2012). During the second quarter of 2011, monthly unique users to *Second Life* averaged over 1 million per month, logging a total of 103 million user hours (Linden, 2011). Economic activities are abundant within *Second Life*, too. Residents traded L$1,151 million worth of in-world virtual products and services, representing a 38.1% growth over the same quarter in the previous year (Linden). While there are no published listings of "first life" corporations with a virtual presence on *Second Life*, it is clear to many that corporations are growing in visiting frequency, size, and sophistication (G. Fisher, personal communication, November 4, 2009).

The entrepreneurial nature of *Second Life* ventures has been pointed out by quite a few researchers (Chandra & Leenders, 2012). For instance, in a recent qualitative field study, Mackenzie, Buckby, and Irvine (2009) examined 20 entrepreneurial firms operating in *Second Life* in 2007. They argued that "lead users" of *Second Life* are pioneering entrepreneurs, who are discovering and shaping innovative and surprising new processes and products. Through a survey of technology firms in Germany, Berry and Brock (2004) identified four ways in which virtual worlds, such as *Second Life*, can benefit corporations: (1) reducing a firm's interaction costs, (2) enhancing and accelerating organizational learning, (3) expanding the geographic reach of the firm, (4) extending the business network, and most importantly for this study—facilitating technological entrepreneurship. In a recent overview of this highly entrepreneurial environment, Wyld (2010, p. 551) stated:

> Certainly, even today, visionaries and entrepreneurs are busy creating whole new ways of doing business and even whole new categories of businesses—some truly hybrid between the virtual and real worlds—in *Second Life* and other virtual world environments.

In sum, a presence in *Second Life* can represent the ability of a firm to strategically renew itself and explore unproven technological innovations. Hence, it can serve as a specific technological entrepreneurship indicator. We measured this form of CTE as a dichotomous variable where a "1" signifies that the firm had a presence in *Second Life* in 2009, and a "0" indicates that the firm was not present in *Second Life*. Table 1 contains a listing of the 54 of the Global 500 firms that had a presence in *Second Life* in 2009.

Since this is a new measure of CTE, we sought to determine its convergent validity (Fiske, 1982). First, we conducted field interviews with *Second Life* adopters to learn how and why they were experimenting with this virtual world. Specifically, we conducted in-depth telephone interviews with executives at five Global 500 adopters of *Second Life*. Some of these managers ventured into *Second Life* on their own and subsequently convinced their employers to conduct entrepreneurial "experiments." Others ventured into

Table 1

Global 500 Firms Demonstrating Specific Corporate Technological Entrepreneurship in an Emerging Virtual World

Company name	Headquarters	Employment	Company name	Headquarters	Employment
IBM	United States	386,558	Pfizer	United States	86,600
Arcelor Mittal	Luxembourg	311,000	Time Warner	United States	86,400
Verizon Communications	United States	235,000	Intel	United States	86,300
Peugeot	France	207,800	Telecom Italia	Italy	83,429
Saint-Gobain	France	207,000	Banco Bradesco	Brazil	82,773
SNCF	France	201,742	Dell	United States	82,700
Toshiba	Japan	198,000	Fujifilm Holdings	Japan	78,231
Accenture	United States	186,000	Enel	Italy	73,500
Fiat	Italy	185,227	TUI	Germany	68,521
Honda Motor	Japan	178,960	Cisco Systems	United States	66,129
BNP Paribas	France	162,687	Mitsubishi Heavy Industries	Japan	64,103
Crédit Agricole	France	162,000	Aviva	United Kingdom	57,011
NEC	Japan	154,786	Groupe Caisse d'Épargne	France	51,245
Best Buy	United States	150,000	Mizuho Financial Group	Japan	49,114
Samsung Electronics	Korea	144,000	Telstra	Australia	47,840
Renault	France	130,179	Royal KPN	The Netherlands	43,531
BT	United Kingdom	111,900	Toyota Industries	Japan	39,528
BMW	Germany	107,539	Mitsubishi Chemicals	Japan	39,305
Mitsubishi Electric	Japan	105,651	Commerzbank	Germany	36,767
Kraft Foods	United States	103,000	Dexia Group	Luxembourg	35,202
Volvo	Sweden	101,700	Manpower	United States	33,000
Nokia	Finland	100,534	Mapfre Group	Spain	29,740
Comcast	United States	100,000	Millea Holdings	Japan	24,959
Novartis	Switzerland	98,200	Energie Baden-Württemberg	Germany	20,499
Intesa Sanpaolo	Italy	98,122	KDDI	Japan	15,865
BP	United Kingdom	97,600	Xerox	United States	13,000
Microsoft	United States	91,000	Samsung Life Insurance	Korea	6,337

Note: The 211 companies in this table showed a presence in the 3D virtual world *Second Life* as of 2009.

Second Life because "we are an entrepreneurial firm and we can't afford to not learn from and attempt to shape this new technology." Furthermore, one top executive declared: "Exploring this virtual world keeps us thinking fresh, and it helps to avoid complacency. This exploration may or may not lead to new business opportunities, but we don't want to be blindsided by new emerging technologies." These limited field data suggest that the search for technological innovation and strategic renewal is integral to the exploration of a corporate presence in *Second Life*.

Predictor Variables

To limit collinearity, we restricted our measures of each subsystem to a single archival proxy, which are themselves often a composite indicator developed via multiple data sources. Each of those measures is discussed later.

Freedom of Capital Flows. Previous literature and logic argues that the availability and free flow of financial capital into and out of an economy can influence entrepreneurial activity within an economy, and Whitley (2007) concurs. Consequently, we obtained data on the freedom of capital flows into and out of a national economy. For Freedom of Capital Flow, we obtained the data for 2008 from the Global Competitiveness Report by the World Economic Forum (2009). This measure was evaluated by over 12,600 executives and experts for 134 countries. The specific item reads: "How restrictive are regulations in your country relating to international capital flows?" (1 = highly restrictive; 7 = not restrictive at all), and it is located on page 454 of the Global Competitiveness Report.

Quality of Education. Our measure of the educational subsystem was obtained from the same Global Competitiveness Report, on page 17. However, we selected a composite measure of the education system so that both formal education and informal training and development were captured, as Whitley (1992) insists. The composite index is a blending of the following two archival measures (i.e., secondary and tertiary enrollment) and six perceptual measures on a 1–7 Likert scale: (1) quality of educational system, (2) quality of math and science education, (3) quality of management schools, (4) Internet access of schools, (5) availability of research and training services, and (6) extent of staff training.

Legal System Type. La Porta et al. (2008) argued that countries whose legal systems have a common-law origin emphasize freedom of contract and the protection of private property, whereas those with civil-law roots favor an activist role for the state. Consequently, in this study, we coded the headquarters nation for the multinational as a "1" if it was located in a common-law system, and a "0" if in a civil-law system. We obtained this Legal System data for 2008 from the Central Intelligence Agency's (CIA) website (CIA, 2009).

Perceived Corruption. According to a recent meta-analysis of national corruption studies, Judge et al. (2011) determined that the Corruption Perceptions Index (CPI) by Transparency International provided the best overall measure of aggregate perceived corruption within a national economy. This index measures the perceived levels of public-sector corruption in a given country and is a composite index, drawing on different expert and business surveys. The 2008 CPI scores 180 countries on a scale from 0 (highly corrupt) to 10 (highly clean). To make this measure more intuitive, we transformed this

measure to make higher numbers indicate greater levels of corruption. We obtained this data for 2008 from the Transparency International (2010) website.

Control Variables

CEO Characteristics. Previous research has clearly shown that CEO characteristics directly and indirectly influence CTE (Baum, Locke, & Smith, 2001; Simsek, Heavey, & Veiga, 2010). Two prominent CEO characteristics that influence their behavior are CEO Age and CEO Tenure. For instance, CEO Age has been found to limit the CEO's career horizon and lead to risk aversion (McClelland, Barker, & Oh, 2012). Therefore, older CEOs are often less likely to engage in highly risky and uncertain entrepreneurial ventures. Similarly, CEO Tenure has been found to be systematically and negatively related to CTE (Ling, Simsek, Lubatkin, & Veiga, 2008; Wu, Levitas, & Priem, 2005). In this study, we obtained both CEO Age and CEO Tenure from Thomson One Financial. We recorded CEO Age as of 2008 and measured CEO Tenure as the number of years in which the sitting CEO had been operating in his or her chief executive role by 2008.

Firm Characteristics. Previous research has also found that Firm Size is systematically related to CTE and that larger firms generally have more resources at their disposal to pursue entrepreneurial ventures (Damanpour, 1996; Leiblen & Madsen, 2009). Firm size data were obtained from the Fortune online database and was measured as the natural log of the number of employees in 2008.

Industry Characteristics. We include Industry Growth Rate as an industry-level control variable, which is generally believed to positively influence corporate innovation and entrepreneurship via the structure/conduct/performance perspective (e.g., Galbraith & Stiles, 2008; Gohmann, Hobbs, & McCrickard, 2008). We obtained the primary Standard Industrial Classification (SIC) code for each firm from the Fortune Global 500 listing and manually collected data on the industry growth rate associated with that industry for the time period leading up to 2008. Specifically, we used the 3-year average growth rate instead of growth rate for a single year to capture a more stable trend in industry growth. The data were obtained from the *Datamonitor* global industry profiles (Datamonitor, 2009).

In addition, we included Industry Sector as a control variable. This was a dichotomous variable where a "1" indicated that the multinational firm's primary industry was in a manufacturing sector, and a "0" indicated that the primary industry was in the service sector. Previous literature has shown that entrepreneurship investment levels and types vary considerably by industry sector (Cheng, 2011). Specifically, we used the primary SIC code for each firm and classified each firm by considering whether the SIC was essentially a manufacturing- or service-based industry. Table 2 summarizes the operationalization and data sources for all variables.

Data Analysis and Results

Sample Statistics

Table 3 contains a summary listing of the 24 countries represented by our sample, as well as number of MNEs headquartered in each country and the central tendencies for the

Table 2

Sources and Measures of Constructs

Variable	Measure (year)	Data source
R&D intensity	Annual research and development expenditure divided by net sales times 100 (2009)	Thomson One Financial
SL presence	Firm presence in *Second Life* (2009)	Manual observation in the *Second Life* virtual world
Freedom of capital flows	The perceived degree of restriction on capital flows into and out of the country (2008)	Global Competitiveness Report, Item number 8.05
Quality of education	A composite index reflecting secondary and tertiary enrollment rates, the quality of education as assessed by the business community, and the extent of vocational and on-the-job training (2008)	Global Competitiveness Report, Institutional Pillar #5
Legal system type	A country's legal system as civil-law (0) or common-law (1) system (2008)	Central Intelligence Agency website
Perceived corruption	Corruption Perceptions Index (2008)	Transparency International website
CEO tenure	The number of years in which the current CEO had been operating in the chief executive role (2008)	Thomson One Financial
CEO age	Age of the current CEO (2008)	Thomson One Financial
Firm size	Log-transformed number of employees (2008)	*Fortune* Global 500 Listing
Industry growth rate	Average annual growth rate in industry total sales for the previous 3 years (2005–2008)	Datamonitor
Industry sector	Whether the firm's primary industry represents a manufacturing (1) or service (0) sector (2008)	*Fortune* Global 500 Listing

R&D, research and development; CEO, chief executive officer; *SL*, *Second Life*.

two dependent and five firm-level independent variables. Notably, the United States contains the greatest number of MNEs, but Japan is not far behind. Germany is the third most common headquarters location, as might be expected by these three country's traditional share of the global economy. While China only has six MNEs represented in our sample, this datum is to be expected given our study period of 2008–2009. Notably, Finland has the highest average R&D investment intensity, closely followed by Switzerland and the United States. Interestingly, Austria has the lowest R&D intensity in our sample, but MNEs headquartered in India, Turkey, and Australia are also R&D investment laggards.

A further interesting fact is that MNEs located in Luxembourg, Italy, Finland, and Australia are all well represented in the *Second Life* virtual world despite their relatively sparse representation among the 500 largest firms in the world. In contrast, MNEs located in Austria, Belgium, Brazil, Canada, China, India, Israel, Norway, Russia, Taiwan, and Turkey did not establish a presence in *Second Life*. Mean values by country for the firm-level controls are also included in this table.

Multilevel Data Analysis

To capture the unique contribution of our national-level predictors, we used two-level hierarchical linear modeling to analyze our data. In essence, the statistical model grouped the sample firms into a nested structure of firms within countries. At the first level, we modeled CTE as a function of all firm- and industry-level control variables and a country-level intercept. Equation 1 shows the first-level equation for technological entrepreneurship:

Table 3

Summary of 211 Multinational Firms Sampled Within Each Country

Countries	Number and percent of firms in global 500	Number and percent of firms in sample	Average firm R&D intensity (%)	Firms in *Second Life* (%)	Average firm size†	Average CEO tenure	Average CEO age	Average industry growth rate (%)	Firms in manufacturing sector (%)
Australia	9 (1.8%)	2 (1.0%)	.17	50	10.70	4.84	51	14.4	50
Austria	2 (.4%)	1 (.5%)	.08	0	10.45	7.42	50	22.0	100
Belgium	5 (1.0%)	1 (.5%)	.43	0	11.67	3.42	50	2.9	100
Brazil	6 (1.2%)	1 (.5%)	.75	0	11.25	3.83	59	22.0	100
Canada	14 (2.8%)	2 (1.0%)	.90	0	11.60	11.21	56	12.6	100
China	37 (7.4%)	6 (2.8%)	.71	0	12.05	2.67	52	9.4	83.3
Finland	2 (.4%)	2 (1.0%)	6.25	50	10.03	3.75	53	17.4	100
France	40 (8%)	19 (9.0%)	3.28	15.8	11.58	5.14	56	8.1	94.7
Germany	39 (7.8%)	20 (9.5%)	2.24	10	11.63	4.32	58	7.9	85
India	7 (1.4%)	4 (1.9%)	.22	0	10.35	5.46	58	21.2	100
Israel	1 (.2%)	1 (.5%)	.45	0	9.83	2.00	52	22.0	100
Italy	10 (2.0%)	5 (2.4%)	3.14	60	11.43	6.74	63	10.6	80
Japan	68 (13.6%)	48 (22.8%)	2.97	18.8	10.83	3.89	62	9.6	83.3
South Korea	14 (2.8%)	9 (4.3%)	.66	11.1	10.23	1.74	57	15.3	100
Luxembourg	1 (.2%)	1 (.5%)	.39	100	12.65	37.5	58	18.8	100
The Netherlands	12 (2.4%)	6 (2.8%)	2.81	16.7	10.99	4.21	61	12.2	83.3
Norway	1 (.2%)	1 (.5%)	.45	0	10.27	4.75	46	22.0	100
Russia	8 (1.6%)	2 (1.0%)	.56	0	12.04	2.21	45	16.2	100
Sweden	6 (1.2%)	4 (1.9%)	4.85	25	11.04	5.99	59	8.4	100
Switzerland	15 (3.0%)	7 (3.3%)	5.89	14.3	11.49	4.22	52	6.76	100
Taiwan	6 (1.2%)	1 (.5%)	1.33	0	13.09	10.25	60	4.2	100
Turkey	1 (.2%)	1 (.5%)	.14	0	11.13	2.00	63	5.2	100
United Kingdom	27 (5.4%)	12 (5.7%)	3.23	16.7	11.23	3.08	51	10.2	83.3
United States	140 (28.0%)	55 (26.1%)	5.12	16.4	11.22	6.32	56	8.4	89.1

† Firm size is the natural log of the number of employees.
R&D, research and development; CEO, chief executive officer.

$$\begin{aligned}\text{RDIntensity}_{ij} = {} & \rho_{i0} + \rho_{i1}\text{CEOAge} + \rho_{i2}\text{CEOTenure} + \rho_{i3}\text{FirmSize} \\ & + \rho_{i4}\text{IndustryGrowthRate} + \rho_{i5}\text{IndustrySector} + \varepsilon_i\end{aligned} \tag{1}$$

where the subscripts *i* and *j* denote firm *j* from country *i*. For specific technological entrepreneurship as measured by *Second Life* presence, because of the dichotomous nature of the variable, we used a logit structure for the first-level as shown in equations 2 and 3 below:

$$\text{Probability}\left(\text{SL Presence}_{ij} | \rho\right) = \varphi_{ij} \tag{2}$$

where φ_{ij} is a latent value estimated from the following logit function:

$$\begin{aligned}Log\left[\frac{\varphi_{ij}}{1-\varphi_{ij}}\right] = {} & \rho_{i0} + \rho_{i1}\text{CEOAge} + \rho_{i2}\text{CEOTenure} + \rho_{i3}\text{FirmSize} \\ & + \rho_{i4}\text{IndustryGrowthRate} + \rho_{i5}\text{IndustrySector} + \varepsilon_i\end{aligned} \tag{3}$$

At the second level, the country-level intercept was modeled as a function of our four country-level predictors, as in equation 4 below.

$$\rho_{i0} = \beta_0 + \beta_1\text{CapFlow}_i + \beta_2\text{Edu}_i + \beta_3\text{Legal}_i + \beta_4\text{Corruption}_i + \varpi_{i0} \tag{4}$$

where CapFlow_i represents the freedom of capital flow; EDU_i captures the overall quality of higher education and on-the-job training; Legal_i indicates the legal system type in country *i*; and Corruption_i indicates the level of national corruption for country *i*. ϖ_{i0} is the country-level error.

Different from ordinary least squares regression, a hierarchical linear model allows error terms for firms from the same country to be correlated with each other. In doing so, it allows for unknown or omitted country-level influences on each subset of firms, thereby yielding more accurate parameter estimates. In our model, we also allowed the parameters for firm- and industry-level control variables to be distributed around a grand sample mean plus a random component across countries. This takes into account the fact that these control variables, such as CEO age, may exert varying influences in different countries.

In addition to the proposed model (Model 5), we tested a few alternative model specifications. One alternative model was to use the same hierarchical linear modeling (HLM) structure but exclude all four national predictors (Model 4). Instead, the first-level intercept ρ_{i0} was set to vary randomly across countries. Comparing this alternative specification with our proposed model can indicate the contribution of the national variables in predicting CTE.

As the HLM is only one way to address a nested sample, we also estimated a single-level random-effects model structure. Here, the national predictors and all control variables were entered simultaneously into a single-level equation with the slope for each variable held constant across countries. The model intercept was then allowed to vary randomly across countries. As the error terms for firms within the same country may be correlated with each other, we used cluster-robust standard errors (Cameron & Trivedi, 2005). Under the random-effects model structure, we estimated two alternative specifications, one without national predictors (Model 2) and one with national predictors (Model 3). Finally, we estimated a fixed-effects model with cluster-robust standard errors (Model 1). This was similar to the random-effects model except that a fixed model

intercept was estimated for each country, instead of using a random distribution. As such a fixed-effects model does not allow country-constant variables in the model; we only estimated the fixed-effects model without the national predictors.

Empirical Results

Table 4 contains descriptive statistics for our dependent, control, and predictor variables, and Table 5 presents simple mean and median tests of our hypotheses without taking into consideration firm- and industry-level controls. There does not appear to be any collinearity problems with our data, with the possible exception of Freedom of Capital Flow and Perceived Corruption, which had a variance inflation factor statistic over 4.0 (4.15 and 4.98, respectively). Because of these concerns, we reran our analysis without these variables and discovered that the results did not change in any substantial way. Therefore, multicollinearity does not appear to influence our results.

Table 6A contains the estimates from our five alternative model specifications for the first dependent variable—general CTE as measured by R&D intensity. As HLM does not yield a traditional R^2 statistic, we used a pseudo-R^2 measure to indicate the variance accounted for in the dependent variable by the two HLM models (Snijders & Bosker, 1999).

Comparing across models, the random-effects model with national predictors (Model 3) yielded the best model fit, with an R^2 of .16. This was followed by the proposed HLM model with national predictors (Model 5), with an R^2 of .14. The significant increase in R^2 between the models with and without national predictors ($F = 4.76$, $p < .001$ for random-effects models, and $F = 2.33$, $p = .057$ for HLM models) suggests the important role of these national predictors in explaining overall CTE. Furthermore, for the full HLM model (Model 5), our four national-level predictors accounted for 90.51% of country-level variance in overall CTE. This suggests that the proposed country-level variables are good indicators of national differences.

As can be seen in Table 6A, the estimates across the five models are quite similar. The national institutions associated with Legal System and Quality of Education System were both positively associated with our general measure of CTE, as supporting hypotheses 2 and 3. Based on the best-fitting random-effects model, a one-point increase (on a 7-point scale) in Quality of Education System increases the R&D intensity for firms in that country by 1.63%, and having a common-law legal system leads to .99% higher R&D intensity than a civil-law system.

The effect of Freedom of Capital Flows was also significant and negatively related, as hypothesized. Indeed, a one-point increase in Freedom of Capital Flow decreases the R&D intensity for firms in that country by 1.12%. Overall, hypotheses 1, 2, and 3 were supported, while hypothesis 4 was not supported by our data when considering the influence of national institutions on general CTE.

In Table 6B, we reran the same five model specifications but using a logit structure for our second dependent variable—specific CTE as proxied by the firms' *Second Life* presence. As HLM with a logit structure has varying first-level error variance across units, it is not possible to calculate a pseudo-R^2 measure for such a model. Therefore, we compared the models on the Akaike information criterion (AIC). The AIC takes into account model fit and at the same time penalizes model complexity, therefore encouraging parsimonious models (Cameron & Trivedi, 2005). A smaller AIC suggests a better model.

Again, the random-effects model with national predictors yielded the best model fit. A log-likelihood ratio test shows that the random-effects model with national predictors

Table 4

Descriptive Statistics and Correlations Among Variables (N = 211)

Variables	Mean	Standard deviation	Bivariate correlations									
			1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. R&D intensity	3.29	4.44	1.00									
2. *SL* presence[†]	.17	.37	.17	1.00								
3. Firm size	11.17	.95	.15	.12	1.00							
4. CEO tenure	4.91	4.86	.08	.31	.13	1.00						
5. CEO age	57.35	6.56	.01	−.10	.02	.06	1.00					
6. Industry growth rate	9.90	6.14	−.24	−.05	−.38	−.01	−.00	1.00				
7. Industry sector[‡]	.89	.32	.16	−.12	−.03	−.11	.06	.07	1.00			
8. Freedom of capital flows	5.32	.67	.13	−.02	−.01	.07	−.03	−.16	.03	1.00		
9. Quality of education	5.28	.43	.24	.02	−.06	.06	−.11	−.17	.04	.65	1.00	
10. Legal system type[§]	.36	.48	.16	−.02	−.01	.13	−.24	.01	−.01	.05	.36	1.00
11. Perceived corruption	2.87	1.30	−.18	−.07	.02	−.10	−.04	.19	.03	−.86	−.69	−.02
Variance inflation factors (VIFs)				1.22	1.08	1.10	1.25	1.05	4.15	2.66	1.39	4.98

[†] Dichotomous variable where 0 = not present in *Second Life* and 1 = present in *Second Life*.
[‡] Dichotomous variable where 0 = service sector and 1 = manufacturing sector.
[§] Dichotomous variable where 0 = civil-law and 1 = common-law legal system.
R&D, research and development; CEO, chief executive officer; *SL*, *Second Life*.

Table 5

Mean and Median Tests of Hypotheses (N = 211)

Variable	Mean			Median		
R&D intensity	Low	High	*p*	Low	High	*p*
— Freedom of capital flows	5.42	5.22	.030	5.42	5.42	.270
— Quality of education	5.18	5.38	.001	5.27	5.37	.010
— Legal system type	31%	42%	.140	N/A	N/A	N/A
— Perceived corruption	3.12	2.61	.004	2.7	2.7	.220
Second Life presence	No	Yes	*p*	No	Yes	*p*
— Freedom of capital flows	5.33	5.30	.81	5.42	5.42	.84
— Quality of education	5.28	5.30	.81	5.37	5.37	.98
— Legal system type	37%	34%	.92	N/A	N/A	N/A
— Perceived corruption	2.91	2.67	.26	2.7	2.7	.58

Note: R&D intensity was recoded into the low and high groups based on a median split. All mean comparisons except legal system type were based on the *t*-test. For the binary legal system type variable, a χ^2 test was used. All median comparisons were based on the Mann–Whitney *U*-test.
R&D, research and development; N/A, not applicable.

(Model 3) fit significantly better than the one without national predictors (Model 2, $\chi^2 = 9.86$, $p = .04$). The HLM model with national predictors also performed better than the HLM model without national predictors (Model 4, $\chi^2 = 9.70$, $p = .04$). Together, the four national predictors explained 69.8% of country-level variance in *Second Life* presence.

Interestingly, for specific CTE as reflected by *Second Life* presence, both the Freedom of Capital Flows and the level of Perceived Corruption had significant negative effects on their relationships with specific CTE. Based on the best-fitting random-effects model, a one-point increase (on a 7-point scale) in freedom of capital flow decreases the odds of venturing in *Second Life* by 85.33%, and a one-point increase (on a 10-point scale) in national corruption leads to a decrease of 62.84% in the odds of *Second Life* presence. Hence, our data provide support for hypotheses 1 and 4 when considering the specific measure of CTE.

However, our data did not support our predicted relationships between Legal System Type and Quality of Education System on specific CTE. Therefore, we did not find empirical support for hypotheses 2 and 3 for the MNE's specific presence in an emerging virtual world. In sum, it appears that national business subsystems influence technological entrepreneurship by multinational firms, but different measures of CTE are affected by different national subsystems. Notably, restriction in financial flows was the only national subsystem that was significantly related to both measures of CTE. This suggests considerable value in exploring both general and specific measures of CTE, and we discuss these differentiated influences in our discussion later.

Table 6

Antecedents of General and Specific Corporate Technological Entrepreneurship in Multinational Firms as Reflected by R&D Intensity (N = 211)

Variable	Predicted sign	Model 1	Model 2	Model 3	Model 4	Model 5
A. General corporate technological entrepreneurship						
Firm/industry controls						
— Firm size	+	.65*	.39	.44	.38	.47
— CEO tenure	+	.08	.05	.05	.06	.06
— CEO age	−	−.02	−.004	.01	−.01	.004
— Industry growth rate	+	−.11***	−.14***	−.14***	−.14***	−.13***
— Industry sector	+	2.73***	2.60***	2.63***	2.60***	2.57***
National predictors						
— Freedom of capital flows	−	N/A	N/A	−1.12**	N/A	−.79*
— Quality of education	+	N/A	N/A	1.63**	N/A	1.83**
— Legal system type	+	N/A	N/A	.99**	N/A	1.09**
— Perceived corruption	−	N/A	N/A	−.61	N/A	−.39
Pseudo R^2		.09	.08	.16	.10	.14
B. Specific corporate technological entrepreneurship						
Firm/industry controls						
— Firm size	+	.43*	.34	.42	.42**	.46**
— CEO tenure	+	.18***	.16***	.16***	.18***	.17***
— CEO age	−	−.09**	−.07*	−.09**	−.08**	−.09***
— Industry growth rate	+	−.01	−.02	−.02	−.01	−.01
— Industry sector	+	−.43	−.54	−.51	−.44	−.48
National predictors						
— Freedom of capital flows	−	N/A	N/A	−1.92**	N/A	−1.83**
— Quality of education	+	N/A	N/A	.56	N/A	.69
— Legal system type	+	N/A	N/A	−.79	N/A	−.73*
— Perceived corruption	−	N/A	N/A	−.99**	N/A	−.92***
Akaike information criterion (AIC)		195.8	179.7	178.0	181.4	179.7

* $p < .10$, ** $p < .05$, *** $p < .01$.
Note:
Model 1: Fixed effects with cluster-robust standard errors, no national predictors.
Model 2: Random effects with cluster-robust standard errors, no national predictors.
Model 3: Random effects with cluster-robust standard errors, full model.
Model 4: HLM, no national predictors.
Model 5: HLM, full model.
R&D, research and development; CEO, chief executive officer; HLM, hierarchical linear model; N/A, not applicable.

Discussion

As Baker, Gedajlovic, and Lubatkin (2005) argue, corporations face different national ecologies for being entrepreneurial. There have been several previous studies that attempt to determine the national-level antecedents of national innovative capacity (e.g., Archibugi & Coco, 2005; Daniels, 1993; Furman, Porter, & Stern, 2002) but few studies that attempt to determine the contribution of national context to CTE at the firm level.

To the best of our knowledge, this is the first scholarly study to explore how national context influences CTE in multinational firms while controlling for individual-, firm-, and industry-level predictors of technological entrepreneurship. We operationalize CTE using a well-established general measure (i.e., R&D intensity) and a relatively novel and

specific measure of CTE (i.e., *Second Life* presence). By differentiating between these two operationalizations of entrepreneurship with multinational corporations, we provide a more robust and comprehensive perspective of the relationship between national business systems and CTE.

Using a variety of model specifications, we find that national-level predictors explain additional variance in CTE, above and beyond firm- or industry-level predictors. Furthermore, we find that all four institutional subsystems advanced by Whitley (1992, 1999) were predictive of CTE, but the specific impact varied by breadth of entrepreneurship construct considered. In other words, national business subsystems help to explain CTE, but the specific influence varies by the measure chosen.

Specifically, we found that the freedom of capital flows, legal system type, and quality of education system all influenced our general measure of CTE. However, general technological entrepreneurship was not influenced by the level of perceived corruption, after considering individual, firm, and industry controls. Notably, in our univariate analysis looking at mean levels of R&D intensity, lower levels of corruption were associated with higher levels of R&D investments, as hypothesized. Hence, there may be some collinearity effects between our measure of perceived national corruption, and our industry- and firm-level controls. Interestingly, however, our prediction for corruption's negative influence on our specific measure of CTE was supported by our data, after controlling for firm- and industry-level effects. In sum, the effect of trust and authority systems, as represented by perceived corruption in this study, on CTE is somewhat equivocal. Our study did not find the expected negative relationship with R&D intensity, as hypothesized, but we did find it for *Second Life* presence. Clearly, future research should explore alternate measures of trust and authority subsystems to tease out this intriguing relationship.

Notably, we also found that the freedom of capital flows also hindered a multinational firm's likelihood of exploring an emerging virtual world. As such, the home country's financial subsystem demonstrated the most robust impact on both general and specific CTE examined in this study. These findings make sense since investments in technology require relatively longer time horizons to realize their payoff. If domestic capital flows are relatively restricted, it appears that multinational firms can either tap the global equity markets to pursue new technologies, or they can invest for the longer term due to the higher likelihood of "patient capital" (Jacobs, 2011).

Overall, we add further evidence that "home country matters" even for multinational firms and that cross-national comparisons offer valuable and new insights into how multinational firms operate and perform (Makino, Isobe, & Chan, 2004). In addition, we add to the theoretical argument that institutional theory can be a promising theoretical framework to better understand technological entrepreneurship in a multinational context (Bruton, Ahlstrom, & Li, 2010). Furthermore, we contribute to the corporate entrepreneurship literature by identifying the importance of considering home country context when attempting to explain entrepreneurial behavior in established firms (Ireland, Covin, & Kuratko, 2009).

While our research findings are encouraging, there clearly are limitations to our study in several areas. First, our findings were limited to the largest firms in the global economy. While these firms account for a considerable share of the global economy, it would be interesting and valuable to see if these results generalize to small- and medium-sized firms since these firms are also major contributors to CTE. Second, our data were limited to archival sources. Future research should be conducted in the field to more precisely determine how national context influences the actual entrepreneurial decision-making process within both established and nascent firms. Finally, our study is confined to a

relatively short time span during a somewhat unusual period within the global economy following a major global recession. Future research should examine these relationships in longitudinal studies across different business cycles.

Despite these limitations, we believe that this study provides valuable and interesting new insights into how national context influences CTE in multinational firms. Previous research has shown that despite the growing influence of the global economy, home country effects hold considerable sway on large multinational firms (Asmussen, 2009; Hejazi, 2007). Our research reinforces this notion despite the fact that the geographic scope of MNEs continues to expand. Notably, our study suggests that the national context of the headquarters continues to hold substantial influence on organizations' behavior, particularly with respect to CTE.

Clearly, R&D intensity and *Second Life* presence are relatively crude proxies for CTE. However, our findings suggest that national context as well as the proxy used for studying CTE matter. Hence, future researchers may want to consider alternative measures of CTE. Based on our reading of the literature, the most common way to operationalize CTE is via survey methods to members of the top management team (e.g., Barringer & Bluedorn, 1999; Birkinshaw, 1997; Zahra, 1991). The clear advantage of this approach is the precision of the measure and its construct validity. The clear disadvantages of this approach are reliability issues associated with self-report measures, language translation, and interpretation issues, as well as practical issues related to meaningful response rates by executives within global multinational firms.

Alternatively, using structural proxies such as corporate venture capital units to represent CTE could add new, interesting, and useful insights to our understanding of the antecedents of CTE in a global sample of firms (Gaba & Bhattacharya, 2012). However, structural proxies suffer from various problems as well, including: (1) they are also crude measures of entrepreneurial activity and hence their construct validity is questionable, (2) structural proxies are often binary measures and fail to consider varying levels of commitment to CTE, and (3) archival data are currently not reliably available in a global sample of multinational firms to the best of our knowledge. Consequently, such structural measures may be more suitable for studying CTE within the United States rather than in a global setting. More research is needed to identify additional measures of CTE that are both available and comparable across multiple countries.

One of the primary practitioner implications of our study is that CTE appears to be influenced by its national context, even in rather large multinational firms above and beyond the impact of the firm and its primary industry context. This finding is consistent with studies of managerial discretion in a cross-national context (e.g., Crossland & Hambrick, 2011). With an understanding of these national factors, a firm (or government policy makers) can take remedial measures to counter the negative influences (Porter, 1990). For instance, the firm may want to lobby a national government to invest more comprehensively in the nation's education and training subsystem, or establish a severe policy that prohibits paying bribes or making contributions to government officials in order to reduce corruption.

At the extreme, an MNE can decide to move its headquarters to a more entrepreneurial national context. While this decision certainly must be considered amidst many factors, moving a headquarter location can be done without extensive disruption to the business today and may prove a better long-term strategy for a more competitive positioning of the firm in the global economy (Birkinshaw, Braunerhjelm, Holm, & Terjesen, 2006). In choosing the proper destinations for such a move, the four national antecedents to CTE found in this study could be used to identify national innovative capacity, or the MNE could utilize other research focused at the national level (e.g., Furman et al., 2002) to

select the national context that is most suitable for the firm's entrepreneurial activities and strategic goals.

Perhaps most importantly, our research demonstrates that different national subsystems may influence different measures of CTE. Consequently, scholars may want to develop more and better constructs to capture CTE beyond the traditional measures of patent production and/or R&D intensity. Interestingly, CEO characteristics were found to have a major influence on entrance into an emerging virtual world but were unrelated to R&D Intensity despite these two organizational outcomes being correlated with each other. We encourage future scholarship to examine actual corporate forays into technological entrepreneurship in tandem with or in lieu of traditional measures.

Appendix 1

Test for Sample Selection Bias

To test for potential sample-selection bias, we ran the Heckman selection model. This approach involved two steps. In Step 1, a Probit model representing the sample-selection process (i.e., whether each unit in the population is included in the sample) was run using the main model predictors. From this model, an inverse Mills ratio was calculated for each firm. In Step 2, the main models for R&D intensity and *Second Life* presence were estimated with the inverse Mills ratio included as an additional predictor. If there were indeed sample-selection bias, the coefficients for the ratio would be significant. The table later shows the results from this analysis using random-effects models with clustered standard errors in Step 2. Clearly, the inverse Mills ratio was not significant for either CTE indicator, which suggests that sample-selection bias was not an issue. Furthermore, the coefficients are similar to our proposed models, suggesting that our findings are relatively robust. Overall, these results suggest that our sample was reasonably representative and robust.

	Step 1: Firm inclusion		Step 2 (R&D intensity)		Step 2 (*SL* presence)	
Variable	Estimate	T value	Estimate	T value	Estimate	Z value
Intercept	−7.14	−3.46***	−7.55	−.62	13.79	1.53
Firm size	.31	4.83***	1.29	1.47	−.04	−.07
CEO tenure	−.01	−.85	.02	.25	.18	3.47***
CEO age	.01	.65	.04	.74	−.10	−2.52*
Industry growth	.01	.43	−.12	−2.30*	−.03	−.66
Industry sector	1.75	11.31***	8.58	1.49	−3.74	−.91
Freedom of capital flows	.07	.35	−1.02	−1.16	−2.16	−2.58**
Quality of education	.44	1.73	3.03	1.99*	−.02	−.01
Legal system type	−.58	−3.51***	.53	2.30*	−.07	−.07
Perceived corruption	−.11	−1.03	−.93	−1.60	−.89	−2.12*
Mills ratio			5.20	1.05	−2.81	−.79

* $p < .05$, ** $p < .01$, *** $p < .001$.
CEO, chief executive officer; R&D, research and development; *SL*, *Second Life*.

Appendix 2

Empirical Studies of Corporate Entrepreneurship, Technological Entrepreneurship, or Corporate Technological Entrepreneurship

Author(s)	Publication Year	Publication Outlet	CE/TE/CTE operationalization	Primary data source	Geographic focus	Time period
Burgelman	1983	ASQ	Formation of internal corporate venture project	Interviews	U.S. firm	1973–1979
Zahra	1991	JBV	9-item scale	Survey	U.S. firms	1986–1989
Morris, Avila, & Allen	1993	JoM	9-item scale	Survey	U.S. firms	1986–1989
Stopford & Baden-Fuller	1994	SMJ	Attempts at strategic renewal	Interviews	U.K. firms (7)	Undisclosed
Zahra	1995	JBV	R&D intensity and new products	Survey	U.S. LBO firms	Undisclosed
Zahra & Covin	1995	JBV	7-item scale	Survey	U.S. firms	1983–1990
Zahra	1996	AMJ	14-item scale	Survey	U.S. firms	1991
Birkinshaw	1997	SMJ	7-item scale	Survey	Canadian subsidiaries	1992
Barringer & Bluedorn	1999	SMJ	9-item scale	Survey	U.S. firms	1994
Sorenson & Stuart	2000	ASQ	Domestic patents granted in the United States	Archival	U.S. biotech and semiconductor firms	1975–1994
Miner et al.	2001	ASQ	New product development projects	Interviews	U.S. firms (2)	1999
Furman et al.	2002	RP	International patents granted in the United States	Archival	17 OECD countries	1973–1996
Dushnitsky & Lenox	2005	SMJ	CVC sector investments	Archival	U.S. firms	1990–1999
Zhang & Dodgson	2007	JWB	New product initiatives	Interviews	Korean firm (1)	2002–2004
Ling et al.	2008	AMJ	16-item scale	Survey	SMEs in the United States	2004
Van de Vrande et al.	2009	JBV	Creation of technology alliances	Archival	U.S. pharmaceuticals	1990–2000
Filatotchev & Piesse	2009	JIBS	R&D intensity	Archival	IPOs in the United Kingdom, Germany, Italy, and France	1985–2004
Heavey, Simsek, Roche, & Kelly	2009	JMS	17-item scale	Survey	SMEs in Ireland	2008
Kelley, Peters, & O'Connor	2009	JBV	Technology-based projects	Interviews	U.S. firms	Undisclosed
Da Gbadji, Gailly, & Schweinbacher	2010	SSRN	Corp venture capital unit adoption	Archival	Global 500 firms	2008
Romero-Martinez, Fernandez-Rodriguez, & Vasquez-Inchausti	2010	JWB	6-item scale	Survey	Spanish SOEs	1985–2000
Kotha et al.	2011	SMJ	Domestic patents in the United States	Archival	U.S. biotech firms	1980–1999
Williams & Lee	2011	JMS	4-item scale	Survey	MNCs in 17 countries	Undisclosed
Gaba & Bhattacharya	2012	SMJ	CVC unit adoption and termination	Archival	Forbes 500 firms in the United States	1992–2003
Plambeck	2012	JBV	4-item scale	Survey	German firms	2002

CTE, corporate technological entrepreneurship; R&D, research and development; CE, corporate entrepreneurship; TE, technological entrepreneurship; LBO, leveraged buy-out; CVC, corporate venture capital; OECD, Organisation for Economic Co-operation and Development; SME, small- and medium-sized enterprises; IPO, initial public offering; SOE, state-owned enterprise; MNC, multinational corporation.

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