Gerard J. Tellis, Jaideep C. Prabhu, & Rajesh K. Chandy

Radical Innovation Across Nations: The Preeminence of Corporate Culture

Radical innovation is an important driver of the growth, success, and wealth of firms and nations. Because of its importance, authors across various disciplines have proposed many theories about the drivers of such innovation, including government policy and labor, capital, and culture at the national level. The authors contrast these theories with one based on the corporate culture of the firm. They test their theory using survey and archival data from 759 firms across 17 major economies of the world. The results suggest the following: First, among the factors studied, corporate culture is the strongest driver of radical innovation across nations; culture consists of three attitudes and three practices. Second, the commercialization of radical innovations translates into a firm's financial performance; it is a stronger predictor of financial performance than other popular measures, such as patents. The authors discuss the implications of these findings for research and practice.

Keywords: innovation, corporate culture, cross-cultural, cross-national, marketing metrics

Radical innovation is crucial to the growth of firms and economies. It merges some markets, creates new ones, and destroys old ones. It can propel small outsiders into a position of industry leadership and can bring down large incumbents that fail to innovate (Chandy and Tellis 2000; Srinivasan, Lilien, and Rangaswamy 2002; Utterback 1994). Firms at the leading edge of radical innovation tend to dominate world markets and to promote the international competitiveness of their home economies (Atuahene-Gima 2005; Tellis and Golder 2001). Thus, radical innovation simultaneously drives market growth, firms' success, and nations' economic growth (Landes 1999; Sood and Tellis 2005; Sorescu, Chandy, and Prabhu 2003). For these reasons, managers and governments throughout the world are realizing the critical importance of radical innovation (e.g., Measuring Innovation in the 21st Century Economy Advisory Committee 2008; Yadav, Prabhu, and Chandy, 2007; Zhou, Yim, and Tse 2005).

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Radical innovation varies substantially in firms across nations (Diamond 1999; Furman, Porter, and Stern 2002; Landes 1999). The primary question this article addresses is what explains these differences. A substantial body of literature on this topic already exists (e.g., Bartholomew 1997; Fagerberg, Mowery, and Nelson 2005; Im et al. 2003; Murtha, Lenway, and Hart 2001; Song and Parry 1997). However, researchers have pointed out at least four major limitations of this literature.

First, a growing body of cross-national literature on innovation has focused on consumer adoption of innovations and not on firms' commercialization of those innovations (e.g., Chandrasekaran and Tellis 2007, 2008; Tellis, Stremersch, and Yin 2003). However, the commercialization of innovations is a prerequisite for their adoption.

Second, the literature on firm innovation across nations has mainly focused on comparing the inputs of innovation, such as research-and-development (R&D) spending, scientific personnel, and patents (Archibugi and Coco 2005; Furman, Porter, and Stern 2002; Porter and Stern 1999). Few studies of innovation across nations have formally examined the outputs of innovation, such as commercialized innovations and the financial rewards to such innovations (see Godin 2002). However, inputs do not automatically lead to the creation of new products (Acs and Audretsch 1987; Griliches 1990) or guarantee the financial value firms and governments seek (Von Hippel 2005). The key challenge of converting inputs into commercially valuable outputs remains largely unaddressed (see Chandy et al. 2006; Hauser, Tellis, and Griffin 2007). Indeed, as Mairesse (qtd. in Kortum 2004, p. 358) noted in a recent roundtable of some of the leading thinkers on the topic, "We have exhausted all we can get from our old data sets on R&D, patents, citation counts."

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Third, current research on innovation in firms across nations has favored comparisons among firms in the developed economies of North America, Europe, and Japan (see Godin 2002, 2003; Therrien and Mohnen 2003) rather than with firms from emerging economies, such as those of East and South Asia. Yet firms and governments in emerging markets, such as Korea and Taiwan (Im et al. 2003), India (*The Economist* 2004), and China (Atuahene-Gima 2005; Song and Parry 1997), among others, increasingly understand that their long-term future lies in stimulating radical innovation. Given this reality, a broader sampling of nations would be fruitful.

Fourth, prior research has studied the importance of either national drivers (e.g., Archibugi and Coco 2005) or firm drivers (e.g., Damanpour 1991; Sethi and Iqbal 2008) of innovation but has not formally compared the effects of these drivers in the same study (see Kortum 2004). In the absence of such integrated research, policy could be directed at some drivers (e.g., regulation, intellectual property protection) that may well be less powerful than others (e.g., management practice within firms) in spurring innovation (Branstetter and Nakamura 2003; Kortum 2004).

This study is an initial attempt to address these gaps in existing research. We identify 42 drivers of radical innovation, including 31 country drivers and 11 firm drivers. We test our models using data from a survey of more than 750 public firms of various sizes and sectors across 17 nations (see Table 1). In doing so, we make four contributions to the study of innovation in firms across nations.

First, we examine a critical output of innovation—the commercialization of radically new products—rather than the inputs of innovation, as many existing studies of cross-national innovation tend to do. Moreover, we contribute to recent research in marketing on conversion ability by examining which inputs actually yield outputs in the form of innovative products and financial returns (Chandy et al. 2006).

TABLE 1
Sample and Responses Rate by Nation

Nation	Sample	Responses	Response Rate (%)
Total	4074	772	18.9
Australia	128	35	27.3
Canada	154	25	16.2
China	183	31	16.9
France	242	39	16.1
Germany	315	81	25.7
Hong Kong	167	15	9.0
India	139	28	20.1
Italy	99	32	32.3
Japan	409	57	13.9
Korea	333	87	26.1
The Netherlands	62	17	27.4
Singapore	176	24	13.6
Sweden	113	26	23.0
Switzerland	80	23	28.8
Taiwan	243	83	34.2
United Kingdom	383	67	17.5
United States	848	102	12.0

Second, we study radical innovation in a fairly large number of nations, including both developed and emerging economies. In contrast, existing research tends to focus on relatively limited sets of nations (see De Luca and Atuahene-Gima 2007; Im et al. 2003; Song and Parry 1997; Zhou, Yim, and Tse 2005).

Third, we combine insights and data at the macro (national) level with insights and data at the micro (firm) level to examine the relative importance of firm versus national factors in driving innovation in firms across nations. Researchers in marketing have typically focused on the firm level, whereas researchers in fields such as public policy have examined the national level.

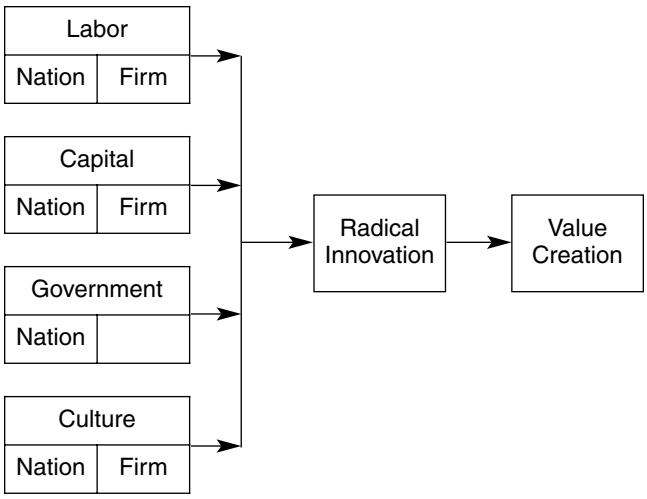
Fourth, and perhaps most important, we integrate prior research in marketing and management with recent research on trends in the global economy to propose and test a theory of radical innovation based on the corporate culture of the firm. This theory posits that in today's converging economies, among the many drivers of radical innovation, those based on corporate culture are likely to be primary drivers of such innovation in firms across nations (e.g., Chandy and Tellis 1998; Govindarajan and Kopalle 2004).

Theory

The disciplinary wellsprings of research on innovation are many (Fagerberg, Mowery, and Nelson 2005). Scholars in history, economics, law, engineering, sociology, management, marketing, international business, and public policy have all contributed to the understanding of the drivers of innovation across nations (e.g., Bartholomew 1997; Fagerberg, Mowery, and Nelson 2005; Im et al. 2003; Murtha, Lenway, and Hart 2001; Song and Parry 1997). Given how many ideas populate the subject of innovation and how dispersed they are, unifying these ideas is a challenging task (see Kortum 2004; Nelson 1993). Within any disciplinary area, researchers tend to examine the drivers of innovation that are most salient to their own discipline. Few existing theories or frameworks integrate both firm and national drivers of innovation across nations. Cross-disciplinary frameworks that exist tend to be tailored to fit the unique circumstances of individual industries (e.g., Bartholomew 1997) or individual nations (e.g., Mowery and Rosenberg 1993) and are not easily applied beyond their original contexts (see Furman, Porter, and Stern 2002; Nelson 1993).

The current status of the literature is both a challenge and an opportunity for marketers interested in the drivers of radical product innovation. Now is an opportune time to integrate the far-flung ideas that are relevant to this topic. Indeed, a "home-grown" theory of the type advocated by Rust (2006, p. 1) has the potential to guide thinking and practice not just in the field of marketing but in associated fields as well. As a first step toward building such theory, we propose a framework that links key drivers of innovation with key innovation outcomes (see Figure 1). The next section uses this framework to build a metatheory of the drivers and fruits of radical innovation in firms across nations. We first outline some of the potential drivers proposed in the literature on innovation in firms across nations.

FIGURE 1
Framework of the Drivers of Radical Innovation and Value Creation



Next, we introduce our culture-centric theory of radical innovation.

Drivers of Radical Innovation in Firms Across Nations

A review of the literature on innovation across nations suggests that four factors underlie most explanations for why certain firms in certain nations are more innovative than others: skilled labor, capital, government, and culture (Bartholomew 1997; Demirgüç-Kunt and Levine 2001; Furman, Porter, and Stern 2002; Nelson 1993). The terms to describe these factors and the variables studied within them may differ by discipline (Kortum 2004). Moreover, the boundaries between these factors can be fuzzy. Nevertheless, we believe that these factors incorporate most variables that are currently viewed as driving radical product innovation in firms across nations in a reasonably coherent way. Of these factors, all except government operate at two levels: (1) the national level, in the context of the entire economy, and (2) the firm level, in the context of the individual firm. In the subsequent paragraphs, we briefly describe the role of each factor in driving radical innovation. For the sake of brevity, and consistent with objectives of this research, we focus on the main effects of these factors in our discussion.[1]

Labor. We use the term labor to refer to the skilled workforce accessible to a particular firm in a particular country. A long tradition of research has pointed to the importance of a skilled workforce as a primary driver of innovation, both at the national and at the firm level (e.g., Committee on Science, Engineering, and Public Policy 2005; Daniels 1993; Furman, Porter, and Stern 2002; Mowery and Rosenberg 1993). In general, an educated and skilled workforce, especially in scientific and technical fields, is viewed as a prerequisite for the development and commercialization of novel products. For example, at the national level, Freeman (1992, p. 171) traces the emergence of the United States and Germany as technological powers in the nineteenth and twentieth centuries and the loss of British technological leadership during this time to these factors: "It was above all the increasing availability of considerable numbers of professional engineers and other skilled people which gave the decisive advantage to German and American industry."

As with the national level, a skilled workforce is also important at the firm level. Of special importance to firms is the availability of skilled scientific and technical talent within the firm (Zucker, Darby, and Armstrong 2002). Despite national differences, differences among firms' ability to recruit and retain talented technical personnel are likely to explain differences in their innovation output and the value they capture from this output (Sorescu, Chandy, and Prabhu 2007).

Capital. Capital refers to the financial resources that are available in the country as a whole as well as within firms that operate in the country. Countries with strong and vibrant financial systems are likely to provide greater access to the financial resources needed for innovation (see Edquist 2005; Huang and Xu 1999) than countries that are not so well equipped. Sources of financial inputs include banks, stock markets, and venture capital. While stock markets provide access to equity for established firms, banks serve as a source of finance for private firms and small firms from established sectors (Levine and Zervos 1998). A fair number of countries now have an active network of venture capitalists that support new innovative enterprises. Risky and emerging firms and sectors are likely to benefit from such networks in their drive toward innovation (Kortum and Lerner 2000).

At the firm level, the financial resources available within individual firms are likely to play an important role in driving innovation. Within any specific country, firms that have greater access to financial resources are, ceteris paribus, likely to be more innovative and to create greater value from their innovations (Sorescu, Chandy, and Prabhu 2003).

However, the mere availability of capital, whether at the national or the firm level, will translate into innovation only if the capital is used to make the right kinds of investments. At the national level, greater investment in R&D is likely to yield greater access to new product ideas for firms in the economy; the spillover of knowledge created by such spending is likely to benefit firms operating throughout the economy (Jaffe, Trajtenberg, and Fogarty 2000). Similarly, within firms, those that spend more on R&D are likely to be more innovative and, ceteris paribus, to capture more value from innovation than firms that spend less on R&D (see Dutta, Narasimhan, and Rajiv 1999).

Government. Prior literature has suggested that several aspects of government policy can help or hurt innovation within firms that operate in a country (Edquist 2005; Nelson

[1]The literature also indicates that these factors may intersect and interact dynamically with each other (see Bartholomew 1997; Murtha, Lenway, and Hart 2001; Nelson 1993). We test for these intersections and interactions subsequently.

1993). As Nelson (1993, p. 512) notes, "Much of the current interest in national systems of innovation reflects a belief that the innovative prowess of national firms is determined to a considerable extent by government policies." Among the most important aspects of policy are the protection the government provides for intellectual property; its involvement in technology development through its encouragement of collaboration between universities and industry; and its involvement in the diffusion of innovation through its procurement of innovative outputs in sectors such as defense, health, and education.

The case for intellectual property protection in driving innovation is made strongly by legal scholars and some economists (Gutterman and Anderson 1997; Webster and Packer 1996). The argument is that protection for the ideas behind innovations enables innovators to reap the rewards for developing innovations and undertaking risks in commercializing them. Some proponents suggest that the success of Europe relative to Asia in the post-Renaissance period resulted from the former's legal support of intellectual property rights (e.g., Landes 1999; North and Thomas 1973). Others offer the innovativeness of the United States over Europe in the past 100 years as being due to its strong patent, trademark, and copyright laws (e.g., Rosenberg and Birdzell 1986).

Many scholars argue that government legislation, such as the U.S. Bayh–Dole Act (35 U.S.C. § 200–212), which encourages and facilitates collaboration between universities and industry, is a likely driver of innovation within firms in the country (Etzkowitz and Leydesdorff 2000; Mowery and Sampat 2004). Such policy may help transform the basic research that occurs at universities into applications that firms can commercialize. In addition, it may yield graduates whose skills are closely attuned to the innovation tasks that firms face. By creating laws that enable universities to engage in such collaboration with firms and by providing incentives that encourage them to do so, governments can help stimulate the innovativeness of firms that operate in their countries.

Governments can also support innovation in firms either indirectly through R&D tax credits or directly through the procurement of new technology (Bartholomew 1997; Hall 1993; Hall and Van Reenen 2000). Such support can potentially create markets for products and technologies that otherwise may take many years to materialize or never materialize at all. In recent years, R&D programs targeted at security, military, and public health needs have been a primary arena for government procurement and tax credits (Nelson 1993). For example, now-ubiquitous technologies in semiconductors, telecommunications, energy, and computing owe their origins in part to government-sponsored research with military aims. Nevertheless, the actual impact of government procurement and R&D tax policies remains ambiguous; some scholars note that though such policies might have raised technical development or scientists' wages in certain fields, innovation outputs have been nonexistent or slow to follow (Goolsbee 1998; Mansfield 1984).

Culture. Culture refers to a core set of attitudes and practices that are shared by the members of a collective entity, such as a nation or a firm (Hofstede 2003; Smircich 1983). The definitions of culture are many, and "culture, like love, is a many-splendored thing" (Prabhu, Chandy, and Ellis 2005, p. 120). However, as Triandis (1996, p. 407) states, "almost all researchers agree that culture is reflected in shared cognitions [and] standard operating procedures." Our definition of culture in terms of attitudes and practices is consistent with and analogous to definitions that view culture in other terms, such as values, rituals, and codes (see Denison 1996; Deshpandé and Webster 1989; Gregory 1983; Jones, Jimmieson, and Griffiths 2005; Miles and Snow 1978; Rokeach 1973; Triandis 1994). As with labor and capital, culture can operate at both the national and the firm level.

An extensive body of literature suggests three related aspects of national culture that may drive innovation: a nation's religion, its geographic location, and the values of its citizens (Hofstede 2003). Some analysts argue that religious beliefs can influence the development and adoption of innovations (see Gorski 2003) because some faiths provide believers with a strong rationale to work in and transform their environment, while others tend to emphasize the renunciation of worldly pleasures for rewards in the afterlife (DeLong 1988; Landes 1999; Weber 1930).[2] Similarly, some researchers argue that a nation's geographical location—specifically, its distance from the equator—could reflect attitudes and practices that help or hinder innovation (e.g., Landes 1999; Parker 2000). Because warm climates are more abundant in animal and vegetable life than cold ones, they could lead to easier lifestyles and fewer incentives for work and innovation, while cold climates, which are more hostile, require long-term planning and motivate people to action, work, and innovation (Landes 1999). Finally, Hofstede (2003) shows that nations may differ along specific cultural dimensions, such as individualism–collectivism, uncertainty avoidance, power distance, masculinity–femininity, and long-term orientation. Recently, other researchers have updated and refined these dimensions (House et al. 2004) and have highlighted their likely impact on innovation (see Dwyer, Mesak, and Hsu 2005; Shane 1994).

As with national culture, recent research indicates that corporate culture may play a role in radical innovation. Corporate culture refers to a core set of attitudes and practices that are shared by the members of the firm (Denison 1996; Deshpandé and Webster 1989; Detert, Schroeder, and Mauriel 2000; Hatch 1993; Martin 2002; Schein 1999; Schultz and Hatch 1996). A culture that fosters relentless innovation may help ensure that the firm stays constantly at the leading edge of innovation (Govindarajan and Kopalle 2004; Tellis and Golder 2001).

In the next subsection, we highlight the importance of corporate culture in driving innovation and propose a culture-centric theory of radical innovation in firms. We use

[2]However, as an anonymous reviewer noted, the distribution of religious beliefs among decision makers in a given firm may not reflect the distribution of religious beliefs in the country as a whole.

the terms "firm culture" and "corporate culture" interchangeably.

A Culture-Centric Theory of Radical Innovation

Although researchers have proposed labor, capital, government, and culture as drivers of innovation, few have formally examined the relative importance of these factors in contemporary firms. In the next stage of theory development, we propose that in today's capitalist economies, labor, capital, and government may not be the primary factors that distinguish innovative firms from others. Nor may national culture in itself be the major factor of importance. Rather, we argue that corporate culture is likely to be an important driver of innovation in firms across nations, for three reasons.

Importance of corporate culture. First, markets for labor and capital have been evolving in capitalist economies over the past 400 years (Mannie, Zhang, and Hu 2006; Wright, Pruthi, and Lockett 2005). In many capitalist countries, especially with the onset of information technology, these markets are now reasonably efficient and increasingly mature and interconnected. Thus, innovative firms now have the ability to tap these markets for labor and capital to bring their innovations to fruition. In particular, the presence of markets for venture capital enables entrepreneurs and entrepreneurial firms to gain access to capital for radical innovations, though at a steeper rate than in the stock market (Gompers and Lerner 2001).[3]

Second, recent years have witnessed an increased convergence across developed and emerging nations in the extent to which labor and capital are accessible to firms (Demirgüç-Kunt and Levine 2001; Krugman, Cooper, and Srinivasan 1995) and the extent to which government policies are synchronized across nations (Gong and Keller 2003; Hussler 2004; Lemola 2002). Although far from easy, negotiations across governments have led to some agreements on market and capital access across borders. Moreover, our discussions with policy makers in both developed and emerging nations suggest another factor that could be even more important than formal agreements in promoting policy convergence. Policy makers in many nations have learned to keep a close eye on regulatory and technological developments elsewhere and have unilaterally integrated their own nations into international markets (see Baldwin 2006; Krugman, Cooper, and Srinivasan 1995; Naim 2007). In addition, though far from frictionless, markets of a reasonably efficient kind exist for both labor and capital in many leading and emerging nations. Capital markets have flourished in economies in many parts of the world (Kumar and Russell 2002). Novel and promising ideas, whether in emerging economies, such as India and China, or in established markets of the Organisation for Economic Co-operation and Development (OECD), now attract capital in a manner that is in many ways unprecedented in history. Similarly, both developing and developed nations understand the importance of educational and other labor-related investments. Even in cases such as India and China, where the proportion of qualified technical personnel is not currently large relative to the population of these nations, the sheer number of available personnel makes it possible for firms to meet their current innovation needs. Increasingly, therefore, access to labor is also diminishing in its importance as a factor that explains differentials in innovation in firms across nations. Moreover, multilateral trade agreements and pannational institutions, such as the World Trade Organization, have helped promote an increased convergence in government policies across nations on intellectual property protection, government procurement, and collaboration between universities and industry (Baldwin 2006).

Third, culture is a uniquely human product that develops slowly within firms, is tacit and not easily defined, and is not easily transported across firms (Jassawalla and Sashittal 2002; Schein 1999). Indeed, markets for culture are either nonexistent or not very efficient. Reporting requirements and the presence of firms (e.g., Dun & Bradstreet) that specialize in corporate information help ensure that the size and type of labor and capital pool employed by a particular firm is often evident to (and thus open to imitation by) its competitors. However, corporate culture is a much more elusive factor than labor, capital, and government regulation.

Thus, we posit that capital, labor, and government regulation may be important drivers of radical innovation in firms across nations. However, in today's converging economies, corporate culture may also be more important than labor, capital, government, and national culture in explaining innovation in firms across nations.

Components of corporate culture. Following prior research, we examine corporate culture by studying the core set of attitudes and practices shared by members of the firm (Deshpandé and Webster 1989; Henard and Szymanski 2001; Smircich 1983). We do so with the recognition that the attitudes and practices that are most relevant to the innovation task are unlikely to be identical to those for other tasks. For this reason, scholars of corporate culture have called for middle-range descriptions of corporate culture—descriptions that preserve the holistic aspects of the construct while acknowledging the particulars of the tasks or outcomes being studied (see Bourgeois 1979). For example, Homburg and Pflesser (2000) examine market-oriented culture by studying the attitudes and practices that the literature suggests are most relevant to market orientation. Hofstede and colleagues (1999) examine the role of corporate culture in employee promotion and dismissal outcomes by studying attitudes and practices that the literature suggests are most relevant to those outcomes. In the same vein, we examine the role of corporate culture on radical innovation by studying attitudes and practices that the literature suggests are most relevant to this outcome.

On the basis of prior research, we identify three firm attitudes and three firm practices that may drive innovation (see Chandy and Tellis 1998; Olson, Walker, and Ruekert

[3]That said, we acknowledge that the sources of available capital may vary among nations as a result of historic and systemic reasons. For example, although German and Japanese firms rely more on debt and bank sources, U.S. firms rely more on stock and nonbank sources (see Demirgüç-Kunt and Levine 2001). Furthermore, stock markets in some nations, such as China, are more nascent than stock markets in North America or Western Europe.

1995). The attitudes are the willingness to cannibalize assets, future orientation, and tolerance for risk. These attitudes are likely to be essential drivers of innovation for the following reasons: First, a great hindrance to enduring innovation is the stream of profits that emerge from current products and services. The firm invariably tends to marshal great resources to protect this stream of profits. Any change or innovation that might threaten it is vetoed or frozen. A willingness to cannibalize assets is an attitude that puts up for review and sacrifice current profit-generating assets, including current profitable and successful innovations, so that the firm can get ahead with the next generation of innovations (Chandy and Tellis 1998). Second, a firm that is successful in one generation of technology is under pressure to focus on the many micro problems it faces in managing its success with that generation. A future orientation forces a firm to realize the limitations of the current technology and the emergence of a new generation of technology that may become dominant in the future (Christensen and Bower 1996; Narver and Slater 1998; Yadav, Prabhu, and Chandy 2007). Third, trading a current, sure stream of profits for a future, uncertain stream of profits is risky and does not come naturally to managers. It is vital that a firm foster and promote a tolerance for risk to make that essential trade-off (Fiegenbaum and Thomas 1988; Gilman 1995; Kuczmarski 1996). Thus, willingness to cannibalize assets, future orientation, and tolerance for risk are three essential attitudes that constitute an innovative culture.

Prior research has also led us to identify three practices that engender and sustain these attitudes. First among these is the empowerment of product champions. By this practice, a firm empowers an individual with resources to explore, research, and build on promising, but uncertain, future technologies (Howell and Higgins 1990; Markham and Griffin 1998; Shane 1994). In effect, empowerment embeds within the firm the enterprising spirit that enabled it to initiate the original innovation that brought it success. Second, the firm needs to establish incentives for enterprise (Makri, Lane, and Gomez-Mejia 2006; Zenger and Lazzarini 2004). By this practice, the firm refrains from rewarding only or primarily seniority or management of current products. Rather, it ensures that adequate, if not large, incentives are reserved for employees who venture to explore or build new enterprises for the firm. A third practice is the creation and maintenance of internal markets (Halal, Geranmayeh, and Pourdehnad 1993). This practice involves two elements: internal autonomy and internal competition (Chandy and Tellis 1998). Internal autonomy refers to the extent to which division managers enjoy decision-making authority in the firm relative to the corporate office (Aiken and Hage 1968; Olson, Walker, and Ruekert 1995). Internal competition requires that divisions or groups of employees within the firm compete among themselves to identify promising technologies and build innovations on those technologies. A firm with an active internal market creates the marketplace within itself, ensuring that an innovator from outside will not upstage the firm.

In summary, although many variables at the national and firm level can drive radical innovation in firms across nations, our culture-centric theory of radical innovation posits that in today's converging economies, corporate culture may be the most important driver among all these variables. Next, we describe the model we use to test our arguments.

Model

Our empirical model has two equations: Equation 1 tests the effects of various drivers of innovation on radical innovation in firms across nations, as our previously articulated arguments suggest. Equation 2 tests the effects of radical innovation (relative to traditional metrics, such as patents and R&D) on a firm's financial performance. For both equations, we have repeated measures across many industries; we account for industry heterogeneity using an industry fixed-effects model.

On the basis of our theory, we specify Equation 1 as follows:

$$\begin{aligned}(1)\quad \text{Radical Innovation}_{fci} = {} & \delta_0 + \delta_j\text{Labor}_c + \delta_j\text{Labor}_f \\ & + \delta_j\text{Capital}_c + \delta_j\text{Capital}_f \\ & + \delta_j\text{Government}_c + \Sigma_k\delta_{jk}\text{Culture}_{ck} \\ & + \Sigma_l\delta_{jl}\text{Culture}_{fl} + \Sigma_m\delta_{jm}\text{Controls}_{fcim} \\ & + \nu_i + \varepsilon_{fci},\end{aligned}$$

where f, i, and c are firm, industry, and country indexes, respectively; δ_js are parameters to be estimated for the jth variable; the subscripts k, l, and m are indexes for variables in national culture, firm culture, and control variables, respectively; Radical Innovation is a measure that captures the radical innovation of a firm f; Labor is a set of variables that measure skilled labor-related drivers of innovation at the national or firm level; Capital is a set of variables that measure capital-related drivers of innovation at the national or firm level; Government is a set of variables that measure government policy–related drivers of innovation; Culture is a set of variables that captures national and firm culture; ν_i are industry-specific error terms, and ε_{fci} is the remaining error term (initially assumed to independently and identically follow a normal distribution). Finally, Controls is a set of variables that are also likely to influence firms' radical innovation; these include firms' citation-weighted patents and the nation's population and gross domestic product (GDP).[4]

Equation 2 assesses the effect of radical innovation on financial performance:

$$\begin{aligned}(2)\quad \text{Value}_{fci} = {} & \beta_0 + \beta_j\text{Radical Innovation}_{fci} + \beta_j\text{Patents}_f \\ & + \beta_j\text{R\&D}_f + \Sigma_l\beta_{jl}\text{Controls}_{fcil} + \nu'_i + \varepsilon'_{fci},\end{aligned}$$

where f, i, and c are firm, industry, and country indexes, respectively; β_js are parameters to be estimated for the jth variable; Value is the market-to-book ratio of firm f; Radical Innovation is a measure that captures the radical innovation of firm f; Patents is the citation-weighted patents owned by

[4]Other firm factors, such as leadership quality and cross-functional integration, may also drive innovation. Because of resource constraints, we do not cover these factors in this research.

firm f; R&D is the percentage of sales spent on R&D by firm f; ν'_i are industry-specific error terms; and ε'_{fci} is the remaining error term (initially assumed to independently and identically follow a normal distribution). Controls is a set of variables that are also likely to influence firms' financial performance; these include firm size and country GDP, population, inflation, and credit rating. We do not include national culture in Equation 2, because there is little literature to support the effects of these variables on firms' financial performance. However, including these variables in the estimation does not substantially change the results of the financial impact of radical innovation.

We estimate both Equations 1 and 2 using industry-level fixed-effects regression models. Furthermore, we estimate Equations 1 and 2 separately because (1) the two equations form a recursive system—Radical Innovation influences Value, but Value (which is forward looking and measured later in time than Radical Innovation) does not influence Radical Innovation; (2) an analysis of the correlation between the error terms of each of the equations indicates that these errors are uncorrelated; and (3) recursive systems with uncorrelated errors do not require joint estimation of their constituent equations (for a formal proof, see Land 1973).

Method

Sampling

Resources at our disposal limit our study to 17 nations. To ensure that we capture a large fraction of the world economy, we chose the 8 largest economies on the basis of purchasing power parity: the United States, China, Japan, India, Germany, the United Kingdom, France, and Italy. To capture the possible role of innovation in propelling nations' recent progress, we chose 4 nations that have developed rapidly: Taiwan, Hong Kong, Korea, and Singapore. We also chose 5 nations with known major innovative or multinational firms: Canada, Switzerland, Netherlands, Sweden, and Australia.

We selected a sample of publicly listed firms only, which enables us to integrate our survey data with data from archival sources on these firms. We also chose only firms within the manufacturing sector that are primarily local to their country of origin. In other words, we excluded local subsidiaries of multinational firms because they confound the role of parent firm and local national culture (see Bartlett and Ghoshal 1995; Prahalad and Doz 1987). We sampled between 62 and 848 firms from each nation to reflect the size of these nations' economy and the extent of public listings within them (for sample sizes by nation, see Table 1). We used stratified sampling by firm size; 15% of our sample consists of the largest firms in the country, and the remaining 85% consists of a third each of large, medium, and small firms.

Procedure

Survey data. We used the following procedure to develop our questionnaires and conduct the survey: First, we developed a preliminary questionnaire based on discussions with managers and using scales and items from prior academic research as well as innovation surveys conducted by the OECD and the European Union (EU); for the latter, we drew on both the OECD's (2005) Oslo Manual and the EU's Community Innovation Survey (Eurostat 1997, 2000). Second, in the questionnaire, we were careful to provide respondents with clear definitions of our key terms, such as firm, industry, and radical product innovation. We also provided examples of each of these types of innovations. We used multiple items for each construct and negatively and positively valenced items to minimize demand bias and yea-saying (Baumgartner and Steenkamp 2001, 2006). Third, we pretested this questionnaire by sending it to a subsample of 100 firms from four English-speaking nations in our sample (the United States, Canada, the United Kingdom, and Australia). Fourth, after checking for the validity and reliability of the scales, we translated the original English language questionnaire into the other seven languages in our sample (French, German, Italian, Japanese, Korean, Mandarin Chinese, and simplified Chinese). We used independent experts to back translate and retranslate these questionnaires to ensure accuracy and consistency. In some cases, we cross-checked the translated surveys face-to-face with managers from the nation in question (Germany, Switzerland, Japan, and Korea).

Fifth, we obtained the names of firms to make up our sample from the OSIRIS and Worldscope databases, telephoned these firms to identify the vice president for innovation or technology or the equivalent at each firm, and mailed the surveys to all firms in all countries over a six-month period. We sent a reminder letter to each firm 10 to 14 days after we mailed the survey. Sixth, we performed relevant validity, reliability, and cross-cultural equivalence checks (see item 6 in Appendix A) on the survey data to develop the metrics we used in our analysis. Finally, we controlled for yea- and nay-saying, midpoint bias, and extreme response bias across firms and nations by applying the correction procedure used by Triandis (1994) and House and colleagues (2004). By subtracting the mean and dividing by the standard deviation across all responses per firm, this method corrects for the four types of previously mentioned biases. All survey-based items used in subsequent analyses are corrected for these biases.

Archival data. In addition to survey data on firm innovation inputs, outputs, and drivers of innovation, we collected data from multiple archival sources (see Table 2). We collected two types of firm secondary data: patent data from Delphion and firm financials from OSIRIS and Worldscope. We also collected several types of national secondary data. First, we collected ratio scale data from the OECD and perceptual data from the World Economic Forum and the IMD World Competitiveness Report on various measures of national labor, capital, and government policy. Second, we collected data on religion from the CIA World Factbook and data on geographical location from Parker (2000) and worldatlas.com. Finally, we collected data on national culture from Hofstede (2003) and the GLOBE leadership survey (House et al. 2004). We linked the survey and archival

TABLE 2
Sources and Measures of Constructs

Conceptual Variable	Measure	Data Source
Radical innovation	•Three-item additive scale with GLOBE correction	•Global Innovation Survey
Firm financial performance	•Market-to-book ratio	•Worldscope, OSIRIS
Labor	**National Level:**	
	•Availability of scientists and engineers	•World Economic Forum
	•Quality of scientific research institutions	•World Competitiveness Report
	•Quality of management schools	
	•Total public expenditure on education as a percentage of GDP	•IMD World Competitiveness Report
	•R&D personnel nationwide per capita	•OECD Science and Technology Indicators
	Firm Level:	
	•R&D employees as a percentage of total employees	•Global Innovation Survey
Capital	**National Level:**	
	•Financial market sophistication	•World Economic Forum
	•Soundness of banks	•World Competitiveness Report
	•Ease of access to loans	
	•Venture capital availability	
	•R&D expenditure per capita	•OECD Science and Technology Indicators
	Firm Level:	
	•Sales revenue	•Global Innovation Survey
	•R&D spending as a percentage of sales	
Government	•Intellectual property protection	•World Economic Forum
	•University/industry research collaboration	•World Competitiveness Report
	•Government subsidies and tax credits for firm R&D	
	•Government procurement of advanced technology products	
Culture	**National Level:**	
	•Religion: % of population belonging to major world religions: Catholic, Protestant, Buddhist, Muslim, Hindu-Sikh, nonaffiliated, and other	•CIA World Factbook
	•Geographic location: latitude (degrees) of country's capital city	•Parker (2000) and worldatlas.com
	•Values: Hofstede's measures of power distance, uncertainty avoidance, individualism, masculinity, and long-term orientation	•Hofstede Web site
	Firm Level:	
	•Willingness to cannibalize	•Global Innovation Survey
	•Future market orientation	
	•Risk tolerance	
	•Product champions	
	•Incentives	
	•Internal markets	
Control variables	**National Level:**	
	•GDP	•World Economic Forum
	•Population	•World Competitiveness Report
	•Inflation	
	•National credit rating	
	Firm Level:	
	•Citation-weighted patents	•Delphion
	•Primary industry	•OSIRIS, Worldscope

data at the firm and national level to assemble a pooled database that we use in all subsequent analyses (for response rates to the survey, see Table 1).

Measures

Dependent Variables

Radical innovation. We used a three-item scale to measure radical innovation (Chandy and Tellis 1998; Nijssen, Hillebrand, and Vermeulen 2005). These items are all seven-point Likert items measuring the extent of radical innovation within the firm. We combined these items into a three-item additive scale. We found this scale to be fairly reliable (Cronbach's $\alpha = .62$). We also found it to have validity: It correlates well ($\rho = .38$, $p < .0001$) with a fourth seven-point item that measures the percentage of sales based on radical innovations by the firm in the previous three years (for details, see Appendix B).[5]

Financial performance. We measured financial performance using individual firms' market-to-book ratio (Barber and Lyon 1997; Fama and French 1992, 1995)—that is, the ratio of a firm's stock market value to the book values of its assets. We used this measure for three reasons. First, market-to-book values represent investors' valuation of a firm based on all its activities and potential. Second, this measure is future oriented because stock prices represent the net present value of expected current and future cash flows. Third, the ratio provides a measure of the intangible value of the firm beyond its assets, due to factors such as innovation. We collected financial data for each firm at the end of 2003 from Worldscope and OSIRIS.

Independent Variables

Corporate culture. We collected data through the questionnaire on several organizational drivers of innovation: willingness to cannibalize, future focus, risk tolerance, use of incentives, product champions, and internal markets. Willingness to cannibalize refers to the extent to which a firm is prepared to reduce the value of its own prior investments. Future market orientation is the extent to which a firm emphasizes, in its market research activities, customers and competitors that are not currently in the markets it serves. Tolerance for risk refers to the extent to which a firm takes on risk to fulfill a desired goal. The key practices we examine are incentives, empowerment of product champions, and internal markets (see Howell and Higgins 1990; Quinn and Rivoli 1991). Incentives refer to the monetary and nonmonetary rewards a firm has in place to reward innovation. Empowerment of product champions refers to the extent to which a firm promotes the activities of people who aggressively pursue new product ideas. Finally, internal markets refer to the level of internal autonomy and internal competition that exists among business units in a firm.

We developed items for these measures (for details, see Appendix B) from existing research (e.g., Chandy and Tellis 1998; Mols 2001). We combined these items to develop additive scales for each of the variables of interest, after controlling for response biases as discussed previously.

National culture. We used two sources of data on national culture. Consistent with prior research, we used Hofstede's (2003) measures of national culture on the following dimensions: power distance, uncertainty avoidance, individualism, masculinity, and long-term orientation (see also Mitra and Golder 2002). We also collected data from the GLOBE Study of Culture, Leadership, and Organizations (House et al. 2004) on the following dimensions: performance orientation, future orientation, gender egalitarianism, assertiveness, individualism and collectivism, power distance, humane orientation, and uncertainty avoidance. The results we report in this article use Hofstede's measures. However, our results are also robust to the use of the GLOBE measures. We measured national religion by collecting data on the percentage of people within a nation who belong to the following religious groups: Protestant, Catholic, Jewish, Hindu, Buddhist, and Muslim. We obtained this information from the CIA World Factbook. We measured geographical location using the latitude of the capital city of the country.[6] We obtained this data from Parker (2000) and worldatlas.com.

National labor, capital, and government policy. We collected and coded archival data on labor, capital, and government policy for each nation in our sample. To measure labor, we collected data on five variables: the availability of scientists and engineers, the quality of scientific research institutions, the quality of management schools (all from the World Economic Forum's World Competitiveness Report), R&D personnel per 1000 people nationwide, and the total public expenditure on education as a percentage of GDP (from the IMD World Competitiveness Report). All five variables load on one factor, and we used the factor score as a summary measure of national labor.

To measure capital, we collected data on five variables: financial market sophistication, soundness of banks, ease of access to loans, venture capital availability (all from the World Economic Forum's World Competitiveness Report), and the nation's per capita R&D spending (from the IMD World Competitiveness Report). Again, all five variables load on one factor, and we used the factor score as a summary measure of national capital.

Finally, to measure government policy, we collected data on intellectual property protection, university/industry research collaboration, government subsidies and tax credits for firm R&D, and government procurement of advanced technology products (all from the World Economic Forum's World Competitiveness Report). Again, all four variables load on one factor, and we used the factor score as a summary measure of national capital.

Firm labor and capital. We also collected and coded data on skilled labor and capital for each firm in our sample.

[5]We also created an alternative scale that uses all four items; our results are robust to the use of this four-item additive scale instead of the three-item scale we used for the results reported herein.

[6]We also used an alternative measure based on the squared latitude of the capital city. The results are robust to this measure.

We measured skilled labor using the percentage of the total number of employees who were employed in R&D in the year before our survey. We measured capital using the firm's R&D spending as a percentage of sales in the year before our survey.

Control Variables

The control variables in Equation 1 include the national GDP and population and the firm's citation-weighted U.S. patent outputs and its size in sales revenue. Patents represent codified know-how that, as intermediate outputs of the innovation process, may in turn be embodied in final outputs, such as radical innovations. Some researchers and policy makers consider the registration of patents so important that they equate patents to innovation and sometimes measure the latter with the former (Archibugi and Coco 2005; Furman, Porter, and Stern 2002; Porter and Stern 1999). This line of thinking suggests that patents would be an important driver of radical innovation. Furthermore, if markets value patents as highly as many researchers do, patents should have a major influence on financial returns of a firm. We used patents granted in the United States as our metric of patents because (1) most firms that seek patents tend to patent their significant innovations in the United States; (2) patent laws vary considerably across nations, and thus patents in the United States are a reasonable standard for cross-national comparisons; and (3) U.S. patents are the most widely accepted measure of patents used in cross-national studies of patenting (see Furman, Porter, and Stern 2002). We weighted the patents by their forward citations because doing so captures the importance of the patents rather than merely their volume (Griliches 1984; Jaffe, Trajtenberg, and Henderson 1993).[7] We collected the patent and citation data from Delphion for the year before the survey.

The measures of the control variables in Equation 2 include the national GDP, population, inflation, national credit rating, the firm's citation-weighted U.S. patent output, and the firm's size in sales revenue. We control for industry in both Equations 1 and 2 as follows: We identified the two-digit Standard Industrial Classification code for the primary industry in which each firm operates and used this information to run industry-level fixed-effects estimations of Equations 1 and 2.

Results

We describe the results in four parts: response to the survey, validity and reliability of the measures, the drivers of radical innovation, and the financial impact of radical innovation. In addition, Appendix A explores the robustness of our results, including the potential for mediating and moderating effects on the dependent variables.

Survey Response

The response rates to our survey vary between 9% and 34% across nations, with an overall average response rate of 19% (see Table 1). These rates compare well with those in other large-scale international studies (e.g., Baim 1991). Nevertheless, we also checked for nonresponse bias as follows: First, we compared means on the number of employees and total assets (standardized across our sample frame) for respondents and nonrespondents. We found no significant difference between respondents and nonrespondents on these demographic measures. This pattern also holds for most comparisons at other levels of analysis (within nations, across the four strata of firm size in our sampling plan, and across strata within each nation). Second, we compared means on important variables in the survey for respondents in the first versus last quartile in terms of date of response after the mailing. We performed this analysis across nations and found no significant difference in means for most of our variables in most nations. These results provide some assurance that our data do not suffer from nonresponse bias.

Respondents to the survey have substantial experience (they average 17.4 years of experience in their industry and 12.4 years of experience in their firm) and are closely involved in innovation activities (average level of personal involvement in innovation activities is 5.8 on a seven-point Likert scale anchored by "not at all involved" [1] and "highly involved" [7]). After cleaning the survey data and accounting for missing values, we have a sample size of 772. We then integrate the archival firm and national data with the survey data and achieve a sample size of 759. To our knowledge, this is the largest sample among multicontinent studies of firm innovation (for descriptive statistics, see Table 3). We first present the results of the estimation of our measurement model and then present the results of our formal tests and additional analyses.

Reliability and Validity

Following Anderson and Gerbing (1988), we assessed the measurement model before estimating the research model. To obtain reliable and valid measures of our focal variables, we first examined the face validity, interitem, and item-to-total correlations to arrive at the scales we described previously. All scales show satisfactory reliabilities, with Cronbach's alphas above the acceptable cutoff of .60 (except willingness to cannibalize, which has an alpha of .58).

Next, we used confirmatory factor analysis to examine the unidimensionality of the constructs (i.e., the extent to which a single construct underlies a set of measures [items]). The overall fit of the measurement model provides the necessary information to determine whether unidimensionality is satisfied (Gerbing and Anderson 1988; Steenkamp and Van Trijp 1991). The overall fit of the full model is satisfactory (Browne and Cudeck 1993).

To check for discriminant validity of the latent constructs, we constrained the correlation between each pair of latent constructs to 1; the constrained models show evidence of poor fit relative to the freely estimated equivalent. Lagrange-multiplier tests indicated no significant cross-loadings, thus providing further evidence of discriminant validity. The preceding tests provide support for the psychometric adequacy of our measures.

[7]We also ran our models with patent counts only and found that our results are robust to this measure.

TABLE 3
Descriptive Statistics

Conceptual Variable: Level of Analysis	Variable	M	SD	Minimum	Maximum
Radical Innovation					
Firm	Radical product innovation	12.39	3.87	3	21
Financial Performance					
Firm	Market-to-book ratio	.90	1.21	3×10^{-4}	11.93
Labor					
Nation	National labor	-2.91×10^{-9}	.97	–2.20	1.53
Firm	R&D employees/all employees	3.60	1.39	0	7
Capital					
Nation	National capital	-6.66×10^{-9}	.98	–2.18	1.33
Firm	R&D spending/sales revenue	3.27	1.16	1	7
Government					
Nation	Government	-2.18×10^{-9}	.91	–2.56	1.80
Culture					
Nation	Religion: % Catholic	19.06	25.12	0	85.5
	Religion: % Protestant	17.01	23.88	0	94
	Religion: % Buddhist	20.56	34.08	0	93
	Religion: % Muslim	2.60	3.65	0	14.9
	Religion: % Hindu-Sikh	3.25	15.38	0	82.4
	Religion: % nonaffiliated	18.94	21.45	0	95
	Geographic location: distance from equator	1926.57	585.99	56.84	3038
	Values: power distance	49.90	14.65	31	80
	Values: individualism	57.26	28.96	17	91
	Values: masculinity	56.45	18.40	5	95
	Values: uncertainty avoidance	58.78	21.33	8	92
	Values: long-term orientation	47.50	31.875	0	118
Firm	Attitude: willingness to cannibalize	12.49	3.34	3	21
	Attitude: future market orientation	16.40	3.95	4	28
	Attitude: risk tolerance	15.42	4.27	4	28
	Practice: product champions	10.40	2.26	2	14
	Practice: incentives	7.64	2.73	2	14
	Practice: internal markets	3.91×10^{-4}	.79	–1.75	2.64
Control Variables					
Nation	Country GDP	2363.09	3308.48	90.24	10,445.63
	National population	167.23	304.36	4.2	1294.4
	Inflation	1.39	1.51	–3	4.3
	National credit rating	82.60	12.29	46.7	95.3
Firm	Citation-weighted patents	5.21	44.429	0	1046
	Firm size	1,431,539	5,641,951	–111,669	6.40×10^{7}

Drivers of Radical Innovation

Recall that our theory suggests that corporate culture is a primary driver of radical innovation, in addition to the effect of government, firm, and national labor, capital, and culture. Equation 1 specifies the model that captures this theory. The results (standardized coefficients) of the test of this model appear in Table 4. To show robustness of the results to multicollinearity, we present the results in six nested versions of Equation 1. We highlight the key results.

Model 5 shows that most of the traditional variables from the literature have little effect on radical innovation after we account for corporate culture. Model 5 also shows that five of the six measures of corporate culture (all except internal markets) have effects that are significantly greater than zero. Based on standardized coefficients and t-statistics, the effects of future market orientation, willingness to cannibalize, and tolerance for risk are particularly strong. Although the effects of incentives and product champions are relatively weaker, they are still significantly larger than zero. A reason for this difference may be because attitudes are a more proximate driver of innovation than practices. Other important results that emerge from Table 4 are that citation-weighted patents do not affect radical innovations. Conversely, firms' R&D activities, measured as the percentage of R&D employees to all employees, have a significant, positive effect on radical innovation. Indeed, R&D may be a measure of a firm's commitment to innovation, at least in technology-driven markets.

TABLE 4
Estimates of Independent Variables on Radical Innovation (Equation 1)

Conceptual Variable: Level of Analysis	Independent Variable	Model 1: National Culture Only	Model 2: Corporate Culture Only	Model 3: Corporate and National Culture	Model 4: All Alternative Hypotheses	Model 5: Full Model	Model 6: Model 5 Without Religion
Labor							
Nation	National labor				–.12	–.01	.01
Firm	R&D employees/all employees				.13*	.11**	.11**
Capital							
Nation	National capital				–.14	–.17	–.10
Firm	R&D spending/sales revenue				.10	.04	.04
Government							
Nation	Government				.12	.08	.05
Culture							
Nation	Religion: % Catholic				.11	.13	
	Religion: % Protestant				.01	–.08	
	Religion: % Buddhist				.26	.12	
	Religion: % Muslim				–.11	–.15	
	Religion: % Hindu-Sikh				.15	.16	
	Religion: % other				–.02	–.00	
	Geographic location: distance from equator				.17	.13	.01
	Values: power distance	–.09		–.09	.10	.04	–.01
	Values: individualism	–.07		–.10	.05	–.04	.03
	Values: masculinity	.02		.01	–.01	–.02	.01
	Values: uncertainty avoidance	–.03		.001	–.28	–.28	–.07
	Values: long-term orientation	–.03		.01	–.15	–.01	.05
Firm	Attitude: willingness to cannibalize		.11*	.11*		.10*	.10*
	Attitude: future market orientation		.11*	.10*		.13*	.12*
	Attitude: risk tolerance		.25*	.27*		.23*	.24*
	Practice: product champions		.10*	.10*		.10*	.10*
	Practice: incentives		.10*	.10*		.09*	.10*
	Practice: internal markets		.06	.06		.03	.04
Control Variables							
Nation	Country GDP				.04	.07	–.03
	National population				–.11	–.17	–.08
Firm	Citation-weighted patents				.03	.02	.02
	Firm size				.06	.04	.05
	R^2 overall	.05	.25	.26	.13	.29	.29
	Adjusted R^2	.00	.22	.22	.05	.23	.23
	AIC	3424.7	3243.1	3247.6	3398.5	3247.5	3245.4

*$p < .01$.
**$p < .05$.
Notes: All survey measures are corrected for midpoint and extreme response bias. All coefficients are standardized values. AIC = Akaike information criterion.

Note that none of the measures of religion have an impact on radical innovation (Model 4 and 5). However, the measures of religion correlate with national culture, as measured by Hofstede's (2003) variables, causing multicollinearity between these two sets of variables. To examine whether this multicollinearity affects the other results, we drop the religion variables from the full model (see Model 6) and find that significance levels and standardized coefficients of the other variables remain essentially unchanged.

Thus, for our sample of firms and nations, few of the national variables are significant drivers of radical innovation. This result holds across a plethora of robustness tests, including tests of mediation and moderation (see Appendix A). However, two broad drivers of radical innovation emerge as important: firms' corporate culture and their investments in skilled labor.

Financial Impact of Radical Innovation

An additional objective of this research is to establish the financial value of radical innovation. Table 5 presents the results of the impact of radical innovation on financial performance, as measured by firms' market-to-book ratio. Model 1 in Table 5 reveals that radical innovation has a significant effect on the market-to-book ratio, even after we control for industry fixed effects. Furthermore, Model 2 in Table 5 reveals that radical innovation continues to have a significant effect on the market-to-book ratio in the full model, which includes other firm and national variables. This model also indicates that at the firm level, skilled labor, which we measure as a ratio of R&D employees to all employees, is a strong predictor of market-to-book ratios, while patents, a commonly used measure of innovation, are not. At the national level, we find that national capital and national population have a significant impact on the market-to-book ratio. In summary, our results suggest that (1) markets strongly reward radical innovation beyond any returns to patents, R&D, and other control variables and (2) radical innovation is a more powerful metric of commercial value/performance than patents.

Conclusions

This study leads to two important conclusions. First, several factors do not seem to be as important drivers of radical innovation in firms across nations as many researchers believe. Among these are some frequently emphasized metrics of national labor, capital, government regulation, and culture. In contrast, internal corporate culture is an important driver of radical innovation. The reasons we propose for this pattern of results are as follows: The current economic environment is characterized by increasing globalization and the lowering of barriers to mobility of labor and capital. This "flattening" is often accompanied by the rapid adoption of best practice and policy by governments. The rapid progress of India and China presents some evidence of these factors in operation. In such an environment, national drivers are unlikely to be major discriminators of firms' performance, at least in the 17 nations we sample. In addition, firm and national factors have different levels of sensitivity; this is because firm factors reflect the unique features of each firm, while national factors are common across all firms in the country. Indeed, corporate culture is a factor that is unique, intangible, sticky, and difficult to change. Moreover, success in one generation of technology can breed attitudes of complacency and invulnerability with

TABLE 5
Estimates of Radical Innovation on Market-to-Book Ratio (Equation 2)

Conceptual Variable: Level of Analysis	Variable	Model 1: Radical Innovation Only	Model 2: Full Model
Radical Innovation			
Firm	Radical product innovation	.10*	.06**
Labor			
Nation	National labor factor		.001
Firm	R&D employees/all employees		.14*
Capital			
Nation	National capital factor		.23*
Firm	R&D spending/sales revenue		.05
Government			
Nation	Government factor		.07
Control Variables			
Nation	Country GDP		.07
	National population		.27*
	Inflation		−.06
	National credit rating		.03
Firm	Citation-weighted patents		.03
	Firm size		−.03
	R^2 overall	.15	.27
	Adjusted R^2	.0	.21
	AIC	2066.8	1989.9

*$p < .01$.
**$p < .05$.
Notes: All survey measures are corrected for midpoint and extreme response bias. All coefficients are standardized values. AIC = Akaike information criterion.

a focus on managing current products and protecting current profits that brought that success. These cultural traits can blind a firm to radical innovations on the frontier. Thus, maintaining a culture of relentless innovation is difficult.

Some examples illustrate the main results we obtain. A traditionally innovative nation, such as the United States, can be home to innovative firms, such as Apple or FedEx, and lumbering ones, such as Kodak and Kmart. Innovative firms such as Samsung (Korea) and Infosys (India) in traditionally lagging economies can leapfrog ahead of slumbering giants in traditionally advanced economies. Indeed, the corporate culture in some of these innovative firms develops precisely to overcome aspects of their home economies that would otherwise hinder them. Thus, national factors, such as government, culture, labor, and capital, are not unimportant. Rather, in the current environment among the 17 economies in our sample, corporate culture seems to be more important than these traditional country drivers in predicting radical innovation in firms across nations.

Second, we find that radical innovations translate into financial value to the firm. The importance of this finding lies in our measurement of radical innovations with a survey but financial value with archival, publicly available data. Thus, the result underscores the validity and importance of our measure of radical innovation: Such innovation significantly increases market-to-book value, even after we control for patents, R&D, and other variables. Significantly, patents—a measure of innovation widely used in previous research—are not as important in influencing financial value as radical innovations in firms.

Implications

The prior analysis and our findings lead to some important implications for managers, researchers, and policy makers. First, our study suggests that firms are special forms of organizations that increasingly transcend national boundaries, constraints, and systems. Innovative firms, it would seem, are similar: They share the same cultural practices and attitudes despite differences in location. However, this culture is difficult to observe, measure, and develop. We provide a diagnostic tool that can assess the relevant dimensions of culture and enable firms to benchmark themselves against others of their size, history, or industry. Thus, managers can be attuned to these cultural factors, can measure them, and can foster them to maintain a culture of relentless innovation. Such a focus may bear more tangible fruit than one that relies on government to invest in or protect markets. Indeed, the appeal for government relief and intervention by firms may well be a cover for cultural deficiencies in their organizations that they may have previously overlooked.

Second, we identify specific attitudes and practices within innovative firms that make them special and foster a culture that helps drive radical innovation. The attitudes include a willingness to cannibalize, future market orientation, and risk tolerance, while the practices include empowering product champions and providing incentives for enterprise. Firms, such as Apple, that have such cultural attitudes and practices are distinct and excel at radical innovation (Tellis and Golder 2001). They do not need to count patents and engineers. Indeed, Apple's "best feat may be the culture that helps generate so many folks who've gone on to create great products elsewhere" (*BusinessWeek Online* 2005).

Third, our study highlights the usefulness in a cross-national context of an output-based measure of radical innovation (i.e., radically new products) over surrogates, such as patents and national scientific talent, used in the past (Acs and Audretsch 1987; Von Hippel 2005). Measuring radical innovation directly enables firms and nations to gauge where they really stand on the ultimate outputs that count rather than on inputs or intermediate outputs that reflect costs. This measure can enable firms and governments to channel resources toward drivers that matter and to ensure that the entire process of innovation is efficient and productive.

Fourth, patents, a measure often used as a surrogate for radical innovation, turn out not to significantly affect firm capitalization and radical innovation. These results are robust and not due to model design or multicollinearity. Firms and policy makers have probably used patents because they are easily measured, seem to be a precondition for innovation, or seem to offer protection to intellectual property. However, many high-tech firms now realize that patents provide only partial protection for their inventions, and firms can be highly innovative without patenting. In this context, as a senior vice president of research at a *Fortune* 50 firm in the United States noted, "We have many technologies and patents sitting on the shelf. Our problem is getting them out to market!" So, firms and nations need to focus primarily on outputs such as radical innovation rather than on inputs such as patents, or they should at least focus on converting inputs into outputs. This conversion is not obvious, as our results and many contemporary examples show. For example, innovative Apple, with a little more than a hundred patents, stole Sony's market for mobile music, while Sony, with thousands of patents, refrained from cannibalizing its successful Walkman and music businesses.

In summary, our results question some long-held premises about radical innovation, suggest a direct measure for the construct, and outline the attitudes and practices within a firm that support innovation. Authors who debate national labor, capital, culture, or government policy may be underappreciating the innovative revolution within firms. Policy makers who rely exclusively on the plausible metrics of scientific talent, patents, and intellectual property protection may be missing the real battle taking place. The battle is within. It is a cultural one: between glorifying the past or being paranoid about the future (Grove 1996), between protecting successes or cannibalizing them (Chandy and Tellis 1998), between averting risk or embracing it. The battle is for the soul of the firm. Innovative firms are those that clearly understand this battle and adopt decisive practices to win it.

Limitations and Further Research

Limitations of this study suggest three major research themes that could prove groundbreaking. First, we do not explore whether radical innovation leads to national wealth in addition to firm value. Current studies of nations' wealth

attribute such wealth to natural resources, economic capital, talent, or favorable regulation. Further research could ascertain whether innovation is an important driver of national wealth in addition to the previously mentioned factors. Such research would have significant policy implications in addition to implications for managers of firms.

Second, consumer innovativeness and firm innovation have been topics of extensive research in marketing and strategy. To date, research has not attempted to join these two fields of inquiry. Further research could ascertain whether the innovativeness of consumers in a country drives or is influenced by the innovation of firms in that country. The findings of that research would have significant implications for our understanding of whether and when radical innovation is a market-driven versus a market-driving phenomenon.

Third, we do not study subsidiaries of multinational firms. A worthwhile extension of this study would be to explore whether corporate culture is strong enough to hold across various subsidiaries located thousands of miles apart in widely different nations and cultures. This topic is of special importance as firms rush to establish innovation centers in distant locales.

In addition to the major research themes we have discussed, our research also suggests some methodological extensions. First, our measures of corporate culture are from self-reports, while those for country variables are from secondary sources. A major challenge for researchers is to develop and gather hard measures of culture, such as those we use for patents, R&D expenditures, and financial returns (Rindfleisch et al. 2007). Such measures would obviate the concern that some of our results may be affected by measurement error or differences in the level of measurement.

Second, recent research (Wong, Rindfleisch, and Burroughs 2003) has shown that mixed-worded scales can cause problems in reliability and factor loading. In this research, we use mixed-worded scales to reduce the systematic bias due to the use of a particular response style within a particular nation (Baumgartner and Steenkamp 2001). Use of such scales might account for why the Cronbach's alphas of our scales are sometimes lower than the more desirable cutoff of .70.

Third, we restrict our sample to 17 nations. These results may not hold for nations wrecked by political instability or riddled with corruption, nepotism, or war. Conversely, small, highly innovative nations, such as Israel, or highly populous nations, such as Indonesia and Brazil, may hold special lessons that further research can uncover. In particular, research on these nations might shed more light on the ways firm and national factors are likely to interact and intersect in driving innovation.

Finally, our sample of firms is restricted to publicly listed firms in each nation. In nations such as China, where the population of publicly listed firms is not very large, our sample frame is necessarily small. Generalizations beyond such firms should be made with caution and care and after much further research.

Appendix A
Tests of Robustness

1. Are Our Results Driven by Common Method Bias?

Common method bias is irrelevant when testing Equation 2 because the dependent variable in this equation (market-to-book ratio) uses data from a set of secondary sources that are entirely independent of the sources of data for virtually all the independent variables in this equation (see Podsakoff et al. 2003). Indeed, the results for this equation help validate our survey-based measures because they demonstrate that our survey-based measure of radical innovation is a powerful predictor of financial outcomes measured in a future period by independent sources.

To check whether common method poses problems in Equation 1, we conduct two additional analyses. First, we employ Harmon's one-factor test for common method bias. Specifically, we perform a confirmatory factor analysis (see Podsakoff et al. 2003) in which we link all items in our corporate culture (independent) variables as well as our radical innovation (dependent) variable to a single latent factor. The results of this analysis strongly reject the single-factor hypothesis, thus alleviating some concerns about common method bias.

Second, to further alleviate concerns regarding common methods in Equation 1, we examine the correlations between two nomologically related constructs—radical innovation and patents. In our survey, we ask respondents to report on both radical innovation in their firm and the number of U.S. patents granted to their firm in the previous year (2003). If common methods bias is pervasive in our data (e.g., as a result of social desirability), firms would respond similarly on both radical innovation and patents. We find that this is not the case. None of the items that make up our measure of radical innovation correlate with our measure of patents granted. Moreover, the information from the survey-based measure of patents matches closely with that from Delphion, an independent (secondary) source of patent data. All these analyses indicate that our results are not driven by common method bias.

2. Do the Results Change if Country Factors Are Modeled as Fixed Effects?

An alternative approach to the theory-based approach we use to model country-level factors is simply to use country-specific dummy variables to account for the unobserved heterogeneity that is due to each nation in our sample (see Baltagi 2005). The results from such an analysis (which are available from the authors on request) indicate that, in general, the effects of corporate culture are consistent with those in the results we presented previously.

3. Does Corporate Culture Mediate the Effect of National Culture on Radical Innovation?

A key question is whether national culture affects corporate culture or whether the latter mediates the effect of the former on radical innovation (Kirca, Jayachandran, and Bearden 2005). To address these questions, we carry out a formal test

of mediation. Baron and Kenny (1986) list three conditions that must hold for mediation to exist. We test for the existence of each of these conditions in our data and find that none are satisfied. As such, the effects of national culture on innovation are not mediated by internal (firm) culture.

Specifically, Condition 1 states that the exogenous variables and the proposed mediator must each be significantly related to the dependent variable when considered separately. In our case, this condition requires that the national and corporate culture variables, taken separately, should each have a significant impact on innovation. We find that this condition does not hold. The coefficients of corporate culture (in the regression that does not include national culture) are significant (see Model 2 in Table 4). However, the coefficients of the national culture variables (in the regression that does not include corporate culture) are not significantly different from zero (see Model 1 in Table 4).

Similarly, Condition 2 states that the exogenous variables should be significantly related to the proposed mediator. In our case, this would suggest that the national culture variables should have a significant impact on corporate culture. This condition, which is crucial for mediation, does not hold. The results of a regression of corporate culture on the national culture variables indicate that none of the national culture variables have a significant impact on corporate culture.

Finally, Condition 3 states that the relationship between the exogenous variables and the dependent variable should be weaker (for partial mediation) or nonsignificant (for full mediation) when the proposed mediator is included in the model than when the mediator is not included. In our case, this condition requires that the coefficients of the national culture variables on innovation should be significantly smaller when corporate culture is included in the model than when it is not included. This condition for mediation also does not hold. The coefficients of the national culture variables in the regression that does not include corporate culture are identical to those in the regression that does include corporate culture (both sets of coefficients are not significantly different from zero).

Thus, not only does corporate culture not mediate the effect of national culture on radical innovation, but its effect also does not arise from national culture. In our sample of publicly held firms in 17 leading economies, the latter does not affect radical innovation at all.

4. Do Firm and Nation Factors Interact to Drive Radical Innovation?

Some authors have implied that firm and national factors may interact to drive innovation (see Bartholomew 1997; Murtha, Lenway, and Hart 2001; Nelson 1993). To test for this possibility, we ran several models that included first-order interactions between the key firm and national factors in our model in addition to including all the main effects about which we theorize. We find that most of the interaction coefficients are not significantly different from zero; moreover, the pattern of results is not consistent with any systematic effects that would be predicted by the literature. Given these results, we conclude that further study of the interaction between national and firm drivers of innovation would be a promising avenue for theoretical and empirical work.

5. Do the Effects of Corporate Culture Vary by Nation?

To examine this question, we first run random coefficient regression models (Raudenbush and Bryk 2002) that allow the coefficients of each corporate culture variable to vary across nations. We find that the full model, in which all corporate culture coefficients vary by nations, does not converge. We then run separate random coefficient regressions, such that a single corporate culture coefficient varies randomly across nations in each regression equation. In each of these equations, we find that none of the corporate culture coefficients vary significantly across nations. We also run a random-intercept regression, in which random variations from the intercept reflect national unobserved heterogeneity. We find that the intercept for the radical innovation equation does not vary significantly across nations and that all effects of the corporate culture variables remain substantively similar to those we reported previously. Finally, a model that incorporates heterogeneity through latent class analysis also yields similar results. These analyses indicate consistency in the effects of corporate culture on radical innovation across the nations in our sample.

6. Do Our Survey Measures Have Cross-Cultural Equivalence?

Our survey measures rely on respondents interpreting key constructs, such as radical innovation, in a consistent manner across nations. To ensure this, we take several steps (see Harkness, Van de Vijver, and Mohler 2003): (1) translation and back translation to ensure consistency in the meaning of constructs and items across different languages, (2) a clear definition of radical innovation while anchoring it in two universal examples (the compact disc player relative to cassette tapes and record players and the microwave oven relative to conventional ovens), and (3) in-depth, face-to-face interviews with managers from different cultural contexts (Germany, the United Kingdom, Korea, India, Japan, and China).

In addition, we test our data for metric equivalence across nations. Because testing for metric invariance in eight constructs across 17 nations would require a far larger sample size than ours, we create four groups of nations that share a similar cultural and economic background. The group "English speaking" includes Canada, the United States, the United Kingdom, and Australia. All European nations (Italy, Germany, the Netherlands, France, Switzerland, and Sweden) are grouped together. The group "emerging nations" includes China, India, Taiwan, Korea, Singapore, and Hong Kong. Japan is a fourth group because it does not fit with any other group. Following Steenkamp and Baumgartner (1998), we first test the hypothesis of full metric invariance by constraining the matrix of factor loadings to be invariant across groups. Because there is a significant increase between the configural model and the full metric model invariance ($\Delta\chi^2(42) = 76.966$, $p = .001$), we do not find support for full metric invariance.

However, prior research has suggested that "full measurement invariance is particularly unlikely" (Steenkamp and Baumgartner, 1998, p. 81) and should be considered scientifically unrealistic (Horn, McArdle, and Mason 1983), while partial metric invariance can be regarded as sufficient to establish cross-cultural equivalence (Byrne, Shavelson, and Muthen 1989). To identify the source of lack of full metric invariance, we examine the difference between each pair of factor loadings. We find that only 23% (13 of 57) of the pairs of factor loadings are significantly different across nations; moreover, there are no clear patterns in these differences. These findings are largely consistent with Steenkamp and Baumgartner's (1998). To test for partial metric invariance, we free up the constraints on the model parameters and find that the partial metric invariance model is not significantly different from the configural model ($\Delta\chi^2(34) = 32.192$, $p = .566$). Furthermore, the partial metric invariance model shows better fit than the configural model because the root mean square error of approximation and the consistent Akaike information criterion, which take into account both goodness of fit and model parsimony, are lower. Thus, we find support for partial metric invariance in our data. Overall, these results provide some evidence of cross-cultural equivalence in our survey measures.

APPENDIX B
Key Measures in Survey

	Standardized Factor Loadings	t-Value	Composite Reliability
Radical Product Innovation			
Primary Measure			.73
1. Our firm rarely introduces products that are radically different from existing products in the industry. (R)	.70		
2. Our firm lags behind others in introducing products based on radically new technologies. (R)	.74	12.94	
3. We have no difficulty in introducing products that are radically different from existing products in the industry.	.37	8.37	
Alternative Measure			
% of total sales revenue from radical product innovations introduced by our firm in the last three years (2001–2003) (1 = 0%, 2 = 0%–1%, 3 = 1%–5%, 4 = 5%–10%, 5 = 10%–20%, 6 = 20%–30%, and 7 = over 30%)			
Willingness to Cannibalize			.65
1. We are very willing to sacrifice sales of our existing products to improve sales of our new products.	.71		
2. We tend to oppose new projects that could take away from sales of our existing products. (R)	.32	8.17	
3. We will not aggressively pursue a new technology that causes existing investments to lose value. (R)	.56	8.13	
Future Market Focus			.66
1. Our firm gives more emphasis to customers of the future relative to current customers.	.38	7.13	
2. Market research efforts in our firm are aimed at obtaining information about customers' needs in the future, relative to their current needs.	.50	8.49	
3. We are slow to detect fundamental shifts in our industry (e.g., competition, technology, regulation). (R)	.52	9.01	
4. Our firm is oriented more toward the future than the present.	.57		
Risk Tolerance			.72
1. Managers in our firm rarely take risky decisions. (R)	.71	11.29	
2. Relative to other firms, we tend to favor higher-risk, higher-return investments.	.57	10.47	
3. We are reluctant to engage in untested business ventures. (R)	.54		
4. We believe it is often necessary to take calculated risks.	.44	8.82	
Product Champions			.56
1. Employees with new product ideas receive no support in our firm. (R)	.70	6.77	
2. Top managers in our firm strongly support champions of ideas for new products.	.39		
Incentives for Enterprise			.77
1. We provide generous monetary rewards to innovative employees.	.66	9.25	
2. We provide many non-monetary rewards (e.g., recognition, autonomy) to innovative employees.	.82		

APPENDIX B
Continued

Autonomy			.74
1. All new product and process decisions in our firm require the approval of the corporate office. (R)	.88	9.23	
2. Few strategic actions can be taken in divisions in our firm until the corporate office approves these actions. (R)	.72		
Internal Competition			.68
1. Divisions in our firm frequently enter markets served by other divisions.	.64	6.54	
2. Divisions in our firm actively compete with each other to gain new markets	.84		

Notes: R = reverse-coded item. All items are seven-point Likert-type scales anchored by "strongly disagree/strongly agree" unless indicated otherwise.

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