Author(s) Haapaniemi, Tomi

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Cross-National Adoption of Innovations: The Effects of Cultural Dimensions on the Amount of Adopters at the Takeoff

Haapaniemi, Tomi P.
CITER – Center for Innovation and Technology Research
Institute of Industrial Management
Tampere University of Technology
P.O. Box 541, FI-33101 Tampere, FINLAND
Fax +358 3 3115 2027
tomi.haapaniemi@tut.fi

ABSTRACT

The study focuses on the domain of the cross-national evolution of innovation adoption. Of special interest in national markets is innovation adoption at the moment of takeoff. The takeoff point lies between the introductory and the growth phases of innovation adoption, and divides the behavior of adopters. Following earlier research on the influences of cultural attributes on consumer behavior and differences in national markets, this paper empirically investigates how attributes at the cultural and national level may affect the amount of innovation adopters at the takeoff point in a cross-national setting. The paper reports results that confirm the influence of cultural and national attributes, despite global converging trends. The study reveals that particularly the masculinity and national income level of a culture can affect the adoption of innovations. This information might be useful to those companies launching radical innovations internationally and planning operations.

Keywords: takeoff point, adoption of innovation, cultural dimensions, national attributes, cross-national

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INTRODUCTION

This paper focuses on the cross-national adoption of innovations by investigating the evolution of innovation adoption in national markets. The national adoption of newly launched innovations has been found to depend on various attributes of the nation, including national economic and political conditions, religious beliefs, language, and lifestyles (e.g. Ganesh et al., 1997, Takada and Jain, 1991). These attributes have also been observed to influence the whole dynamics of innovation adoption (e.g. Golder and Tellis, 2004, Ganesh and Kumar, 1996, Tellis et al., 2003, Andonova, 2006, de Mooij, 2000).

The evolution of innovation adoption has been divided into phases extending from initial slow growth to accelerated growth, ending finally in maturity and decline phases, with the phases differing dramatically in their characteristics along the adoption life cycle (e.g. Moore, 1999, Rogers, 1995). The intermediate point between the introductory and growth phases, the "takeoff" point, marks a change in customer requirements and preferences from technical functionality to usability and reliability (Moore, 1999, Rogers, 1995). The takeoff point is also the juncture in innovation dynamics where dominant designs are adopted (Utterback, 1994). For these initial phases, such activities as marketing communications, product designs and advertising message, among others, should differ from those required for mass markets later in the evolution of innovation adoption (e.g. Mohr, 2001). Therefore, companies developing innovations and products must be prepared to change their competitive basis from technical functionality to such market-oriented factors as reliability and usability (Christensen, 1997). Accordingly, at this point, companies need to change the focus in their management of technology from technological development to product development and incremental improvement (Utterback and Abernathy, 1975).

The existing literature on international innovation adoption has primarily focused in on estimating and comparing diffusion parameters between countries (e.g. Gatignon and Robertson, 1985, Heeler and Hustad, 1980, Helsen et al., 1993, Mahajan and Muller, 1994, Talukdar et al., 2002). In order to explain differences in diffusion parameters between countries, these studies have reported that the adoption process is both product- and country-specific and that cross-national influences may also have an effect on the adoption of innovation (e.g. Kumar et al., 1998, Takada and Jain, 1991, Tellefsen and Takada, 1999, Gatignon et al., 1989, Stremersch and Tellis, 2004, Golder and Tellis, 2004). However, these diffusion models have been criticized in the applied international setting from a number of perspectives. Heeler and Hustad (1980) found difficulties in fitting diffusion models into the international setting. Moreover, as noted by Mahajan, Muller and Bass (1990a) in their review, the parameter estimation for diffusion models is largely of historical interest, since reliable estimation requires that data should span across the inflection point into the growth phase of innovation or product life cycle (Schmittlein and Mahajan, 1982). Furthermore, Dekimpe et al. (1998) have found that estimating diffusion parameters can be risky and even misleading in the international setting.

Despite the extensive research carried out on this topic, little research has attempted to identify the cross-national patterns describing the national innovation adoption dynamics in terms of the differing customer segments adopting the innovation. No studies have explored the effect of cultural and national attributes on the amount of innovation adopters. Therefore, this paper reports results on how cultural and national level attributes affect the amount of innovation adopters at the takeoff point in a cross-national setting. The paper also provides managers with normative recommendations regarding the management of new innovations.

THEORETICAL FOUNDATIONS

Overall, adoption of innovation proceeds first slowly over the period following a product's commercial launch (Bass, 1969, Gort and Klepper, 1982, Rogers, 1995) and then later at a sharply increasing rate. For most innovations, the takeoff point is clear, because they typically penetrate the market rapidly upon reaching mass markets (Agarwal and Bayus, 2002). Agarwal and Bayus (2002) report that before sales take off, as shown by the "elbow shape" pattern in sales histories, the number of firms in the industry increases. At the early phases of innovation adoption, the customer segment is predominated by innovators (Rogers, 1995). This innovator segment is critical for validating the functionality of the innovation and the basic existence of the markets for a new technological innovation.

A culture builds a relatively consistent set of shared symbolic ideas associated with societal patterns of cultural environment (Gudykunst and Kim, 1984). National-level cultural attributes have been found to have an impact on the adoption of technology and innovation in a cross-national setting (e.g. de Mooij, 2000). Hofstede's original four cultural dimensions, i.e., power distance index (PDI), individualism index (IDV), masculinity index (MAS), and uncertainty avoidance index (UAI), represent cultural variability and different value systems in cultures (Hofstede, 1980). Hofstede's view forms a broad concept of culture comprising everyday practices, symbols, and rituals shared by the members of a society (Schwartz, 1997). Later, the Confucian work dynamism was added to the original four, labeled as long-term orientation (LTO). These values form the core of culture and define tendencies to prefer certain states of affairs over others (Hofstede, 1997). In addition, the five cultural dimensions describe cultural tendencies and orientations in a researchable construct.

Hierarchy and its pervasiveness inhibits individual decision-making in high PDI cultures (Hofstede, 1997), whereas low PDI cultures prefer a more democratic form of decision-making characterised by fewer supervisory personnel. High PDI also leads to a general distrust of others, thus further inhibiting fast, decisive decision-making (Dawar et al., 1996). Further, a high power distance index has even been found to hinder the adoption of new products (Sivakumar and Nakata, 2001).

In high IDV cultures, the need for achievement and industriousness can be emphasized (Tellis et al., 2003). Independent decision making and the need for personal rewards are preferred values in individual cultures with high individuality index. In contrast, members of collective cultures tend to seek acceptance of the group and express needs for maintaining harmony and traditions (Schneider and Barsoux, 1997). Interstingly, a high IDV score would suggest earlier adoption of new products (Sivakumar and Nakata, 2001).

The MAS index assesses the level of assertiveness, competition, ambition and forms of materialism, like money and earnings. In low MAS (i.e., "feminine") cultures, people strive more to promote the overall well-being of the society rather than own individual welfare. Here, the adoption of new products or innovations might be an important aspect in exhibiting wealth and success, a trait more compatible with masculine societies (Tellis et al., 2003). Further, it has been found that consumer innovativeness is higher in countries, whose national culture is characterized by higher levels of masculinity (Steenkamp et al., 1999). However, some studies suggest that MAS may have no significant effect on product acceptance or innovation adoption (Tellis et al., 2003, Yeniyurt and Townsend, 2003).

High UAI is associated with a strong identification with one's own group and its rules (Dawar et al., 1996). On the other hand, in low UAI cultures, uncertainty is accepted as a normal feature of life (Hofstede, 1997). It has been found that low UAI results in faster overall adoption (Tellis et al., 2003). Further, it has been found that cultures with high UAI are intolerant of ambiguity and distrustful of new ideas or behaviors (Dawar et al., 1996).

High LTO refers to future-focused values, such as persistence, thrift, and perseverance toward slow results. Low LTO cultures focus on respect for tradition, personal steadiness and stability, and a reciprocation of favors and gifts. Long-term values are oriented toward the future whereas short-term values are oriented toward the past and the present (Bond et al., 1987, Hofstede, 2001, Hofstede and Bond, 1988).

The existing literature has been using these cultural dimensions for seeking explanatory factors for national level behaviors and cross-cultural variations (e.g. Dawar et al., 1996). There exists both research that support the existence of the dimensions and their power of classifying national cultures (e.g. Watson et al., 2002) as well as those that criticize them. Despite the critique of Hofstede's dimensions, they still can be considered a coherent theory that explains variation between national cultures (Sivakumar and Nakata, 2001, Søndergaard, 1994, McSweeney, 2002b, Hofstede, 2002, McSweeney, 2002a, Yeniyurt and Townsend, 2003). Researchers have favored this framework because of its clarity, parsimony and resonance with managers (Kirkman et al., 2006). Therefore, based on previous work it can be concluded that the validity and the reliability of the measures are established in the current literature.

According to the existing literature, the national level attributes have impacts on innovation and product adoption in a cross-national setting. For example, Tellis, Stremersch, & Yin (2003) found that products are adopted faster in wealthy, educated countries as well as in more open, internationally focused economies than in poor or less open economies. They further reported that a higher need for achievement, lower uncertainty and industriousness are factors that may affect the adoption dynamics. Economic conditions were also found to affect adoption in the study by Golder and Tellis (2004). Furthermore, Dwyer et al. (2005) found support linking Hofstede's cultural dimensions to cross-national product diffusion. It has also been found that cultural value differences persist, despite the continued globalization of markets and the convergence of national incomes (Watson et al., 2002, de Mooij, 2000). This implies that people are able to spend more money on products that correspond to their value patterns, thus making cultural value differences more apparent.

EMPIRICAL RESEARCH

The empirical data consisted of 49 national markets throughout the world with yearly adoption data of cellular mobile telephone subscribers, personal computer possessions, and internet hosts. These three data sets consisted of the same 49 national markets for each innovation. The cellular mobile telephone subscribers category covered the years 1978 through 2004, the PC category 1979 through 2004, and the internet hosts category 1974 through 2004. The source of the data was the International Telecommunication Union's (ITU) World Telecommunication Indicators database.

The dependent variable of the study was the percentage of innovation adopters at the moment of the takeoff relative to the total population of the country. The percentage describes the relative amount of adopters needed to reach the takeoff point and is comparable between countries. The takeoff is defined as the point that is followed by the first dramatic and sustained increase in product category sales (Golder and Tellis, 2004). In order to reliably and consistently determine the takeoff points in time series the study used a content analysis method. Another possible method for determining the takeoff point would have been the discrimination analysis procedure (Agarwal and Bayus, 2002, Gort and Klepper, 1982, Mahajan et al., 1990b). However, the method has been shown to produce less reliable estimates for the takeoff point than the content analysis method with expert judges (Haapaniemi and Mäkinen, 2006). Countries for which experts' determinations differed from one another or where the adoption dynamics were distorted were removed from the data set, since a smooth or distorted adoption pattern could prevent precise determination of the takeoff point in these outliers.

The independent variables were Hofstede's five cultural dimensions, and an additional two national attributes were used as control variables. In Hofstede's dimensions of culture, the scores (indices) were preferred to the rankings. The reason for the usage of scores rather than the rankings is that the scores contain more accurate information. The rankings are derived from the statistically calculated scores, while the mathematical indices describe the relative difference between the national cultures. For the purposes of this study, the scores provide a more precise representation of the 'distance' between the cultures than would the rankings. Further, culture and nation are used as synonyms. This is considered to be a generally accepted principle in cultural discussions (Ganesh and Kumar, 1996). The two national attributes were a wealth measure (GDP per capita in 1995) and an education measure (tertiary degree students in 1990).

Only those countries for which Hofstede's dimensions had been measured and identified were included in the study. These dimensions have been identified for 50 countries. The data set consisted of the adoption data of 49 countries, since one country (Salvador) from Hofstede's original data set had to be rejected due to a lack of data. Thus, the total data set of the time series for the present study – after the elimination of outliers – included the innovation adoption data of the mobile telephone for 49, the PC for 41, and internet hosts for 47 countries.

The relationship between dependent and independent variables was determined using a multivariable regression analysis (e.g. Newbold, 1995). Different variations of the independent variables were considered in the study. In this case, there was a total of 32 different models of independent variables for each innovation category. The standard regression model is presented in Equation 1.

$$y_i = \alpha_i + \beta_{ij} x_{ij} + \mu_i \qquad (1)$$

where y_i is the dependent variable (the percentage of innovation adopters at the moment of he takeoff relative to the total population of the country) and x_{ij} is the independent variable *j* (Hofstede's dimensions or national attributes), α_i and β_{ij} are regression parameters, and μ_i is a random disturbance term with the mean of 0 for country *i*. The goodness of each model with differing independent variables was estimated by analyzing the T-test, R square, F-test and multicollinearity statistics (variance inflation factor, VIF). Thus, the author extensively tested all possible combinations of independent variables and selected the best regression models according to the analysis of T-test, adjusted R square, F-test and VIF.

VIF measures the impact of collinearity among the independent variables in a regression model on the precision of estimation. VIF expresses the degree to which collinearity among the predictors degrades the precision of an estimate. Typically, a VIF value greater than 10 is of concern.

RESULTS

Table 1 presents the descriptive statistics and correlation matrix for the variables used in the study.

Table 1. The descriptive statistics and correlation matrix for the variables used in the study.

Independent variable	**Mean**	**S.D.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Takeoff Adoption, Mobile			1.000									
2. Takeoff Adoption, PC				1.000								
3. Takeoff Adoption, Internet hosts					1.000							
4. PDI	55.61	22.169	-0.401 **	-0.527 **	-0.513 **	1.000						
5. IDV	44.45	25.863	0.304 *	0.583 **	0.519 **	-0.678 **	1.000					
6. MAS	49.04	18.982	-0.166	-0.220	-0.307 *	0.064	0.062	1.000				
7. UAI	65.33	24.837	-0.386 **	-0.173	-0.210	0.238 *	-0.335 **	-0.021	1.000			
8. LTO	42.69	21.609	0.194	-0.128	0.016	0.263	-0.401 *	0.019	0.000	1.000		
9. GDP per capita	11778.22	10134.674	0.576 **	0.629 **	0.658 **	-0.608 **	0.701 **	0.062	-0.270 *	0.156	1.000	
10. Education	28.64	16.860	0.206	0.263	0.552 **	-0.452 **	0.574 **	-0.095	0.018	-0.148	0.606 **	1.000

* p < 0.05 (one-tailed tests)
** p < 0.01 (one-tailed tests)

As can be seen from Table 1, the strongest pairwise correlation among the independent variables is that between IDV – GDP per capita ($r = 0.701$, $p < 0.01$), PDI – IDV ($r = 0.678$, $p < 0.01$) and PDI – GDP per capita ($r = 0.608$, $p < 0.01$). However, these variables primarily measure different aspects and the correlations are also taken into account in the regression analysis for selection of the best model. Table 2 presents the best results of the multivariate regression analysis.

Table 2. The results of the multivariate regression analysis for the mobile telephone, the PC and internet hosts innovations.

Independent variable	**Mobile Telephone**		**PC**		**Internet Hosts**	
	Std. b	**VIF**	***Std. b***	**VIF**	***Std. b***	**VIF**
PDI	-0.109	1.712			-0.265	1.889
IDV			0.476 *	1.852	-0.076	2.161
MAS	-0.305 *	1.060	-0.261 †	1.008	-0.367 *	1.033
UAI	-0.241 †	1.116				
LTO	-0.226 †	1.231	-0.036	1.476	0.137	1.259
GDP per capita	0.656 **	1.979	0.378 †	1.560	0.231	2.117
Education	-0.372 *	1.377	-0.426 *	1.591	0.284 †	1.582
R square	0.613		0.459		0.502	
F	5.02 **		2.72 †		3.20 *	

† p < 0.10 (one-tailed tests)
* p < 0.05 (one-tailed tests)
** p < 0.01 (one-tailed tests)
*** p < 0.001 (one-tailed tests)

As shown in Table 2, the best regression models include either three or four of Hofstede's five variables. The results demonstrate that multicollinearity does not present a problem (VIF in the models is between 1.008 and 2.161). In addition, we also verified that none of the control variables alone could explain the variation of the dependent variable better than the models presented in the Table 2.

Table 2 also shows that the best model for explaining mobile telephone innovation is obtained with three statistically significant Hofstede's dimensions: MAS (b(MAS) = -0.305, $p < 0.05$), UAI (b(UAI) = -0.241, $p < 0.10$) and LTO (b(LTO) = -0.226, $p < 0.10$), and two statistically significant national attributes (b(GDP per capita) = 0.656, $p < 0.01$; b(education) = -0.372, $p < 0.05$). In addition, the best model also involves PDI, though this is not statistically significant. The coefficients of all variables, except GDP per capita, are negative. The explanatory power of the model is 0.613, and the model exhibits statistically significant F statistics ($F = 5.02$, $p < 0.01$).

As shown in Table 2, the best model for describing PC innovation is achieved with two statistically significant Hofstede's dimensions, namely IDV (b(IDV) = 0.476, $p < 0.05$) and MAS (b(MAS) = -0.261, $p < 0.10$), and two statistically significant national attributes (b(GDP per capita) = 0.378, $p < 0.10$; b(education) = -0.426, $p < 0.05$). In addition, the best model also involves LTO, though this is not statistically significant. The coefficients of IDV and GDP per capita are positive, with all others being negative. The explanatory power of the model is 0.459, and the model exhibits statistically significant F statistics ($F = 2.72$, $p < 0.10$).

Finally, Table 2 shows that the best model for explaining the internet host innovation is attained with one statistically significant Hofstede dimension (b(MAS) = -0.367, $p < 0.05$)) and one statistically significant national attribute (b(education) = 0.284, $p < 0.05$). In addition to these two variables, the best model also involves PDI, IDV, LTO and GDP per capita, though these are not statistically significant. The coefficients of PDI, IDV and MAS are positive, while the others remained negative. The explanatory power of the model is 0.502, and the model exhibits statistically significant F statistics ($F = 3.20$, $p < 0.05$).

DISCUSSION

In general, the results of this study confirm earlier empirical findings suggesting that cultural values do have an effect on national-level innovation adoption dynamics. Based on the results of this study, cultural and national level attributes seem to be able to explain one-half or more of the variation in the amount of innovation adopters at the moment of the takeoff in a cross-national setting. This supports the expectations that cultural and national differences persist, in spite of the globalization of the markets.

The empirical results for the mobile telephone show that the takeoff can be expected to occur earlier in those countries characterized by high masculinity, uncertainty avoidance, future orientation and education score together a low GDP per capita. Thus, in countries with these characteristics, a relatively smaller proportion of adopters needs to adopt the innovation before the takeoff can occur. This result is partially contrary to that expected from earlier literature. In the current literature, the takeoff is expected to take place later in high uncertainty avoidance, high long-term orientation and low-income countries. Nevertheless, this is still in line with the findings from earlier literature showing that in more masculine and educated countries, takeoff can be expected to occur earlier.

The empirical results for the PC suggest that in collective, masculine, educated, low-income countries, adoption of innovations takes off with smaller amount of adopters. The results for masculinity and education are in line with the current literature; that is, the higher the MAS and the education, the earlier the takeoff can be expected to occur. However, the results for individualism and GDP per capita is contradictory to earlier findings indicating that high IDV and income level lead to earlier takeoff. Traditionally, it has been expected that IDV would be associated with the need for achievement and industriousness and wealth with the financial ability to try new ideas and innovations.

Similar to the results above, the empirical finding for the internet hosts, also show that high masculinity results in earlier innovation adoption takeoff. However, these results contrast the above trends in that higher education appears to lead to later innovation adoption takeoff for internet hosts. As mentioned above, this result for the masculinity is in line with earlier findings, while the result for education runs contrary to current literature. Whereas countries with lower education levels can be expected to adopt more simple and mature phase innovations, those with higher education levels would be expected to adopt innovations that are more sophisticated.

These contradictory results would be fruitful grounds for future research, especially for studying the mechanisms and processes involved in the adoption of innovations. The contradictory result may be partially explained by the types of innovations addressed in this study, since if the installed base is sufficient, frequent communication between users might accelerate the innovation adoption process. On the other hand, these innovations are different in their nature. The mobile telephone is intended for individual use, whereas the personal computer can be used by both individuals and industry, and the internet hosts are largely for industry use only. Moreover, extensive discussion in the public media and mass communications concerning the innovations might also explain these results to some extent. Similar new hypotheses could be built based on the existing literature, thus making these contradicting results especially fruitful avenues for future enquiry.

To confirm these findings and to make it possible to generalize from these results, more research with other innovations will be needed. In addition, further research is needed with other methods to determine the amount of innovation adopters at the moment of the takeoff. The method used here was based on the amount of adopters relative to a population; however, the population measure is not the same as a measure of the potential adopters. Moreover, research could be conducted with other independent variables, as well. For example, other sets of cultural dimension systems or other national attributes could be used.

Taken together, these results suggest that companies launching radical innovations can expect earlier takeoff to occur in more masculine and indigent countries. Furthermore, education seems to have an influence on the amount of adopters at the takeoff. These factors need to take these into account by companies when planning operations such as production capacity and logistics. In addition, other multiple variables may also need to be considered when anticipating the adoption dynamics to reach majority, including competition, institutional environment, infrastructures, and co-operation between companies. Further, industry and product type should be taken into consideration, as discussed above, as they can also be expected to influence the behavior of the adopters. Conversely, this study shows that power distance seems to have little effect on innovation adoption.

These results are interesting especially for the planning of marketing communications, product development, and market entry determination, as they would enable a company entering markets in an international setting to plan an appropriate entry strategy and sequence, as well as for directing marketing efforts. On the other hand, the findings can also provide ideas on how to change the 4Ps in the process, as national markets shift from the introduction phase to the growth phase of innovation adoption, since the adoption dynamics change after the takeoff. Finally, the results can be critical in anticipating these changes in national-level markets and in integrating these into international or global marketing management and planning.

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