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User behaviour towards protective information technologies: the role of national cultural differences

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Abstract. *Computer technologies that protect data and systems from viruses, unauthorized access, disruptions, spyware and other threats have become increasingly important in the globally networked economy and society. Yet little is known about user attitudes and behaviour towards this category of information technologies. Comparative studies across different cultures in this context are even rarer. In this study, we examine the cross-cultural differences between South Korea and the United States in user behaviour towards protective information technologies. We develop a theoretical model of user behaviour based on the framework of the theory of planned behaviour and national cultural dimensions and indices. We posit that cultural factors moderate the strength of the relationships in the behavioural model in the context of protective information technologies. The model was then empirically tested using structural equation modelling techniques in conjunction with multi-group analysis. Most of the hypothesized moderating effects of national cultural factors were found to be statistically significant. Our findings suggest that cultural factors should be considered in order to design effective information security policies, practices and technologies in global networks where multiple cultures coexist. Theoretical and practical implications of the study are discussed.*

Keywords: protective information technologies, spyware, awareness, cross-cultural differences, information security, culture

INTRODUCTION

In this global community enabled by the internet and other digital technologies, computer users are facing increasingly higher levels of security risks if they are not fully aware of the threats and their systems are not well protected. Thus, technologies that protect computers and systems from viruses, unauthorized access, disruptions, spyware and other threats have

become increasingly important in the highly networked society. Yet, little is known about user attitudes and behaviour towards this category of information technologies. Some of these technologies, such as viruses and spyware, may inflict damages without being detected for a long time. Unfortunately, the technologies designed to protect individual users and computer systems from these negative technologies, called protective information technologies (Dinev & Hu, 2007), are often lagging behind both in terms of variety and complexity. What has made the situation even worse is the fact that many computer users are complacent about the potential danger of negative technologies and often avoid using the protective information technologies (Hu & Dinev, 2005).

Computer users are connecting to the internet from their homes or workplaces, thus having more options to choose which applications to download, install and use. This freedom, while empowering users, poses high security risks to their systems and the systems they connect to. Given this situation, some computer users perceive the threats and choose to use protective information technologies, whereas many others do not. Thus, fighting against the threats of negative technologies requires not only developing effective protective information technologies but also educating users to use these technologies. Therefore, understanding user attitudes, intentions and behaviour towards protective information technologies is essential for designing effective technologies, policies and practices in order to successfully defend against the negative technologies, a core interest of research in the Human–Computer Interaction (HCI) domain (Zhang *et al.*, 2002). This need is further exacerbated in the global economy where organizations tend to have offices in different countries and employ people from different cultures to work together physically and virtually. Studies have shown that cultural factors, such as individualism and power distance, have a significant impact on how individuals form their attitudes and conduct themselves in organizational environments (Inglehart, 1997; Straub *et al.*, 1997; Kim & Peterson, 2002; Straub *et al.*, 2002; Ein-Dor *et al.*, 2004; Gefen *et al.*, 2005; Karahanna *et al.*, 2005).

The use of protective information technologies has attracted some attention recently, and rigorous empirical studies that offer theoretical insights into user behaviour towards protective information technologies are beginning to emerge (e.g. Dinev & Hu, 2007). However, the role of cultural factors in the use of protective information technologies is not clear. We conduct our study based on the model of user behaviour towards protective information technologies developed by Hu & Dinev (2005) and Dinev & Hu (2007), with a focus of identifying the moderating effects of cultural factors on the causal relationships in this model. To test for the effects of cultural factors, we adopted a comparative approach by testing the model with data collected from two contrasting cultures: the United States and South Korea. These two countries were chosen for several reasons. First, while both countries are democracies with well-developed economies, the ethos of both countries have shaped different philosophies and values (Kim & Peterson, 2003; Samaddar & Kadiyala, 2006; Yun, 2006; Keil *et al.*, 2007). Second, these two countries represent two significantly different cultures based on Hofstede's national culture indices and thus could provide revealing evidence about cultural effect on user attitudes towards protective information technologies. Finally, according to a recent report by the International Telecommunications Union (Kelly *et al.*, 2003), both countries are among the

most wired and advanced nations in terms of IT infrastructure and thus provide a comparable base that is relatively free from the noises of other unrelated factors. In addition, the fact that the authors have access to potential research subjects in both countries and have a fairly good understanding of the two cultures and languages also made such comparative research feasible.

The rest of the paper is arranged as follows. In the next section, we develop our research hypotheses based on a user behaviour model that focus on the moderating effects of cultural factors on user behaviour in the context of protective information technologies. Next, the research methodology and the testing results are presented. We then discuss the results of multi-group analysis to ascertain the impact of culture differences in the study setting. Finally, implications and limitations of this study and future research directions are discussed.

THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESES

User behaviour towards protective information technology (IT)

For the purpose of cross-cultural comparison, we adopted the model developed by Hu & Dinev (2005) and Dinev & Hu (2007) for understanding user behaviour towards protective IT. This model drew upon the theory of planned behaviour (TPB) (Ajzen, 1988; Ajzen, 2002) as well as the integrated model of user acceptance of e-commerce developed by Pavlou & Fygenson (2006). According to TPB, a person's behaviour (B) is determined by his or her intention to perform the behaviour of interest. This behavioural intention (BI) is in turn determined by attitude towards the behaviour (AB), subjective norm (SN), and perceived behavioural control (PBC). AB refers to a person's judgement on whether it is good or bad to perform a behaviour of interest. SN is a person's perception of the social pressure to perform or not perform the behaviour in question. SN thus reflects the individual's perceptions of whether the behaviour is accepted and encouraged by influential people in the individual's social circles. Finally, PBC refers to the perceived ease or difficulty of performing the behaviour and is an antecedent to both intention and behaviour (Ajzen, 1988).

In a study about user behaviour towards online purchase, Pavlou & Fygenson (2006) proposed two sub-constructs as underlying dimensions of PBC – self-efficacy (SE) and controllability (C). Self-efficacy is defined as the individual's judgement of one's skills and capabilities to perform the behaviour (Bandura, 1986). Controllability is defined as the individual's judgement about the availability of resources and opportunities for performing the behaviour (Ajzen, 2002; Pavlou & Fygenson, 2006). In addition, they added two well-established constructs, perceived ease of use (PEOU) and perceived usefulness (PU), to their TPB based model. Empirical tests confirmed the hypothesized relationships in their model.

Dinev & Hu's (2007) model described the formation of user behavioural intentions and actual behaviour in response to negative technologies such as cyber attacks, viruses and spyware. The study investigated the determinants of individual usage of technologies that protect

personal computer systems from intrusions of negative technologies. It showed that a new construct, namely technology awareness, emerged as a central and strong determinant of user behavioural intention, subjective norm and user attitudes. Following Dinev & Hart (2005), who defined social awareness as a predictor of privacy concerns, Dinev & Hu (2007) defined technology awareness as the user's following, being interested in, and knowledgeable about technological issues, problems, and techniques to solve them. They also found that PEOU and SE were no longer strong determinants of the attitudes towards behaviour in the context of protective information technologies, as they are in the context of positive information technologies.

User behaviour and cultural dimensions

In order to understand the variations of technology use between cultures, cultural factors and dimensions need to be integrated into user behaviour models. This is because attitudes and behaviours of individuals are conditioned by their culture. Although several definitions of culture have been proposed by cultural anthropologists, the symbolic views of culture, represented by Hofstede's (1993; 2001) description of national cultures, are commonly adopted in the context of information systems (IS) research. In that sense, culture is defined as the collective programming of the mind which distinguishes the members of one group or category of people from another (Hofstede, 1993). Several notable studies have discovered the moderating effects of culture on the relationships within the TPB models (Kacen & Lee, 2002; Pavlou & Chai, 2002; Tan *et al.*, 2004) or the technology acceptance model (TAM) (Straub *et al.*, 1997; Zakour, 2004). In general, however, studies about cultural effects on user behaviour are few and often conflicting, with only selective dimensions studied. Karahanna *et al.* (2005) presented a more comprehensive treatment regarding the influence of culture on individual behaviour based on the TPB model. The authors concluded that behaviours involving different values and practices are influenced by cultures at different levels such as professional and organizational.

Cross-cultural anthropologists (Bourdieu, 1984; 1989; Triandis, 1995; Rhee *et al.*, 1996; Hill *et al.*, 1998; Straub *et al.*, 2001; Loch *et al.*, 2003; Choudrie & Lee, 2004) have argued that culture-specific beliefs and social norms, technological culturation, along with the national policies and infrastructure all have some degree of impact on systems usage. In addition to the Hofstede formulation of culture, there are several cultural theories that address various cultural aspects of human behaviour. For example, the cultural theory of proxemics (Hall & Hall, 1990; Trompennaars, 1993) argues that human perception of space is influenced by culture. Fukuyama's (1995) theory of trust and social capital combines economic and cultural arguments to present a theory in which he correlates a country's economic prosperity with the amount of social capital within that country. Fukuyama identified groups of 'high-trust' countries (e.g. US, Germany, and Japan) and 'low-trust' countries (e.g. Italy, France, Korea, and Taiwan). Perceptions of space and trust can have important implications in organizational and individual behaviour and are especially important factors when trust and privacy are considered (Dinev *et al.*, 2006a,b). They can also significantly influence social norms and expectations.

However, the nature of the TPB-related factors and relationships call for adoption of a more comprehensive cultural theory which integrates multiple dimensions of culture. For that reason, the cultural theory developed by Hofstede (1993; 2001) is deemed as the most appropriate cultural framework for this study. Hofstede's framework is predominantly used when individual behaviour is considered (Srite & Karahanna, 2006). Hofstede generated and validated a cultural framework that clusters cultures based on five distinct dimensions: (1) Power Distance Index (PDI); (2) Individualism–Collectivism (IND); (3) Uncertainty Avoidance Index (UAI); (4) Masculinity–Femininity (MAS); and (5) Long-Term Orientation (LTO). PDI refers to the extent of adherence to formal authority. IND focuses on the basic level of behaviour regulation of an individual's relationships with respect to others. In a collectivist society, individuals regard as more important to look after the interest of their group before themselves. UAI measures the importance of rules and standards and how much people feel threatened by high levels of uncertainty and ambiguity in the environment. MAS measures the degree the society reinforces the traditional masculine work role model of male achievement, assertiveness, control and power. Finally, LTO has been added later (Hofstede & Bond, 1988) specifically to describe Asian cultures. It is related to the Confucian values of Eastern societies and measures the strategic and financial caution exhibited by members of a society. High LTO societies place great significance on thrift, persistence and long-term alliances.

Although Hofstede's cultural theory is widely used in the IS literature (e.g. Straub *et al.*, 1997; Pavlou & Chai, 2002; Srite & Karahanna, 2006), there are critics of this theory (e.g. McSweeney, 2002; Myers & Tan, 2002; Ford *et al.*, 2003) and its relevance to IT research (For a comprehensive list of literature that analyses and critiques Hofstede's cultural theory, refer to the Hofstede's website at http://geert-hofstede.international-business-center.com/).

While some of the criticism is more relevant to our study than others, it is important to note that culture is relatively enduring (Hofstede, 1980; 2001; Huntington, 1993; Fukuyama, 1995; Inglehart, 1997; Schneider & Barsoux, 1997) and Hofstede's indicators are a stable and slowly changing representation of culture and transcend generations. Notwithstanding the criticism and the limitations, for the purpose of this study, we believe that Hofstede culture theory and its classifications are most appropriate.

We contrast the cultural differences between South Korea and the United States and their potential impact on user behaviour towards the use of protective technologies across the aforementioned dimensions. These two countries measured quite differently on Hofstede's dimension indices. South Korea's high UAI at 85 (vs. US at 46) indicates the society's low level of tolerance for uncertainty. Such societies adopt rules and laws in an effort to minimize levels of uncertainty. They attempt to control almost everything in order to avoid the unexpected. As a result of the high UAI, the society is risk averse and reluctant to change (Hofstede, 1993). South Korea has a low IND index of 18, indicating a collectivist society. This contrasts with the highest IND index of the United States (91). Thus, loyalty to the group in South Korea will be paramount and may override other societal rules and regulations. Strong relationships are fostered where taking responsibility for group fellow members is everyone's duty (Hofstede, 1993). PDI is also higher for South Korea (60) than for the United States (40). This implies that the South Koreans are relatively more accepting of unequal power distributions and more

concerned with group interest rather than self-interest. They tend to be more formal, collectivistic, cooperative and stability-oriented, as shown by their long-term orientation index of 75, vs. 29 for the United States. Finally, MAS for the Korean society is 39, in contrast with the United States at 62. The cumulative cultural characteristics show that individuals in the United States tend to be informal, individualistic and achievement-oriented. They value punctuality, voluntary associations, progress and innovation. The United States' ranking of first among individualistic societies has been confirmed by other empirical studies (e.g., Triandis, 1995).

Research hypotheses on moderating effect of culture

The discussion about the potential impact of cultural factors on the user behaviour towards protective information technologies clearly calls for the integration of cultural measures into the user behaviour models. In this section, we present our research model for this study, as shown in Figure 1. It is built on top of the base model of Dinev & Hu (2007), with the cultural dimensions added as moderators of key relationships. Notice that not all of the relationships in the base model have cultural effects hypothesized in this study. This is because it is theoretically difficult to argue that cultural factors moderate all of the relationships in the base model. However, to preserve the theoretical integrity of the base model, all of the relationships are presented in our research model. Thus, the complete nomological net of the behaviour model is also preserved. In the remainder of this section, we elaborate the cultural moderating effect and develop the research hypotheses as depicted in Figure 1.

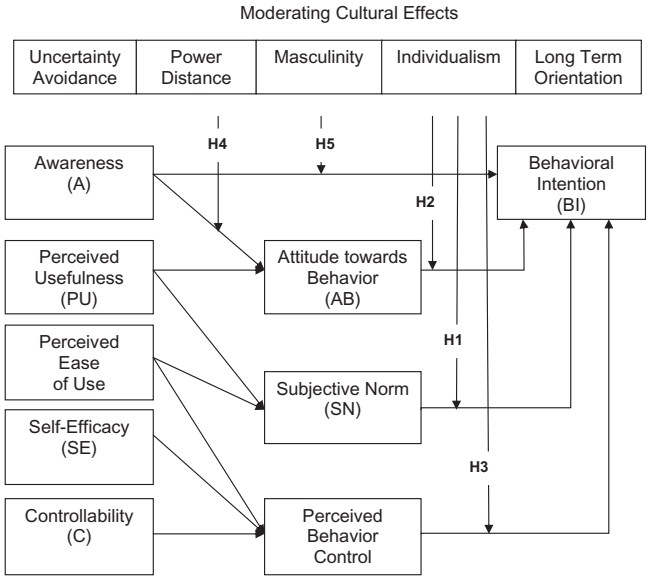

Figure 1. Research model of user behaviour towards protective information technology with cultural moderations.

In order to empirically test this theoretical model, we followed Dinev & Hu (2007) and chose anti-spyware as a representative of protective information technologies for data collection, largely because spyware may have become one of the most serious threats to computer systems and networks worldwide in recent years (Stafford & Urbaczewski, 2004; Hu & Dinev, 2005; Dinev & Hu, 2007). Naturally, anti-spyware has become one of the important protective information technologies for computer users and organizations to counter this growing threat.

As members of a highly collectivist society, South Koreans will exhibit greater influence of the subjective norm on the behavioural intention, as the group norms are of higher priority (Pavlou & Chai, 2002; Tan *et al.*, 2004). In addition to the individualism index, power distance will also moderate the relationship between the subjective norm and the behavioural intention. In higher power distance cultures, individuals' reliance on the opinions of superiors will be more pronounced when assessing behaviour. This argument is supported by studies of cultural effects on TPB (Pavlou & Chai, 2002; Tan *et al.*, 2004; Zakour, 2004). The higher power distance index in South Korea means that it accepts higher levels of social inequality. The third factor that affects the relationship between subjective norm and behavioural intention is the uncertainty avoidance index. Individuals in stronger uncertainty avoidance cultures often attempt to minimize risk by following established rules and norms. The subjective norms thus will be even more important as guidance to behaviour for these individuals than for individuals in cultures where people rely more on their own competence to evaluate behaviour. Finally, South Korea has a less masculine culture where individuals pay more attention to the opinions and behaviours of the others, in contrast to the more masculine cultures where goal achievement is of greater importance. Therefore:

H1: The relationship between subjective norms and behavioural intention is stronger in South Korea users than in US users in the context of protective IT use.

Studies have found that the relationship between attitude towards a behaviour and the behavioural intention will be stronger for members of individualist cultures (Lee, 2000; Kacen & Lee, 2002; Tan *et al.*, 2004) According to them, people in individualist cultures are motivated by their own preferences, needs and priorities, which shape their attitude towards a certain behaviour. Therefore, we argue that how an individual's attitudes influence his or her intention to behave is moderated by how strongly he or she feels as an individual and how strongly he or she feels compelled to act as an individual. Thus, we posit that attitudes towards behaviour would have a stronger effect on behavioural intention in individualist cultures than in collectivist cultures. Furthermore, Tan *et al.* (2004) argued that the masculinity index also moderates attitudes in the same direction as individualism does. Indeed, a goal- and achievement-oriented individual from a more masculine culture will be more prone to act based on his or her individually formed attitudes than an individual in a more feminine culture where personal attitudes will matter less and people's attitudes and relationships will matter more. Thus:

H2: The relationship between attitudes and behavioural intention is weaker in South Korea users than in US users in the context of protective IT use.

Several studies argued about the moderating effect of the long-term orientation dimension on the relationship between perceived behavioural control and behavioural intention (Pavlou &

Chai, 2002; Tan *et al.*, 2004), and between perceived behavioural control and actual behaviour (Tan *et al.*, 2004). The Confucian doctrine, emphasizing persistence, patience and respect for tradition, is firmly embedded in Asian cultures and, therefore, South Korean culture (Hofstede & Bond, 1988). This would be reflected in a desire for steadiness and stability, thus more control over behaviour and stronger relationships between control and behaviour and behavioural intention. However, empirical results have been mixed (Pavlou & Chai, 2002; Tan *et al.*, 2004). We believe that the lack of strong empirical support is indicative of the complexity of cultural influence. We submit that long-term orientation is only one of the factors among masculinity, individualism, and uncertainty avoidance indices that influence this relationship. A person in a more individualistic and masculine society will be more prone to act or to form an intention to act if he or she feels to have enough control over a certain behaviour. Thus, the lower masculinity and lower individualism characteristics of a society will render a weaker relationship between PBC and BI. In our attempt to form a hypothesis, we focus our attention to the magnitudes of Hofstede's measure of cultural indices. We find that the cumulative difference between the two societies' masculinity and individualism indices is larger than the cumulative difference between their uncertainty avoidance index and the long-term orientation indices. Thus, we posit that the strength of the PBC–BI relationships is largely moderated by individualism and masculinity which may override the influence of uncertainty avoidance and long-term orientation. Thus:

H3: The relationship between behavioural control and behavioural intention is weaker in South Korea users than in US users in the context of protective IT use.

In their protective IT usage model, Dinev & Hu (2007) showed the critical role of technology awareness (A) in the formation of user attitudes and behavioural intention. When comparing two cultures, it is important to understand how awareness of an existing problem would influence the formation of an individual's attitude towards a specific behaviour (AB) related to the problem. Using US samples, Dinev & Hu (2007) found that awareness of the spyware problem alone could motivate a computer user to form the intention to act (BI). It is interesting, therefore, to find out how this relationship changes in a different culture. We believe that the major cultural factors, such as masculinity and individualism, will moderate the relationships A–AB and A–BI. A person who is aware of a problem and who comes from an individualist society will more readily form an attitude towards the issue. On the contrary, a person from a collectivist society would be more careful in forming his or her personal attitudes. Similarly, the culture with both higher masculinity (achievement, 'can-do', 'act-now' attitude) and higher individualism ('act regardless of what others think') would forge stronger relationships between A and BI. Thus:

H4: The relationship between awareness and attitudes is weaker in South Korean users than in US users in the context of protective IT use.

H5: The relationship between awareness and behavioural intention is weaker in South Korea users than in US users in the context of protective IT use.

RESEARCH METHODOLOGY

Our study involves investigating the moderating effects of national culture on the TPB-based model of user behaviour towards protective information technologies. The relationships among the constructs in our research model are tested using structural equation modelling (SEM). Tests for moderation in SEM where the moderator is a discrete variable requires multi-group analysis (Byrne, 2001), i.e. separating the samples into groups where membership is based on some level of the hypothesized moderator variable. Separate analyses are run for each group and path coefficients are generated for each sub-sample. These path coefficients are then compared to determine whether the relationships between the variables of interest depend on the group membership, which would indicate the existence of moderation of the variable whose values distinguish the groups (Keil *et al.*, 2000; Venkatesh & Morris, 2000; Venkatesh, 2000). The moderating variable in our study is national culture, which is operationalized as a dichotomous variable: South Korea and US. This two-group design fits well with the multi-group analysis approach.

Data collection and subjects

Surveys of IS professionals and students enrolled in a large university in the south-eastern US and a large university in South Korea were conducted to collect data that could be used to test the theoretical model and the hypotheses. All constructs in the survey were measured using multi-items with 5-point Likert scales developed by Hu & Dinev (2005). For data collection in the United States, students enrolled in various classes were asked to fill in either the online or paper-based questionnaire in class time. Additionally, emails with a request to participate in the study were sent out to IT professionals who graduated from the US university with MIS/CS degrees. In about 4 weeks, a total number of 339 responses were received, out of which seven were unusable because of many missing data items. For data collection in South Korea, the questionnaire was translated into Korean by a person who is proficient in both languages. Next, it was back-translated into English by another person with similar qualifications. Based on this double translation process, minor corrections were made to the Korean versions to ensure that the meanings of all items of the questionnaires had been preserved during translation. Both undergraduate and graduate students enrolled in various classes of the university in South Korea were asked to fill in either the online or paper based questionnaire in class time. A total number of 227 responses were received. The demographics and relevant characteristics of the respondents are shown in Tables 1 and 2.

Measurement validation

The research model was tested through SEM with AMOS version 5. We followed the two-step approach to first assess the measurement model through confirmatory factor analysis (CFA) and then test the hypotheses through the structural model. General procedures for assessing measurement models within the realm of CFA suggest that each of the measured factors be

Table 1. Demographic information of the survey respondents (US and South Korea)

	US		South Korea	
Age (years)	Frequency	%	Frequency	%
≤20	39	11.75	1	0.44
21–30	227	68.37	114	50.22
31–40	46	13.86	79	34.80
41–50	16	4.82	32	14.10
>50	4	1.20	1	0.44
Total	332	100	227	100
Sex				
Male	191	57.53	153	67.40
Female	141	42.47	74	32.60
Total	332	100	227	100

modelled in isolation and then as a collective network (Bollen, 1989). For both US and South Korean data sets, after assessing each construct, we estimated a confirmatory analysis model as collective networks including all constructs with each observed variable restricted to load on its *a priori* factor. Proceeding in this manner provides the fullest evidence of measurement efficacy and also reduces the likelihood of confounds in full structural modelling which may arise due to excessive error in measurement (Anderson & Weitz, 1989). All the necessary steps in the measurement model validation and reliability assessment were conducted following the validation heuristics recommended for SEM (Gefen *et al.*, 2000).

In estimating parameters in SEM, the default mode of Maximum Likelihood estimation was used, because the histogram in the initial data screening clearly showed a normal distribution of the data without skew. To make sure the stability of the parameter estimates, we ran the model with the bootstrap of 500 samples. The analysis resulted in a converged, proper solution with a low χ^2 per degree of freedom and a good fit as indicated by all the listed fit indices (see Table 3). The Comparative Fit Index (Bentler, 1990) and Tucker–Lewis Index (Tucker & Lewis, 1973) are considered to be robust indicators of model fit, and it is recommended that their values be above 0.90. As is evident from Table 3, the values of both of these indicators provide evidence of good model fit. Although the root mean square error of approximation (RMSEA) should ideally be less than 0.05, Browne & Cudeck (1993) suggest that an RMSEA of less than 0.08 is also practical evidence of good model fit. Tables 4 and 5 show assessments of reliability of the operational items for each construct of the research model. Reliability is computed in line with the recommendations of Fornell & Larcker (1981). Scores above 0.50 indicate that at least 50% of the variance in measurement is captured by the trait variance and are therefore evidence of good measurement properties. All constructs pass this criterion.

Statistical evidence of convergent validity was confirmed by high and significant factor loadings as well as low residuals between the observed and implied covariance matrices. The confirmatory factor analysis showed no items with either low loadings (<0.65) or high

Table 2. Computer skills and spyware knowledge of the survey respondents (US and South Korea)

	Computer skills							
	Overall (%)		MIS/CS (%)		Business (%)		Other majors (%)	
Scale	US (N = 332)	South Korea (N = 227)	US (N = 161)	South Korea (N = 28)	US (N = 163)	South Korea (N = 132)	US (N = 8)	South Korea (N = 67)
Basic*	56.6	55.9	34.8	28.6	81	68.2	0	49.3
Advanced†	23.8	37.9	30.4	53.6	17.8	31.8	14.3	43.3
Application development‡	19.6	6.2	34.8	17.9	1.2	3	85.7	7.5
Knowledge of spyware								
Never heard of it	2.7	18.9	2.5	3.6	3.1	22	0	19.4
Don't know details	16	31.7	6.9	25	24.5	34.1	28.6	29.9
Don't know what to do	26.6	15	19.4	21.4	33.7	14.4	28.6	13.4
Fully aware and know how to protect themselves	54.7	34.4	71.2	50	38.7	29.5	42.9	37.4

*Basic skills – limited to word processing, use of email, browsing on the internet.

†Advanced computer skills – include basic skills plus ability to manage, configure and install applications.

‡Application development – include advanced skills plus use of programming languages to develop applications.

MIS/CS, management information systems/computer systems.

Table 3. Goodness of fit indices for both cultures

Goodness of fit indices		x^2 (d.f.)	x^2/d.f.	NFI	CFI	TLI	GFI	AGFI	RMR	RMSEA
Measurement model	US	273.72 (166)	1.65	0.950	0.979	0.971	0.932	0.896	0.038	0.044
	South Korea	311.52 (166)	1.88	0.907	0.954	0.937	0.894	0.841	0.045	0.061
Structural model	US	452.06 (230)	1.97	0.918	0.957	0.949	0.9	0.869	0.049	0.054
	South Korea	518.69 (230)	2.26	0.85	0.909	0.891	0.845	0.798	0.062	0.075

AGFI, adjusted goodness-of-fit index; CFI, comparative fit index; d.f., degree of freedom; GFI, goodness-of-fit index; NFI, normed fit index; RMR, root mean square residuals; RMSEA, root mean square error of approximation.

Table 4. Summary of the assessment of the measurement models (US)

Constructs	No. of items	Mean (SD)	Cronbach's alpha	Composite reliability*	AVE	Loadings (*t*-statistics)
Behavioural intention	3	3.84 (0.93), 3.66 (0.95), 3.68 (0.97)	0.86	0.92	0.78	0.83 (33.04), 0.91 (63.43), 0.92 (72.26)
Attitudes towards behaviour	3	4.36 (0.82), 4.36 (0.81), 4.38 (0.84)	0.91	0.95	0.85	0.89 (48.63), 0.95 (127.95), 0.93 (72.21)
Subjective norm	2	3.69 (0.95), 3.73 (0.88)	0.93	0.97	0.94	0.97 (200.57), 0.97 (200.57)
Perceived behaviour control	2	3.39 (1.06), 3.17 (1.01)	0.85	0.93	0.87	0.93 (103.89), 0.93 (103.89)
Perceived ease of use	3	3.21 (1.06), 3.08 (1.15), 3.30 (1.10)	0.84	0.90	0.75	0.82 (29.88), 0.90 (78.49), 0.89 (66.91)
Perceived usefulness	2	4.23 (0.86), 4.21 (0.91)	0.89	0.95	0.90	0.95 (87.96), 0.95 (87.96)
Awareness	3	2.97 (1.11), 3.24 (1.12), 3.42 (1.09)	0.81	0.89	0.72	0.84 (43.02), 0.85 (45.89), 0.86 (42.86)
Controllability	2	3.51 (1.05), 3.50 (1.07)	0.93	0.97	0.94	0.97 (151.70), 0.97 (151.70)
Self-efficacy	2	3.38 (1.00), 3.25 (1.04)	0.85	0.93	0.87	0.93 (105.81), 0.93 (105.81)

*Fornell and Larcker's (1981) internal consistency reliability.

AVE, average variance extracted; SD = standard deviation.

Table 5. Summary of the assessment of the measurement models (South Korea)

Constructs	No. of items	Mean (SD)	Cronbach's alpha	Composite reliability*	AVE	Loadings (*t*-statistics)
Behavioural intention	3	3.72 (0.92), 3.68 (0.91), 3.77 (0.88)	0.90	0.94	0.83	0.90 (54.30), 0.90 (31.68), 0.93 (68.11)
Attitudes towards behaviour	3	4.00 (0.86), 4.10 (0.70), 4.08 (0.81)	0.87	0.92	0.80	0.83 (19.24), 0.93 (79.28), 0.92 (56.12)
Subjective norm	2	3.67 (0.87), 3.66 (0.87)	0.88	0.94	0.89	0.94 (86.22), 0.94 (86.22)
Perceived behaviour control	2	3.30 (1.00), 2.93 (1.02)	0.78	0.90	0.82	0.91 (65.20), 0.91 (65.20)
Perceived ease of use	3	2.84 (0.99), 2.44 (1.07), 2.58 (1.20)	0.84	0.90	0.76	0.83 (30.80), 0.92 (96.57), 0.86 (36.72)
Perceived usefulness	2	3.83 (0.97), 3.77 (0.95)	0.89	0.95	0.90	0.95 (69.76), 0.95 (69.76)
Awareness	3	2.56 (1.00), 2.54 (1.07), 3.21 (0.94)	0.76	0.86	0.69	0.82 (28.80), 0.85 (42.23), 0.80 (26.67)
Controllability	2	2.67 (1.13), 2.59 (1.11)	0.95	0.97	0.95	0.97 (151.70), 0.97 (151.70)
Self-efficacy	2	2.51 (1.05), 2.66 (1.02)	0.79	0.90	0.82	0.97 (184.87), 0.97 (184.87)

*Fornell and Larcker's (1981) internal consistency reliability.

AVE, average variance extracted; SD, standard deviation.

Table 6. Construct correlations and average variance extracted (US and South Korea)

	US								
	PU	A	PEOU	SE	C	AB	SN	PBC	BI
PU	0.95								
A	0.37	0.85							
PEOU	0.15	0.30	0.87						
SE	0.25	0.40	0.69	0.93					
C	0.38	0.47	0.54	0.64	0.97				
AB	0.54	0.35	0.16	0.18	0.28	0.92			
SN	0.45	0.41	0.19	0.33	0.36	0.33	0.97		
PBC	0.16	0.29	0.64	0.58	0.54	0.26	0.17	0.93	
BI	0.43	0.53	0.31	0.39	0.38	0.53	0.41	0.39	0.88
	South Korea								
	PU	A	PEOU	SE	C	AB	SN	PBC	BI
PU	0.95								
A	0.24	0.83							
PEOU	0.11	0.39	0.87						
SE	0.20	0.34	0.53	0.91					
C	0.22	0.43	0.63	0.56	0.97				
AB	0.31	0.25	0.28	0.17	0.29	0.89			
SN	0.33	0.26	0.20	0.17	0.24	0.36	0.94		
PBC	0.17	0.26	0.50	0.48	0.41	0.39	0.21	0.91	
BI	0.34	0.38	0.29	0.35	0.37	0.50	0.48	0.39	0.91

A, awareness; AB, attitudes towards behaviour; BI, behavioural intention; C, controllability; PBC, perceived behaviour control; PEOU, perceived ease of use; PU, perceived usefulness; SE, self-efficacy; SN, subjective norm.

cross-loadings (per the values of the modification indices), indicating good convergent validity. Discriminant validity was also established by observing the correlations between all latent constructs. For satisfactory discriminant validity, the square root of the Average Variance Extracted (AVE) from the construct should be greater than the variance shared between the construct and other constructs in the model. Table 6 lists the correlation matrix, with correlations among constructs and the square root of AVE on the diagonal. Both tables provide strong evidence of discriminant validity.

Collectively, the data from the factor loadings, *t*-values, correlations, composite reliabilities, and average variance extracted for each construct (Tables 3–6) suggest that the indicators account for a large portion of the variance of the corresponding latent construct and therefore provide support for the measurement modelling for both cultures.

Structural modelling results

The structural model specifies the hypothesized relationships among the constructs. Because of age difference across the US and South Korean samples (Table 1), the model

Table 7. Results of SEM and χ^2 tests for invariance of hypothesized paths between US model and South Korea model

Model description	Path coefficient				Statistical significance with 1 d.f.	Hypotheses
	US	Korea	χ^2	$\Delta\chi^2$		
US model (comparative model)			452.06			
SN → BI constrained	NS	0.324*	483.24	31.18	$p < 0.001$	H1
AB → BI constrained	0.316*	0.298*	452.15	0.09	NS	H2
PBC → BI constrained	0.193*	0.197†	454.1	2.04	NS	H3
A → AB constrained	0.176†	NS	456.25	4.19	$p < 0.05$	H4
A → BI constrained	0.383*	0.231†	456.3	4.24	$p < 0.05$	H5
PU → AB	0.5*	0.298*				
A → SN	0.338*	0.186†				
PEOU → AB	NS†	0.286*				
PU → SN	0.346*	0.325*				
C → PBC	0.208†	NS				
SE → PBC	NS	0.39*				
PEOU → PBC	0.553*	0.355†				
Age → BI	NS	NS				
Sex → BI	NS	NS				

*Path coefficient is significant at $p < 0.01$.

†Path coefficient is significant at $p < 0.05$.

NS, not statistically significant.

also incorporates this demographic factor as control variables. It was found to have an insignificant relationship on BI for both cultures. The goodness of fit indices of the SEM runs with US and South Korean samples are reported in Table 3. All the values are within the acceptable range for a good model fit and thus indicate good empirical support of the theoretical model in both cultures. The results of both US and South Korean models showed that while overall directions of relationships between latent variables were consistent with the findings of Dinev & Hu (2007), the magnitude and/or significance of the path coefficients for the relationships where the moderating effects of national culture were hypothesized were indeed different between the two models, confirming the existence of moderation of cultural differences between the two samples. To identify the evidence of model non-invariance between the two countries, we performed the SEM multi-group analysis through a χ^2 difference test.

This test was accomplished by placing constraints on the parameter whose non-invariance would be tested, thereby testing the statistical difference in χ^2 value ($\Delta\chi^2$) between the unconstrained model and the one with the parameter constrained. The fit of US model provided the baseline value against which all subsequently specified models were compared. That is, tests for invariance were performed by constraining each path of the US model with imposing corresponding path coefficient estimates generated in the South Korean model. Table 7 provides a summary of χ^2 values and χ^2 difference values related to the hypothesized relationships involved in testing for non-invariance.

DISCUSSION AND IMPLICATIONS

Using data collected from two distinct cultures, we observed a notable difference in the relationship between subjective norm and behavioural intention (H1), with statistical significance at $p < 0.001$. While the relationship between subjective norm and behavioural intention for South Korean users was statistically significant and strong, the one for US users was statistically insignificant. As argued in the theoretical section, this difference between the two cultures is a cumulative result of individualism, masculinity, power distance and uncertainty avoidance. However, the hypothesized difference between attitudes towards behaviour and behavioural intention (H2) was not statistically significant. Prior studies (e.g., Pavlou & Chai, 2002; Tan *et al.*, 2004) reported mixed results about this relationship. At this point, we do not have a strong and clear explanation about why the hypothesized moderating effect of culture on this relationship was not supported. More studies are needed to clarify and refine this complex relationship.

The cultural moderation on the relationship between perceived behavioural control and behavioural intention (H3) was not supported by our data. Although the path coefficients for PBC–BI in both cultures were strong, there was only a small difference in the hypothesized direction and it was not statistically significant. Similar to the situation with H2, we do not have a good explanation for this result. Finally, H4 and H5 argued for the cultural effects on the relationships between technology awareness (A) and attitudes towards behaviour (AB), and technology awareness (A) and behavioural intention (BI), respectively. Both hypothesized differences were supported by the data. An awareness of a problem (in our case, the presence of spyware) has less influence on their attitudes and intention to use anti-spyware in South Korean users than in the US users.

In addition to these hypothesized relationships, differences in several other relationships in the research model were found to be statistically significant as well. They are the paths between self-efficacy (SE) and PBC, perceived ease of use (PEOU) and PBC, PEOU and AB, and perceived usefulness (PU) and AB. We believe that these differences can be attributed to the knowledge differences as opposed to cultural differences, as presented in Table 2. For example, self-reported knowledge about spyware and advanced knowledge on how to protect oneself is 54.7% for the overall US sample vs. 34.4% for the overall South Korean sample. As indicated by Dinev & Hu (2007), the level of computer technical skills and knowledge of the threat impact the magnitude of the relationships associated with ease of use, self-efficacy and perceived usefulness. For example, the insignificance between PEOU and AB for the US sample may be attributed to the phenomenon that an informed user may use a protective IT not because he or she likes it but because he or she perceives there is a real threat to the computer and/or the personal information. In that sense, the perceived ease of use is less likely to affect his or her attitude towards using the technology. This is analogous to the situation in medicine where whether an individual feels that a protective measure such as an exam or a procedure is easy or not has little to do with his or her attitude towards going to the office to be examined or treated. An individual feels compelled to use protective measures as long as he or she perceives the technology or treatment is useful, regardless whether it is easy to use. A similar argument can be made about the diminished influence of SE on PBC in the US

sample. Since the South Korean respondents seem to be less knowledgeable and with slightly less self-reported computer skills, the perceived ease of use of the technology still has significant role in forming a positive attitude towards it. We believe that this demographic difference in the two samples resulted in the statistically significant difference in the PU–AB path between the two cultures.

Our findings have several theoretical and practical implications. We validated the Dinev & Hu (2007) model across two cultures and showed that key relationships remained statistically significant, but substantially moderated by cultural dimensions. Our study informs scholars and practitioners about the factors that influence computer users' decision to use protective information technologies against negative technologies such as spyware. Since negative technologies may disenchant potential users from using the internet (Cha, 2004) and may form inhibitions and anxiety towards computer and internet use, it is important to understand how users react to these types of threats in the global environment. Many theoretically interesting cultural effects remain to be uncovered in future studies, such as how cultural factors affect the relationship between attitudes and behavioural intention and actual behaviour. So far conflicting arguments and mixed empirical results have been reported. We believe, however, that our research model and cultural arguments present an important step in cross-cultural research which is finally entering the mainstream in MIS research (Gefen *et al.*, 2005). These findings about user attitudes and behaviour towards protective information technologies, especially the moderating effects of national cultural characteristics on the user–technology relationships, also make a significant contribution to the HCI literature in the areas of user acceptance of technology (Zhang *et al.*, 2002) and IT use and impact (Zhang & Li, 2005).

For security management practices, our findings provide insights for managers to design effective security policies and practices in conjunction with protective information technologies in today's globally networked economy that span diverse cultures. For example, in order to reach average computer users, our findings show that even with cultures that are on the two ends of the spectrum in terms of Hofstede's indices, it is still important to create social advocacy groups and networks that educate and raise user awareness to the potential dangers of negative technologies and the benefits of protective technologies. However, the cultural differences demand different approaches for raising awareness in computer users in these two countries. Because US users in general are not part of cohesive social groups, traditional information channels – media, television and newspapers – could play an important role in forming social pressures and policies that address and compel protection computer systems. In contrast, it is important for South Korean users to work with social groups and their leaders in order to disseminate the need for using protective information technologies, to establish the need to fight negative internet technologies as an important social norm of the society, something that helps the group and the entire society.

CONCLUSIONS

With the belief that information security and national culture are ultimately the enactment of human agents within the constraints of technology and society, we focus this research on the

understanding of how cultural factors moderate the relationships in the well-established human behaviour models. More specifically, we tested the Dinev & Hu (2007) model of user behaviour towards protective information technologies using data collected from two contrasting cultures: the United States and South Korea. The results of the structural equation modelling rendered clearly support to the core thesis of this study: cultural factors do significantly moderate the relationships in the Dinev & Hu (2007) model and thus play a significant role in the formation of user attitude and behaviour towards using protective information technologies. Using anti-spyware technology as a representative of protective information technologies, we found that South Korean computer users exhibit stronger relationship between subjective norm and behavioural intentions than their US counterparts. This is consistent with our analysis on how the differences in individualism, masculinity, power distance, and uncertainty avoidance should affect individual behavioural intention and behaviour. We also found that although in both cultures awareness of negative consequences of spyware is enough to motivate users to develop positive attitudes towards protective information technologies and form the intention to use them, the role of awareness is much stronger in the US than in South Korea, consistent with the individualism and masculinity characteristics of the two cultures.

While these findings could have significant theoretical and practical implications, as discussed in the previous section, the boundary of the study needs to be clearly established before the findings can be generalized. Despite the strong empirical results, our research has some clear limitations which also suggest future research opportunities. The most important limitation is that our results may not be applicable to the environment in some organizations where protective information technologies are installed and managed by IT professionals and thus operate transparently to the computer end-users, in which case, the users' awareness, controllability, and self-efficacy are not relevant. However, many organizations do allow users to install some software (knowingly or unknowingly when browsing certain websites) and access corporate network from home computers. In such cases, even if they have mandated the use of protective information technologies, user behaviour will still be a significant factor in the overall security of the organizations' information and systems. In such environments, our findings can provide valuable insights for designing and implementing security policies and practices.

Another limitation is the external validity of the study which is a typical limitation when convenience samples are involved (Cook & Campbell, 1979). Typically the criticism about using students as respondents or subjects for research revolves around whether students differ systematically from the target population in general in terms of their perceptions of the phenomenon of interest. This may indeed be an issue in cases where students have uncrystallized attitudes (particularly as it pertains to management, organizational or social issues) (Sears, 1986). However, the nature of this study on individual behaviour suggests that the results may be largely generalizable to individual computer users. Spyware is a negative technology that gets disseminated predominantly through the internet, and students, as representative of the younger generations, are heavy and savvy internet users. Thus, the subjects' perceptions and attitudes are well-formed (Agarwal & Karahanna, 2000) and could be used to inform the behaviour and attitudes of an internet user in general.

The third limitation is that we did not control for the technical background of the two samples of users. Although we attempted to get comparable groups in the two cultures by using undergraduate students enrolled in universities (and their graduates), it must be pointed out that there is a notable difference in the general knowledge of spyware between the US and the South Korean samples (Table 2). About 50% of the Korean vs. 19% of the US respondents have never heard of spyware or do not know details about it. The results may be biased across all the observed relationships because of the lack of knowledge of spyware among the South Korean respondents. Future research could correct this bias by having stricter control of the samples.

We hope that this study establishes a baseline for cross-cultural studies on user behaviour towards protective information technologies. Future studies could build on this foundation to further the accumulation of knowledge in this important area. A number of possibilities for future research exist. One of the major questions that are not answered in this study is why the hypothesized moderating effect of culture on the relationship between the attitudes towards behaviour and behaviour intention is not supported. With better controlled samples from multiple cultures, this question could be answered. Another major improvement could be in the direction of finer operationalization of the cultural variables. It is conceivable that if the cultural dimensions are operationalized individually, a much richer and refined understanding of the role of culture on user behaviour in the context of protective technologies could emerge.

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Appendix 1. Instrument items*

Construct	Item	Question	Source
Behavioural intention (BI)	BI1	I intend to periodically use anti-spyware applications to protect my computer from spyware.	Taylor & Todd (1995) and Pavlou & Fygenson (2006)
	BI2	In the immediate future I intend to customize my browser and computer settings to prevent the intrusion of spyware to my computer.	
	BI3	I intend to periodically check my browser and computer settings to prevent the intrusion of spyware to my computer.	
Attitudes toward behaviour (AB)	AB1	For me, cleaning spyware from my computer would be: (Very bad idea – Very good idea)	Taylor & Todd (1995) and Pavlou & Fygenson (2006)
	AB2	For me, preventing spyware from self-installing on my computer would be: (Very bad idea – Very good idea)	
	AB3	For me, protecting my computer from spyware would be: (Very bad idea – Very good idea)	
Subjective norm (SN)	SN1	Most people who are important to me think it is a good idea to clean spyware from my computers.	Taylor & Todd (1995) and Pavlou & Fygenson (2006)
	SN2	Most people who are important to me think it is a good idea to prevent spyware from running on my computer.	

Appendix 1. cont.

Construct	Item	Question	Source
Perceived behavioural control (PBC)	PBC1	Please rate the difficulty for you to clean spyware from your computer using anti-spyware applications. (Extremely difficult – Extremely easy)	Koufaris (2002), Taylor & Todd (1995) and Pavlou & Fygenson (2006)
	PBC2	Please rate the difficulty for you to protect your computer from spyware. (Extremely difficult – Extremely easy)	
Perceived ease of use (PEOU)	PEOU1	The process of configuring my computer to protect from spyware is clear and understandable.	Venkatesh & Davis (1996), Taylor & Todd (1995) and Koufaris (2002)
	PEOU2	It would be easy for me to prevent spyware from running on my computer.	
	PEOU3	It would be easy for me to clean my computer from spyware.	
Perceived usefulness (PU)	PU1	I believe it is beneficial to protect my computer from spyware.	Venkatesh & Davis (1996), Taylor & Todd (1995) and Koufaris (2002)
	PU2	I believe protecting from spyware will enhance my effectiveness in working with computer.	
Awareness (A)	A1	I follow news and developments about the spyware technology.	Hu & Dinev (2005) and Dinev & Hu (2007)
	A2	I discuss with friends and people around me security issues of Internet.	
	A3	I read about the problems of malicious software intruding Internet users' computers.	
Controllability (C)	C1	I have the skill and resources to protect my computer from spyware.	Taylor & Todd (1995)
	C2	Whether or not to clean spyware from my computer is completely under my control.	
Self-efficacy (SE)	SE1	I am confident that I can clean spyware off my system	Bandura (1986) and Pavlou & Fygenson (2006)
	SE2	I am confident I can prevent unauthorized intrusion to my computer.	

*All items used a 5-point Likert scale (*completely disagree* to *completely agree*), unless specified otherwise.

