Cross-cultural reliability and validity of a scale to measure information technology capability

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ABSTRACT

The purpose of this study is to validate a scale of information technology capability (ITC) across cultures. Organization level survey data from small to medium sized exporters in China and the U.S were used to evaluate the cross-cultural invariance of the measure of ITC. Although results generally support invariance of the ITC across the Chinese and US samples, differences in error variances and latent means comparing Chinese and U.S. samples were detected. The potential of the measure of ITC in clarifying sources of competitive advantage for small to medium sized exporters is discussed and directions for future research are suggested.

Keywords: Cross cultural Reliability and validity, Information technology capability, China, U.S.

Introduction

Information technology capability (ITC) has been identified as an important source of competitive advantage for organizations. Wade and Hulland (2004) argued that ITC is valuable, heterogeneously distributed, and imperfectly mobile and, therefore, a source of sustained competitive advantage for a firm. Indeed, Bharadwaj, (2000), Neirotti, Cantamessa, and Paolucci (2008), and Zhang, M.J. (2007) demonstrated significant impact of ITC on the performance of large firms. The impact of ITC on small and medium sized enterprises (SMEs) is less clear, however (e.g., Love & Irani, 2004). Given that SMEs are able to exploit sources of competitive advantage faster than their larger competitors (Knight and Cavusgil, 2004), one would expect that the advantages of ITC would be important for SMEs.

Several studies from this rather fragmented literature suggest that SMEs are likely to benefit from enhanced ITC, though the connection to business performance measures (such as profit and market share) is less clear. Levy et al. (2003) argued that IT enables SMEs to better manage their customer bases, keep information about customers in a more organized manner, and share knowledge within the organization more efficiently. Zhang, Sarker, and Sarker (2008b) and Arenius, Sasi, and Gabrielsson (2006) showed improved performance among export-focused SMEs due to greater ITC. Further Zhang et al. (2008b) showed that aspects of ITC differentially impacted performance (i.e., reports of financial and strategic export performance and performance relative to competitors) among a sample of export focused Chinese SMEs. Finally, Arenius et al. (2006) contend that export-focused SMEs use information technology to mitigate the "liability of foreignness," recognizing that export-focused SMEs have costs associated with travel and transportation to foreign markets, due lack of familiarity with the foreign nation's business environment, and from human and financial resource scarcity. Such challenges are often mitigated by information technology (IT), enabling SMEs to ultimately realize superior performance.

Perhaps the mixed findings are due to the controversy regarding the definition and dimensionality of ITC and the resulting lack of a robust measure of ITC. Although researchers have not reached consensus about the dimensionality of ITC, the research supports Bharadwaj (2000) that ITC is a holistic combination of IT-related resources that enable a firm to gain (and sustain) competitive advantage. The ability of SMEs to measure ITC effectively would provide information about an important source of competitive advantage. Knowledge of ITC capability could then be used to enact changes or leverage firm resources. The present research builds on the work of Zhang et al. (2008b) to provide evidence of the cross-cultural invariance of a measure of ITC. This work evaluates ITC in both Chinese and US export focused SMEs to provide evidence for the validity of the ITC measure.

THEORETICAL FOUNDATION OF THE STUDY

The concept of ITC draws on a number of theoretical perspectives (e.g., work design, power relationships, process transformation), and there is very little consensus on the dimensions of ITC or how it should be measured (Mulligan, 2002).

Previous Research on ITC

In the past, ITC has been conceptualized primarily as a type of firm resource. Many researchers conceptualize ITC as a form of managerial capability (e.g., Sambamurthy & Zmud, 1992; Ross, Beath, & Goodhue, 1996; Prasad, Ramamurthy, & Naidu, 2001). This view advocates that ITC is dependent upon managerial actions that influence the effective use of a firm's information technology. Other researchers conceptualize ITC as a form of technological capability (e.g., Sabherwal & Kirs, 1994; Teo & King, 1997; Clark, Cavanaugh, Brown, & Sambamurthy, 1997; Sabherwal, 1999; Byrd & Turner, 2000). This view advocates that ITC is dependent upon the capability of IT professionals employed by a firm, the amount of money dedicated to IT, and the physical IT components (e.g., hardware and software) owned by a firm.

Recently, however there have been attempts to adopt a more inclusive view of ITC which takes into account both technological and managerial capabilities. For example, Ray, Muhanna, and Barney (2005) view ITC as being composed of two categories of resources. The first category consists of raw IT spending, the technical skills and generic information technologies within the firm (i.e., the technology components). The second category consists of managerial capabilities that "influence how the first [category] of resource is used" (p. 628). Bhatt and Grover (2005) view ITC as being composed of (a) the value of technological capabilities (e.g., IT infrastructure), (b) managerial capabilities such as competitive capabilities (e.g., IT business experience, relationship infrastructure), and (c) dynamic capabilities (e.g., intensity of organizational learning).

It is important to note that ITC and IT resources have often been used interchangeably (e.g., Santhanam & Hartono, 2003; Bhatt & Grover, 2005). This is not surprising given that much of the research on ITC has been informed by the resource-based view of the firm. However, Bharadwaj (2000) attempted to create a distinction between the term "IT resources," and "ITC" as examined next.

The Resource Based View of ITC

Drawing on the resource-based view of ITC, Bharadwaj (2000) provides a rich conceptualization of ITC where ITC is determined by a firm's ability to use its resources to gain (and maintain) competitive advantage. According to Bharadwaj (2000, p. 176), the individual components such as IT infrastructure, IT human skills, etc. are "firm-specific resources, which in combination create a firm-wide ITC." Further, measuring the amount of resources is insufficient. Rather the measurement of ITC must demonstrate a firm's ability to use those resources to achieve competitive advantage. Wade and Hulland (2004) agree with Bharadwaj and suggest that this perspective enables researchers to explain how ITC affects a firm's financial and strategic performance. Thus, this study draws on the integrative view of ITC and define ITC as a firm's ability to acquire, deploy, and leverage its IT related resources in combination with other resources in order to achieve business objectives through IT implementation.

DIMENSIONALITY OF ITC

Evidence of multidimensionality of ITC is evident in the work of earlier researchers. However, there is no widely accepted reconciliation/integration of this body of work, and scholars offer varying perspectives. For example, Sabherwal and Kirs (1994) argue that ITC has four dimensions; Ross, Beath, and Goodhue (1996) identify yet another set of four dimensions; Feeny and Willcocks (1998a, b) discuss eight different aspects; and finally, Bharadwaj (2000) categorizes various aspects of ITC within four dimensions. It is useful to observe that there are varying degrees of overlap among the existing perspectives on ITC. Based on these and other studies, similar elements of ITC were combined to derive a more integrative set of underlying dimensions of the construct: (1) IT architecture , (2) IT infrastructure, (3) IT human resource, and (4) IT relationship resource. Zhang, Sarker, and McCullogh (2008a) describe how existing research maps on to these facets of ITC. Note that the majority of studies do not address all four dimensions mentioned above.

IT Architecture (ITA)

The definition of IT architecture has emerged slowly over time (Sullivan, 1982) with researchers usually focusing on different components of information systems, such as data storage, communications, or applications. For example, Spencer (1985) and Inmon (1989) focused on the data architecture; in contrast, Barrett and Konsynski (1982) emphasized communications in their definition of architecture, while Venkatraman (1991) and Keen (1991) defined the architecture in terms of applications. Gibson (1994) adopted a more integrative approach and viewed architecture as being composed of four physical elements: computing compatibility, data organization, communications connectivity, and applications functionality. Following Gibson's (1994) approach, IT architecture may be defined as a high-level map of information and technology requirements of the entire firm in this study. It provides a vision for how a firm will select and deploy its corporate IT resources to derive business value. Well-designed and well-planned IT architectures deliver significant benefits to a firm, by lowering IT cost through technology standardization and by enabling agility in the organization (Bhatt, 2000; Sambamurthy, Bharadwaj and Grover, 2003).

IT Infrastructure (ITINF)

The value of IT infrastructure, often defined as a shared information delivery base relying on hardware, software, and networks, is growing rapidly in today's organizations (Byrd & Turner, 2000). Many companies have placed the development of an effective IT infrastructure among the top concerns of their overall IT management (Chanopas, Krairit, &

Khang, 2006). An IT infrastructure provides a shared foundation of ITC for building business applications and training employees, and is usually managed by the information systems group. It is comprised of the computer and communication technologies and shareable technical platforms, providing consistent and quick information support by enabling access to relevant databases throughout the organization (Ross, Beath, & Goodhue, 1996; Weill, Broadbent, & Butler, 1996). This IT infrastructure may thus be seen as a key source for attaining long-term competitive advantage (Keen, 1991; McKenney, 1995), serving as an enabler for future applications and helping the organization cope with the uncertainty of future needs (Grossman & Packer, 1989).

It is useful to note that there is some conceptual overlap between IT architecture and IT infrastructure, at least as represented in the earlier literature. The difference between the two dimensions lies in their respective foci. While IT infrastructure focuses on the presence or absence of relevant technologies, IT architecture is concerned with the degree to which the technologies and data are systematically planned, and are harnessed in a consistent and flexible form.

IT Human Resource (ITHR)

As the importance of IT has risen in modern organizations, the role of IT personnel has also become an increasingly critical aspect of ITC. IT staff that consistently solves business problems and addresses opportunities through information technology is a valuable human asset. Insightful IT leaders recognize that the greatest impediments to success are often related to people rather than to information, technology, and systems. Thus, along with technical skills, managerial, business, and interpersonal skills have been increasingly cited as mandatory for these technical employees (Roepke, Agarwal, & Ferratt, 2000). Bharadwaj (2000) argues that these two kinds of skills, namely the technical skills and managerial skills, are the two critical dimensions of Human IT resources. Based on existing literature, technical skills include the ability to evaluate and control IS projects, IT skill base, and IT systems development practices; managerial skills include abilities such as the effective management practice, and planning capability and effectiveness (Capon & Glazer, 1987; Copeland & McKenney, 1988). Research has suggested that those softer skills are crucial to programmers, systems analysts, database administrators, and other IT personnel in modern organizations (Rockart, Earl, & Ross, 1996; Ross et al., 1996).

Recent research and practitioner literature has stressed the value of a broad range of skills for IT professionals in meeting the operational requirements of modern organizations. To add value, IT professionals are called on to blend technical skills with managerial skills and a deep understanding of the business. Drawing from the existing literature, in this study, IT human resource is defined as organizational staff that is capable of addressing; a) IT-related problems/opportunities, and b) business problems/opportunities associated with IT.

IT Relationship Resource (ITRR)

In order to effectively apply IT in the firm, IT management and business units need to share the risk and responsibility. This sharing requires trust and mutual respect, and an ability to communicate, coordinate, or negotiate quickly and effectively. IT relationship resource includes the establishment of IT priorities with the active involvement of relevant stakeholders. To do so, a number of firms have established committees of senior managers, with understanding of the organizational/business needs, to participate as members of IT steering committees. To some degree, this helps ensure a) the wise investment of limited organizational resources, and b) the selected projects have strong support and sponsorship of business managers (Ross, Beath, & Goodhue, 1996). The committees also articulate organizational strategies and specify how IT should support them. The more IT staff people and individuals representing different organizational functions communicate, coordinate, negotiate, and work together, the stronger the partnership becomes, and the more effective the process of planning, risk-taking, and experimentation, which in turn, leads to the development of new applications (Powell & Dent-Micallef, 1997).

ITRR also includes the social capital developed through relationship building. Specifically, it involves developing users' understanding of IT's potential and boosting users' feelings of ownership and satisfaction. It plays an important role in fostering mutual confidence, harmony of purpose, and enabling successful communication among those focused on the business and technical agendas (Feeny & Willcocks, 1998 b). A strong IT relationship is characterized by high levels of respect and goodwill between IT personnel and clients, which results in excellent bi-directional communication without significant distortion of meaning and collaboration across both sides of the relationship. This in turn enables mutual knowledge sharing and appreciation of the capabilities of information technology and the needs of the business. An important element of IT relationship is that it enables convenient IT-based linkages with the organization's customers as well as suppliers, and indeed such connectivity can often be transformed to valuable inter-organizational collaborations, leading to: the creation of joint designs, reduction of transaction costs, better management of inventory, greater agility of the relationship, etc. (Grewal, Johnson, and Sarker, 2007; Turban, Leidner, McLean, and Wetherbe, 2006). Based on the literature, ITRR is defined as the nature of relationship the IT group has with management and other business units/stakeholders.

KEY ASPECTS OF THE CHINESE CULTURE RELEVANT TO INFORMATION TECHNOLOGY

Culture has been defined as the "collective programming of the mind", that differentiates one group of individuals from another (Hofstede, 2001, p. 9). Differences in culture not only affect people's general behavior, but they also affect the "functioning of organizations and the people in them" (Hofstede 2001, p. 373). Given Hofstede's (2001, p. 373) assertion that "global solutions to organizational and management problems do not exist", it is likely that cross-cultural differences would also affect organizations' investment in IT and the extent to which they are able to harness its benefits. Recognizing this, in recent times, the effect of culture on IT adoption/implementation has attracted considerable attention from IS researchers (Davison, 2002; Martinsons, 2004).

The existing literature points to several dimensions of culture that differentiate one collective from another. Hofstede's (2001) cultural dimensions of power distance, uncertainty avoidance, individualism/collectivism, masculinity/femininity has received widespread acceptance, and is frequently used in the management literature. Further, another dimension of culture, long-term/short-term orientation (cf. Chinese Culture Connections, 1987) is also gaining in prominence among culture researchers. While China differs significantly from Western cultures on many of these dimensions (e.g., it has high power distance and high collectivism as compared to the Anglo cluster nations, cf. Hofstede, 2001), there are certain other unique aspects of the Chinese culture (both national and business) that would likely affect the nature of IT capability developed by managers and the impact of such capability on performance.

Confucianism

China has been significantly influenced by the teachings of Confucius, a humble intellectual who preached in China around 500 BC. Confucianism is viewed as "not a religion but a set of pragmatic rules for daily life" (Hofstede 2001, p. 354). One of the key principles of Confucius was that "the stability of the society is based on unequal relationships" (Hofstede 2001, p. 354). As a result of this emphasis on inequality, it is believed that the junior would always obey and respect (unquestioned) the orders and principles of the senior (Zhu, Bhat, and Nel, 2005). Principles of Confucianism have also permeated the Chinese business culture, which has been characterized as adhering to paternalism (Hill, 2006). In other words, Chinese organizations rely on centralized decision-making made mostly by the boss; these paternal figures reserve the right to solely "determine organizational objectives" (Martinsons & Westwood 1997, p. 222). Chinese organizations also rely on an "entrepreneurial mode of strategy making", where the paternal figure makes strategic decisions based on "personal knowledge and intuition", rather than "objective criteria or formal and quantitative methods" (Martinsons & Westwood 1997, p. 222). Such paternalism could cause some Chinese to view information technology as a threat to established role hierarchies.

Guanxi and Personalism

Another unique dimension of the Chinese culture that stems from its high power distance, long-term orientation, collectivism, and Confucianism is the importance of "horizontal coordination" or guanxi networks (Hofstede 2001, p. 362). Guanxi refers to "personal networks," (Tung and Worm, 2001) and places high emphasis on "social networks, trust, commitment, favor, mutuality, reciprocity", among others (Shin, Ishman, & Sanders, 2007). Guanxi brings "personalism" into the Chinese business culture (Wong a&nd Tam, 2000; Xin &Pearce, 1996), and consequently, Chinese organizational members tend to initiate and maintain communication through written memos and face-to-face interaction (Martinsons &Westwood 1997), rather than through the mediation of IT (Zhu et al., 2005). In sum, personal networks for sharing information, rather than computerized and standardized networks, are highly emphasized in Chinese culture.

PROPOSITIONS

Given the impact of Confuscianism and Guanxi on Chinese culture, it is possible that IT capability and its dimensions will be perceived differently by US employees compared to Chinese employees. However, measurement theory is founded upon the idea that once the relevant aspects of a construct have been identified, reliable and valid measurement can occur. Therefore the present work is focused on evaluating the cross-cultural validity of the ITC scale developed by Zhang et al. (2008a). Using nest multi-group confirmatory factor analysis, we test the possibility that (a) the dimensionality of the ITC is the same in a US sample; (b) the covariation among the dimensions of ITC is the same in a US sample, and (c) the means of the ITC dimensions will be the same in a US sample.

METHOD

Data Collection

Data from Zhang et al. (2008a) were obtained. Born-global firms were we investigated as follows: 1) firms were established after 1980 (i.e., they are relatively young) and entered foreign markets from or soon after their inception, 2) international sales constituted *at least* 25% of their total sales, indicating strong export focus, and 3) the firms had 500 employees or less. The Chinese dataset from Zhang et al. (2008a) had an effective sample size of 87 firms.

In the US, firms were identified from the *Directory of United States Exporters and CorpTech Directory of Technology Companies* (version 2000). The criterion of export volume (i.e., at least 25%) could not be applied prior to selecting the firms because this is not available in the *Directory of United States Exporters.* Year of inception and number of employees were used to select target firms. Study measures and export volume-related information were collected through the survey. 185 completed surveys were returned. Requiring export volume of at least 25% of total sales reduced the effective sample size to 96. Note that the surveys used with the US firms mirrored the interview protocol used for the Zhang et al. (2008a) Chinese firms identically (except for the addition of the item to obtain export volume). Non-response bias was assessed by dividing responses into two groups. Early and late respondents were compared using a t-test to identify potential differences on key variables (Armstrong & Overton, 1977). Furthermore, we compared between the two groups, the number of employees, firm age calculated from the founding year, total sales between randomly chosen samples of responding and non-responding firms. No significant differences were found in these t-tests ($p>0.05$), and thus no non-response bias was detected in these data. The descriptive statistics of the

Chinese and US samples (i.e., age of firm, number of employees, revenue from exports) are provided in Table 1. Note that there are significant differences between the Chinese and US samples on these criteria. Specifically, t-tests indicate that all differences on these characteristics are significant with $p<.01$.

[Insert Table 1 about here]

Measures

The information technology capability scale (ITC) developed using Chinese firms by Zhang et al. (2008a) was evaluated to determine its cross-cultural validity. The scale measured four dimensions of ITC: information technology architecture (ITA – three items), information technology infrastructure (ITINF– three items), information technology human resource (ITHR– six items), and information technology relationship resource (ITRR– three items). Note that the present study used only five the original six ITHR items. Specifically, given the relatively small sample size (87 Chinese and 96 US firms) and large number of indicators (15 original ITC items), we chose to drop one of the six ITHR scale items. Correlations among ITHR items were inspected and one item was removed, resulting in a 14 item ITC scale. US participants responded to the survey items using a seven point scale, where one indicated strong disagreement and a seven indicated strong agreement with statements referring to the nature of their firm's ITC.

As described in Zhang et al. (2008a), the ITC scale had desirable measurement properties with alphas for each dimension exceeding .80 in their sample of Chinese firms. Exploratory and confirmatory factor analyses also successfully demonstrated the dimensionality, reliability, and validity of the scale.

RESULTS

Internal Validity

Consistent with approaches used by other researchers (e.g., Schertzer, Lauger, Silvera, & McBride, 2008; Bishop, Scott, Goldsby, & Cropanzano, 2005; Zhang et al . 2008a), the procedures used to develop the ITC scale in the Chinese sample were replicated with the US sample. First, exploratory factor analyses (principal components with orthogonal rotation) revealed a matching factor structure for the US sample and good coefficient alpha reliability estimates (see Table 2).

[Insert Table 2 about here]

Next separate confirmatory factor analyses were performed using LISREL version 8.54 with maximum likelihood estimation to evaluate the fit of the ITC scale for both the US and Chinese samples. Several fit indices were evaluated. Researchers caution against sole reliance on chi-square and chi-square difference tests as indicators of good (e.g., Anderson & Gerbing, 1988; Steenkamp & Baumgartener, 1998). Rather, consensus of opinion among CFA researchers argues for considering several indicators of fit. For example, Hu and Bentler (1999) recommend standardized root mean square residual (SRMR) values about .08 or less, with a comparative fit index (CFI) and Tucker-Lewis index (TLI) of .95 or higher. We also included the X^2/df and root mean square error of approximation (RMSEA) fit indices although acceptable ranges for these indices are in question (e.g., Brown, 2006; McCallum, Browne, & Sugawara, 1996; Raykov, 2005). General recommendations suggest that the X^2/df should be less than three, and that RMSEA should be .08 or less with models having an RMSEA of .10 or higher being rejected. Again researchers are urged to consider many indicators when evaluating the fit of a model.

Several indices demonstrated good fit of the model to the data. Hence, the ITC scale with its ITA, ITINF, INTHR, and ITRR dimensions was supported for the both the Chinese and US samples (see Table 3). Chi-square values were 78.80, p=.25 for the Chinese sample and 87.94, p=.08 for the US sample. Also, RMSEA values for both the US and Chinese samples were .05 or less, SRMR was .068 or less, TLI was .98 in both samples, and CFI was .98 or higher. Given these favorable findings, we pursued further evaluation of the equivalence of the scales in the Chinese and US samples, despite the noted differences in sample characteristics.

[Insert Table 3 about here]

External Validity: Measurement Equivalence

Having established the dimensionality and reliability of the ITC scale in the Chinese and US sample, the degree to which the scale's measurement properties would generalize from China to the US (i.e., external validity) was evaluated. A nested, multi-group confirmatory factor analysis was used to establish the measurement equivalence of the Chinese and US samples. Per recommendations by Brown (2006), a series of nested confirmatory factors analyses were performed with increasingly stringent equality parameters comparing the Chinese and US samples. In addition to the fit indices already mentioned, change in the X^2 statistic (X^2diff) was computed and tested for significance. A non-significant increase in X^2 values indicates that adding more stringent parameter equivalence restrictions does not negatively impact the fit of the model. Likewise, if the X^2 values increase significantly, then the restrictions do significantly degrade the fit of the model to the data. Again, note that researchers recommend the use of multiple indicators of fit and evaluating the preponderance of the evidence when evaluating the fit of a model. We considered all the fit indices described above in making our judgments of model fit.

We began by evaluating configural invariance of the two samples to ensure that the same factor structure emerged. Configural invariance is the baseline for testing additional parameter equivalence restrictions. Therefore, no change in X^2 values could be computed. As shown in table 4, fit indices indicated good fit of the model to the data with $X^2(142) = 166.75$,

p = .07, X^2/df =1.31, RMSEA = .044, SRMR = .068, TLI = .98, and CFI = .99. Hence, the same ITC factor structure existed for both the Chinese and US samples, providing support for the invariant dimensionality of the ITC measure between the US and Chinese samples.

[Insert table 4 about here]

Having obtained the same ITC factor structure, metric invariance was tested as an additional level of stringency with regard to measurement invariance. Metric invariance tests whether item loadings on latent factors are equivalent in the two samples. Achieving metric invariance indicates that items relate to the latent dimensions in the same way, although the mean levels of the constructs may not be directly comparable across samples. The model chi-square was significant, X^2 (152) = 183.77, p = .04, but the change in chi-square was not significant, X^2diff (10) = 17.02, p<.05. In addition, the fit indices suggested good fit of the model to the data with X^2/df =1.21, RMSEA = .048, SRMR = .076, TLI = .98, and CFI = .98. Therefore, the results support metric invariance across the Chinese and US samples.

Next invariance of factor variances was evaluated. That is, the variances of the latent constructs, ITA, ITINF, ITHR, and ITRR were constrained to be equal. Although the model chi-square was significant, X^2 (156) = 196.23, p <.05 and the change in chi-square was significant, X^2diff (4) = 12.46, p<.01, the remaining fit indices were favorable. Specifically, X^2/df =1.26, RMSEA = .048, SRMR = .076, TLI = .98, and CFI = .98. Therefore, the results support variance invariance across the Chinese and US samples.

Next, invariance of factor covariances, in addition to factor variances, was evaluated. That is, the covariances and variances of the latent constructs, ITA, ITINF, ITHR, and ITRR were constrained to be equal. Although the model chi-square was significant, X^2 (162) = 207.48, p <.05, the change in chi-square was not significant, X^2diff (6) = 10.09, p>.05. The majority of the remaining fit indices were favorable. Although SRMR increased to a level (.111) that is generally considered to indicate poor fit, X^2/df =1.26, RMSEA = .048, TLI = .98, and CFI = .98 remained favorable. Considering all indices, substantial support was found factor covariance invariance, in addition to configural, metric, and factor variance invariance across the Chinese and US samples. Therefore, responses from both the Chinese and US samples drew from a similar range of scores on the latent factors (ITA, ITINF, ITHR, and ITRR) and that the Chinese and US samples followed a similar pattern of covariance on these latent factors.

Increasingly stringent constraints were tested, such as the invariance of residuals across the two samples. That is, the error variance of items in the ITC measure was constrained to be equal across the Chinese and US samples. Fit indices indicated poor fit with model chi square value of X^2 (176) = 263.82, p <.01 and X^2diff (14) = 45.93, p<.01. SRMR further increased to .128 indicating poor fit. The remaining fit indices were favorable with X^2/df =1.26, RMSEA = .074, TLI = .96, and CFI = .96. However, the significant model X^2, X^2diff, and high SRMR indicated that the model did not fit the data well enough for us to conclude that error variances were invariant across the Chinese and US samples.

Last, invariance of latent means across the two samples was investigated. That is, the intercepts of the indicators of the latent factors (ITA, ITINF, ITHR, and ITRR) were constrained to be equal across the Chinese and US samples. Given the significant differences between the two samples on number of employees, age, and current percentage of foreign sales and the important cultural differences between the US and China, it seemed unlikely to find that both samples achieved the same mean levels of the ITC dimensions. Indeed, many fit indices were severely degraded from the previous step, with X^2 (186) = 345.09, p <.01, X^2diff (10) = 81.27, p<.01, SRMR = .137, and RMSEA = .097. Although, TLI and CFI indexes remained favorable at .94, most fit statistics clearly indicated poor fit of this highly constrained model to the data. Therefore, invariance of latent means was not achieved. Failure to achieve invariance of latent means indicates that any evaluation of mean differences comparing Chinese and US samples using the ITC could be due to differences inherent in the samples or due to differences in the latent means. Therefore, interpretation of mean differences on the ITC across these countries would be confounded. Nevertheless, correlational studies comparing the relationships of ITC dimensions to other variables (such as profitability, market share, innovation, etc.) would be appropriate because configural, metric, variance, and covariance invariance were supported.

DISCUSSION AND MANAGERIAL IMPLICATIONS

This study suggests that ITC can be effectively measured, providing information about an important source of competitive advantage. The configural, metric, variance, and covariance invariance was supported for the Zhang et al. (2008a) ITC measure across Chinese and US samples of export focused SMEs. Hence, firms in markedly different cultures and with markedly different characteristics can use the ITC measure to evaluate relationships among ITC and various outcomes.

While the existing literature on IT is focused mostly on larger firms or organizations (Bharadwaj, 2001; Balotsky and Christensen, 2004; Wijnberg, Ende, Van Den Ende, and Wit; 2002), the present research specifically addressed the measurement of IT among SMEs to expand the literature in this field. Providing a reliable and valid measure of ITC will move the literature forward by helping researchers address mixed findings regarding the impact of ITC on SME firm performance as reported in some research (e.g., Love & Irani, 2004). Validation of the ITA, ITINF, ITHR, and ITRR dimensions help to focus thought about the components of ITC and aid researchers in measuring ITC accurately. As a result of reduced measurement error, relationships between ITC and important outcome variables such as market share, profitability, and innovation will become clearer leading to better understanding of the impact of ITC on firm performance.

As Zhang et al. (2008b) identified, the dimensions of ITC impact performance differently for export focused SMEs. Improved precision in measuring ITC will provide further insight regarding the dimensions of ITC most clearly associated with business performance. Enhanced precision will also help address the impact of the environmental context of a firm on ITC. For example, when firms experience rapid expansion, IT infrastructure may be most critically related to productivity; whereas when firms are searching for new markets, IT architecture may be more important to sales volume.

LIMITATIONS AND FUTURE RESEARCH

Although the contributions of the present work are important, there are also limitations. Scalar invariance was not achieved, likely due to substantive differences between the samples. Chinese and U.S. cultures are different, and the samples differed significantly on relevant characteristics such as number of employees, age, and current percentage of foreign sales. Hence, although obtaining any level of measurement invariance could be considered a feat, scalar invariance proved to be elusive.

Also, the differences among the samples in the present work suggest that other samples should be explored. Specifically, samples from different countries within western cultures could be compared to evaluate the measure of ITC, as in Cadogan, Diamantopoulos, and de Mortanges (1999), and likewise samples from different countries in eastern cultures could be compared, as in Sin, Tse, Yau, Chow, Lee, and Lau (2005). Finally, samples that are in different cultures, but more similar in number of employees, age, and current percentage of foreign sales could be compared to further evaluate the ITC. To the extent that future research is able to identify consistent differences among means and potentially correct for them, the ITC measure could be extended to address mean levels of differences on the ITC dimensions.

To aid practitioners, future research must determine the most salient aspects of ITC under different contexts (as in Zhang et al. 2008b). Hence, researchers will be able to evaluate the most relevent aspects of ITC and make more precise recommendations regarding interventions to enhance ITC and its impact on firm performance. The effect of these efforts will improve our understanding of ITC and our understanding of the competitive advantage ITC lends to firms.

REFERENCES

Armstrong, J.S. & Overton, T.S. 1977. Estimating nonresponse bias in mail surveys. *Journal of Marketing Research, 14*, 396-402.

Anderson, J. C., & Gerbing, D. W. (1982). Some methods for respecifying measurement models to obtain unidimensional construct measurement. *Journal of Marketing Research, 19*, 453-461.

Arenius, P., Sasi, V., & Gabrielsson, M. (2006). Rapid internationalization enabled by the Internet: the case of a knowledge intensive company. *Journal of International Enterprise, 3*, 279-290.

Barrett, S., & Konsynski, B. (1982). Inter-organization information sharing systems. *MIS Quarterly Special Issue*, 93-105.

Balotsky, E.R. & Christensen, E.W. (2004). Educating a modern business workforce. *Group & Organization Management, 29,* 148-170.

Bharadwaj, A. S. (2000). A Resource-based perspective on information technology capability and firm performance, an empirical investigation. *MIS Quarterly, 24*, 169-196.

Bhatt, G.D., & Grover, V. (2005). Types of information technology capabilities and their role in competitive advantage. *Journal of MIS, 22*, 253-277.

Bhatt, G. D. (2000). Exploring the relationship between information technology, infrastructure and business process re-engineering. *Business Process Management Journal, 6*, 139-163.

Brown, T. (2006).Confirmatory factor analysis for applied research. New York: Guilford Press.

Byrd, T. A., & Turner, D.E. (2000). Measuring the flexibility of information technology infrastructure, exploratory analysis of a construct. Jo*urnal of Management Information Systems, 17,* 167-208.

Bishop, J.Q., Scott, K.D., Goldsby, M.G., Cropanzano, R. (2005). A construct validity study of commitment and perceived support variables. *Group & Organization Management, 30*, 153-180.

Cadogan, J., Diamantopoulos, A. , de Mortangees, C. (1999). A measure of export market orientation: Scale development and cross-cultural validation. *Journal of International Business Studies, 30*, 689-707.

Capon, N.,& Glazer,R. (1987). Marketing and technology, a strategic co alignment. *Journal of Marketing, 51*, 1-14.

Chanopas, A., Krairit, D., & Khang, D.B. (2006). Managing information technology infrastructure: a new flexibility framework. *Management Research News*, 29, 632-651.

Chinese Culture Connection (1987) Chinese values and the search for culture-free dimensions of culture. *Journal of Cross-Cultural Psychology*, *18*, 143-164.

Clark, C.E., Cavanaugh, N.C., Brown, C.V., & Sambamurthy, V.(1997). Building change-readiness capabilities in the IS organization: insights from the Bell Atlantic experience. *MIS Quarterly, 21*, 425-456.

Copeland, D. G., & McKenney, J.L.(1988). Airline reservations systems, lessons from history. *MIS Quarterly, 12*, 353-371.

Davison, R.M. (2002) Cultural complications of ERP. *Communications of the ACM*, *45*, 109-111.

Feeny, D. F., & Willcocks, L.P. (1998a). Core IS Capabilities for exploiting information technology. *Sloan Management Review*, *39,* 9-21.

Feeny, D. F., & Willcocks, L.P.(1998b). Re-designing the IS function around core capabilities. *Long Range Planning, 31*, 354-367.

Gibson, R. (1994). Global information technology architectures. *Journal of Global Information Management*, *2*, 28-39.

Grewal, R., Johnson, J., & Sarker, S. (2007). Crises in Business Markets: Implications for Interfirm Linkages. J*ournal of the Academy of Marketing Science*, *35,* 398-416.

Grossman, R. B., & Packer, M.B.(1989). Betting the business, strategic programs to rebuild core information systems. *Information Technology & People, 5*, 235-244.

Hall, E.T. (1976) *Beyond Culture*. Anchor: Garden City, NY.

Hill, J.S. (2006) Confucianism and the art of Chinese management. *Journal of Asia Business Studies*, *1* , 1-9.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6,* 1-55.

Hofstede, G. (2001). *Culture's consequences: comparing values, behaviors, institutions, and organizations across nations* (2nd ed.). Sage: London.

Inmon, W. H. (1989). *Data architecture: The information paradigm.* Wellesley, MA: QED Information Sciences.

Keen, P. G. W. (1991). *Shaping the future, business design through information technology.* Boston: Harvard Business School Press.

Knight, G.A.,& Cavusgil, S.T. (2004). Innovation, organizational capabilities, and the born-global firms. *Journal of International Business Studies, 35*, 124-141.

Lambe, C. J., Spekman, R.E. & Hunt, S.D. (2002) Alliance competence, resources, and alliance success: conceptualization, measurement, and initial test. *Journal of Academy of Marketing Science, 30*, 141-158.

Levy, M., Loebbecke, C., & Powell, P. (2003) SMEs, co-opetition and knowledge sharing: the role of information systems. *European Journal of Information Systems, 12*, 3-17.

Li, H., & Atuahene-Gima, K. (2001). Production innovation strategy and the performance of new technology ventures in China. *Academy of Management Journal, 44*, 1123-1134.

Love, Peter, E.D., & Irani, Z. (2004). An exploratory study of information technology evaluative and benefits management practices of SMEs in the construction industry. *Information & Management, 42*, 227-242.

Martinsons, M.G. & Westwood, R.I. (1997) Management information systems in the Chinese business culture: An explanatory theory. *Information & Management*, *32*, 215-228.

McCallum, R., Browne, M., & Sugawara, H. (1996). Power analysis and determiniation of sample size for covariance structure modeling. *Psychological Methods, 1*, 130-149.

McKenney, J. L. (1995). *Waves of Change: Business Evolution through information technology.* Cambridge, MA: Harvard Business School Press.

Mulligan, P. (2002). Specification of a capability-based IT classification framework. *Information & Management, 39*, 647.

Neirotti, P., Cantamessa, M., & Paolucci, E. (2008). Do companies with a competitive advantage make better use of IT? Evidence from Italian enterprises. International Journal of Technology Management, 42, 158-184.

Powell, T. C., & Dent-Micallef, A. (1997). Information technology as competitive advantage, The role of human, business, and technology resources. *Strategic Management Journal, 18*, 375-405.

Prasad, V. K., Ramamurthy, K., & Naidu, G.M. (2001).The influence of Internet-marketing integration on marketing competencies and export performance. Jou*rnal of International Marketing, 9*, 82-111.

Ray, G., Muhanna, W.A., & Barney, J.B.(2005) Information technology and the performance of the customer service process: A resource-based analysis. *MIS Quarterly, 29*, 625-652.

Raykov, T. (2005). Bias-corrected estimation of noncentrality parameters of covariance structure models. *Structural Equation Modeling, 12*, 120-129.

Rockart, J.F., Earl, M.J., & Ross, J.W. (1996). Eight imperatives for the new IT organization. *Sloan Management Review, 38*, 43-56.

Roepke, R., Agarwal, R., & Ferratt, T.W. (2000). Aligning the IT human resource with business vision: the leadership initiative at 3M. M*IS Quarterly, 24*, 327-353.

Ross, J. W., Beath, C. M., & Goodhue, D.L. (1996). Develop long-term competitiveness through IT assets. S*loan Management Review, 38*, 31-33.

Sabherwal, R. (1999). The relationship between information system planning sophistication and information system success, An empirical assessment. *Decision Sciences, 30*, 137-168.

Sabherwal, R., & Kirs, P. (1994). The alignment between organizational critical success factors and information technology capability in academic institutions. *Decision Sciences, 25*, 301-331.

Sambamurthy, V., & Zmud, R.W. (1992). Man*aging IT for success: The empowering business partnership*. Morristown, NJ: Financial Executives Research Foundation.

Sambamurthy,V., Bharadwaj, A.,& Grover, V. (2003). Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. *MIS Quarterly, 27*, 237-263.

Santhanam, R., & Hartono, E. (2003). Issues in linking information technology capability to firm performance. *MIS Quarterly, 27*, 125-153.

Schertzer, S., Lauger, D., Silvera, D., & McBride, J. B. (2008). A cross-cultural validation of a gender role identity scale in marketing. Inte*rnational Marketing Review, 25*, 312-323.

Shin. S.K., Ishman, M., & Sanders, G.L. (2007) An empirical investigation of socio-cultural factors of information sharing in China. *Information and Management*, *44*, 165-174.

Sin, L., Tse, A., Yau, O., Chow, R., Lee, J., Lau, L. (2005). Relationship marketing orientation: Scale development and cross-cultural validation. *Journal of Business Research, 58*, 185-194.

Spencer, R. A.(1985). Information Architecture. *Journal of Systems Management, 36*, 34-42.

Sullivan, C. H., Jr. (1982). Rethinking computer systems architecture. *Computerworld extra, XVI*, 5-10.

Teo, T. S. H., & King, W. R.(1997). An assessment of perceptual differences between informants in information systems research. *Omega, 25*, 557-566.

Turban, E., Leidner, D., McLean, E., & Wetherbe, J (2006). Information Technology For Management (5th Ed.). NJ: John Wiley & Sons.

Tung, R.L. & Worm, V. (2001) Network capitalism: the role of human resources in penetrating the China market. *International Journal of Human Resource Management*, 12(4), 517–534.

Xin, K.R. and Pearce, J.L. (1996) Guanxi: connections as substitutes for formal institutional support. *Academy of Management Journal*, *39*, 1641–1658.

Venkatraman, N. (1991). *IT-related business reconfiguration*. New York: Oxford University Press.

Wong, Y.H. and Tam, J.H.L. (2000) Mapping relationships in China: Guanxi dynamic approach. *Journal of Business and Industrial Marketing*, *15*, 57–70.

Wade, M. & Hulland, J. (2004). Review: The resource-based view and information systems research: Review, extension, and suggestions for future research. *MIS Quarterly, 28*, 107-143.

Weill, P., Broadbent, M., & Butler, C. (1996). Exploring how firms view IT infrastructure. Working Paper.

Wijnberg, N.M., Van Den Ende; J., De Wit, O. (2002). Decision making at different levels of the organization and the impact of new information technology: Two cases from the financial sector. *Group & Organization Management, 27*, 408-429.

Zhang, M., Sarker, S., and Mc Cullough, J. (2008a). Measuring information technology capability of export-focused small or medium sized enterprises in China: Scale development and validation. *Journal of Global Information Management*, *16*, 1-25.

Zhang, M., Sarker, S., and Sarker, S. (2008b). Unpacking the effect of IT capability on the performance of export-focused SMEs: a report from China. *Information Systems Journal, 18*, 357-380.

Zhang, M.J. (2007). Assessing the performance impacts of information systems from the resource-based perspective: an empirical test of the indirect effect of IS. *Journal of Business Strategies, 24*, 141-164.

Zhu, Y., Bhat, R., & Nel, P. (2005) Building business relationships: a preliminary study of business eExecutives' views. *Cross Cultural Management*, *12*, 63-84.

Table 1
Select descriptive statistics for the total sample and the US and Chinese sub-samples.

Characteristic	**Total sample**	**US sub-sample**	**China sub-sample**
Number of employees	n=185	n=98	n=87
Mean	131.58	75.74	193.91
Standard Deviation	145.07	103.10	159.62
Ages of the firms			
Mean	17.36	24.72	9.15
Standard deviation	16.19	18.17	7.74
Current Percentage of Foreign Sales			
Mean	50.48	41.09	60.97
Standard Deviation	29.45	25.80	29.87

Table 2
Scale items, reliabilities, and exploratory factor analysis loadings for US (n=98) and Chinese (n=87) samples.

	Coefficient α		ITA		ITINF		ITHR		ITRR	
Factors and items	US	China	US	China	US	China	US	China	US	China
Information Technology Architecture (ITA)	.78	.84								
There is consistency in IT policies throughout the enterprise.			0.74	0.84						
There is consistency in IT application portfolios.			0.80	0.81						
There is clarity of vision regarding how IT contributes to business value.			0.80	0.75						
Information Technology Infrastructure (ITINF)	.71	.84								
Communication devices for access of remote database.					0.81	0.76				
Computer facility or IT projects.					0.70	0.82				
Computer labs for employee instruction.					0.69	0.78				
Information Technology Human Resource (ITHR)	.92	.93								
IT skill base							0.62	0.86		
IT project management practice							0.85	0.83		
IT planning capabilities							0.80	0.82		
IT planning effectiveness							0.88	0.80		
IT systems development practices							0.72	0.79		
Information Technology Relationship Resource (ITRR)	.81	.81								
We have technology based links with customers.									0.69	0.79
We have technology based links with suppliers.									0.82	0.81
We use IT based entrepreneurial collaborations with external partners.									0.85	0.85

Table 3
Confirmatory factor analyses for the Chinese and US samples.

Single Group Solutions	X^2	*df*	X^2/df	RMSEA	SRMR	TLI	CFI
US (n=98)	87.94	71	1.24	0.050	0.068	0.98	0.98
China (n=87)	78.80	71	1.11	0.036	0.049	0.98	0.99

Table 4
Nested multi-group confirmatory factor analysis results.

	X^2	df	X^2diff	Δ df	X^2/df	RMSEA	SRMR	TLI	CFI
Configural invariance	166.75	142			1.17	.044	.068	.98	.99
Metric invariance	183.77*	152	17.02	10	1.21	.048	.076	.98	.98
Factor variance invariance	196.23**	156	12.46**	4	1.26	.053	.078	.97	.98
Covariance invariance	207.48**	162	10.09	6	1.28	.055	.111	.97	.98
Error variance invariance	263.82**	176	45.93**	14	1.50	.074	.128	.96	.96
Scalar invariance	345.09**	186	81.27**	10	1.86	.097	.137	.94	.94

*: p<.05
**: p<.01