Assessing e-Banking Adopters: an Invariance Approach

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Abstract

Technology acceptance model (TAM) has been widely applied to investigate the acceptance of varied information technologies in the past decade. A cumulative tradition has practically been achieved in this area of research. In terms of the validity and reliability of TAM construct and measurement, most TAM studies have reported very high reliability and validity values associated with their adopted constructs. However, looking back at these prior TAM studies, it is surprised to find that only a few researchers have analyzed the invariance of their construct prior to using it in their survey. This is a critical issue as variance of users, in terms of their gender, age, experience, and income, would definitely impact their perception of the survey construct. If there is a difference of male and female, for instance, in perceiving the measurement scale of the construct, then the reliability of all subsequent findings from the survey will be seriously in doubt. In the past, quite a few researchers have found some interesting, but unusual correlations of TAM variables in their studies. One explanation would possibly be due to some faults of their construct. Hence this study attempts to perform an invariance analysis on TAM construct, using Ebanking as an illustrative technology. Internet banking has recently received tremendous attention. Many believe this technology will continue to mature, and possibly become the most successful B-C electronic commerce. Therefore, analyzing TAM construct in the context of E-banking would provide insights not only to TAM researchers, but also to E-banking researchers as well.

1. Introduction

In recent years, more banks worldwide are expanding their banking services into the platform of Internet, capitalizing e-banking for different competitive strategies, which include cost containment, performance improvement, market penetration and product transformation. However, these banks all share the same challenge for the success of e-banking, which is the need for a critical mass of customers using their E-banking services. Thus, it is important for banks to know how their customers value e-banking services in order that they will be able to do planning and capture the market. It is through the understanding of these acceptance determinants that allows banks to design effective strategies for attracting more E-banking customers.

Information technology (IT) acceptance has been a subject of many research studies over the past two decades. Since the early 1990s, several theories have emerged that have the potential to offer new insights into the actual IT acceptance and use, at both the individual and organizational user levels. Among these theories, Technology Acceptance Model (TAM) has received more attention, perhaps because of its parsimony and the wealth of recent empirical support for them. Fair to say, a cumulative tradition has already been established in technology acceptance research, especially in the management and IS disciplines. However, the theoretical validity and empirical applicability of TAM still need to be extended to incorporate different technologies, users, and/or organizational context. This is especially true when studying the acceptance of e-banking system, whereby its technology settings and transaction environments are drastically different as compare to conventional IT and their business environment.

The objective of this study is to validate the instrument of TAM, using it in the context of E-banking. In the past, not many researchers have tested TAM in its invariance of gender or any other user profile variables, despite the fact that most TAM findings have validated the reliability of the construct itself. However, we still have a doubt of the validity of TAM construct in its invariance on user's profile, especially in gender as many research studies have report a divergence of male and female in the perceived value of information technology. As an exploratory study of its kind in IS invariance analysis, this study only attempts to assess invariance of TAM construct using gender as an example. The research will be conducted in two phases. First, LISREL will be used to determine if TAM is a valid model for investigating e-banking system adoption. Second, invariance analysis will be applied to explore how female e-banking adopters are differentiated from male adopters in their perception of the construct. This research will contribute to additional understanding of TAM's validity in e-banking acceptance.

2. Internet Banking in Hong Kong

While banks in North America began setting up their Internet Banking units in mid-90s, their counterparts in Hong Kong only started doing their business online in the last quarter of 1999. Bank of East Asia took the lead in Hong Kong's Internet Banking by launching its Cyberbanking in September 1999 and attracted 120,000 registered users in a year, more than 40,000 of which are new customers.

The two largest banking groups in Hong Kong, Bank of China Group and HSBC, followed suit and launched their e-banking units in early 2000. By February 2001, it was estimated, from an AC Nielsen research report, that Hong Kong has about 370,000 Internet Banking users and this figure will increase to 650,000 one year after. Hong Kong Bank and Bank of East Asia are currently the leaders in Internet Banking services, each with over 140,000 registered users. The figures of Hong Kong Monetary Authority have indicated that Internet Banking users represent less than 5% of total bank customers on average, thus there are still lots of room for the growth of Internet Banking in Hong Kong.

The above-mentioned AC Nielsen report has also outlined the major factors that influence Hong Kong people's decision when choosing Internet Banking services. The most important factor, according to its survey, is that the Internet Banking services are provided by a bank that the customer frequently transacts with. The second, third and fourth most important factors are closely related: good bank image, credibility and reputation respectively. Good customer service occupies the last position among the top five factors. Not surprisingly, this survey indicates that Hong Kong people prefer using the Internet Banking services provided by a bank that they are familiar with and consider as reliable and trustful.

At present, almost all retail banks, including the smaller local ones, are providing services online as a defensive strategy. The majority of services that are offered on the Internet are retail-banking services also available via phone or other electronic devices. Some examples are account enquiry, transfer of funds (both intra and inter-bank), loan application and securities and foreign currencies trading. Banks position their online banking as value-added services that supplement the existing delivery channels. As the Interest Rate Agreement will be removed completely in July 2001, it is expected that banks will further promote the use of online banking services to drive costs down so as to maintain competitiveness in the market.

Like their U.S. counterparts, most of the ebanks in Hong Kong are either planning to go or already marching towards the phase of full-service Internet Banking, although they are not as fully developed in terms of the variety of services offered and the sophistication of their websites. Recently, quite a number of banks in Hong Kong have focused on "Wealth Management" and the business clients when formulating their Internet Banking strategies. For example, Bank of East Asia has launched the concept of "My Cyber World" at the end of 2000, which allows the bank's Internet Banking clients to more effectively manage all aspects of their personal finance and wealth and is also a channel for promoting the bank's investment products such as bonds and mutual funds. Moreover, the bank is planning to launch a business-to-business (B2B) e-commerce platform and a payment gateway system for its business clients in 2001.

Regarding Internet security, almost all Internet banks in Hong Kong utilize the Secure Socket Layer (SSL) protocol for the protection of data security. Hong Kong Monetary Authority has strict requirements on Internet Banking security for banks to follow, hence there should be no major difference in the security level among Internet banks of Hong Kong. Some banks have recently adopted an even more secure protocol, Secure Electronic Transaction (SET), as an additional Internet security tool; since this technology requires customers to download a Digital Certificate onto their computers, it may take a longer time for customers to get used to it and to become popular.

3. Invariance Analysis

Empirical study has been a dominant research methodology in the IS field. Researchers of this approach always adopt surveys and questionnaire instruments to investigate correlations of research variables of their proposed models. However, a central concern of this methodology is whether or not all survey respondents ascribe the same meanings to the survey items, particularly in a multi-group survey context. Even in a mono-group research setting, age, gender, and experience may constitute a divergence in an individual's response to a survey item. Hence, the measurement equivalence (invariance) across sample population is an important issue. Researchers (such as Rensvold and Cheung [14]) have repeatedly stressed the importance of invariance analysis, with particular focus on the construct's form, factorial, and intercept invariance, and urged the development of constructs that are operationalized in an unambiguous way to achieve measurement equivalence. If survey items do not display of form of invariance, researchers will find it difficult to conclude whether the observed difference is constituted by the hypothesized difference or is an artifact of non-invariance, thereby making direct comparison of observed scores of different groups meaningless [6].

Measurement equivalence exists at several different levels, but with factorial invariance being a prerequisite for higher levels of equivalence [14]. A construct is said to have a factorial invariance if item responses of different groups (could be subgroups of age, gender, or country) are associated with the same construct and their factor parameter

coefficients are not significantly different from each other or groups of comparison. In the past, several methods have been proposed for testing factorial invariance. For example, Van De Vijver and Harsveld [17] has proposed the examination of the factor parameters of the unconstrained model and identified those with the largest between-group differences as being non-invariant. Marsh and Hocevar [11], on the other hand, suggested examining the modification indexes in the fully constraint model and interpreted large modification indexes of the associated items as indications of non-invariant. However, of all proposed factorial invariance methodologies, Byrne et al.'s [2] approach has been more widely accepted and applied [3]. This approach applies confirmatory factor analysis (CFA) in deriving and comparing the chi-square χ^2) and fit statistics of an unconstrained and a series of constrained measurement models. The unconstrained model is estimated without any condition; while constrained models are estimated with conditions that one or more specified factor parameters would have the same value for both groups.

Specifically, factorial invariance analysis, based on Byrne et al's approach, starts with the unconstrained model. If the fit statistics derived from the model were unsatisfactory, it would then be unnecessary to continue with invariance analysis for subgroups. Otherwise, invariance analysis will move on to estimate a fully constrained model. The χ^2 and fit statistics of this fully constrained models will be compared with the unconstrained model for difference. If the difference is significant, then the construct of at least one of the models would have at least one non-invariant item. It is thus necessary to find the non-invariant item by devising a series of partially constrained models and testing the changes in chi-square ($\Delta \chi^2$) statistics between the models' constructs for significance. If $\Delta \chi^2$ for a partially constrained model, when compared to the fully constrained model, is significant, then the constraint associated with this partially constrained model is a source of non-invariance. Once the invariant items are identified, a researcher could have several options for dealing with them, including eliminating them from the study, retaining them if legitimate arguments can justify their partial factorial invariance on results, and treating the variance as a meaning source of data concerning differences between groups [7].

Subsequent to factorial invariance analysis, a researcher could perform higher levels of measurement equivalence or invariance by checking the construct's covariance natrices, error terms, and latent variable correlations. The performance of these between-group invariance tests are similar to factorial invariance analysis, except that data for testing would be based on covariance matrices, error terms, or variable correlations.

3. Research Model

A research model, as depicted in Figure 1, is proposed to investigate the invariance of Internet banking adopters in Hong Kong. This model focuses on the investigation of the impact of gender on Internet banking acceptance, basing on the theoretical framework of TAM.

4. Research Methodology

4.1 Instrument Development and Pre-test

Survey method was used to collected data for this study. To ensure the validity and reliability of the questionnaire, a three-stage survey validation was conducted. First, whenever possible, previously validated questions, and generally accepted instrument construction guidelines (such as Boudreau et al. [1], Fox et al. [8], and Straub[15]) were followed. Second, the survey was pre-tested by three business professors with expertise in survey research, IS, and banking; and by fourteen bank customers with Internet banking experience. The feedback from this phase of instrument development resulted in some restructuring and refinement of the survey that improves its quality and content validity. Third, a pretest of the questionnaire was administered to thirty-two MBA students taking a graduate-level class in electronic commerce. The Cronbach's alpha values for all question items from this pre-test were above 0.80 [13], thus suggesting adequate reliability of the questionnaire. The final version of the questionnaire, which has been edited for a few minor changes, is provided in the appendix.

4.2 Subjects

The subjects for the study were general banking customers in Hong Kong. Hong Kong was chosen for this study not only because of its convenience for data collection, but also because of its reputation as one of the most developed financial and banking centers worldwide. This, plus the excellent telecommunication infrastructure, high PC and Internet diffusion rate, and high population density, has made Hong Kong an appropriate city for studying Internet banking acceptance.

To ensure proper samples selected for this study, local bankers have been consulted of their Internet banking user's profiles, which were of the age group of around 25-45, possibly more educated and more computer literate. With such finding, three hundred and twelve part-time post-graduate (mostly MBA and MSc) students at a major university in

Hong Kong were assessed on their Internet banking use. These students were surveyed in class, whereby they were informed of the voluntary nature of the study and that their individual responses would be treated with strict confidence.

Although using students at tertiary education institutions as subjects in academic research is quite common, researchers still challenge whether students differ systematically from the target population in general about their perceptions of the technology of the phenomenon of interest. This may indeed be critical in cases where students have not clarified their attitudes or where their social norms play a critical role in the theoretical model of interest. In this study, though student subjects were used to examine the Internet banking phenomenon, they were all full-time employees with several years of working experience. More importantly, they fit the profile of the desired potential users of Internet banking and had well-formed perceptions and attitudes towards this information technology.

4.3 Variable Operationalizations

Studies on perceived ease of use, perceived usefulness, and attitude towards use have been well researched, especially in the context of TAM application. Their measurements have also been developed, validated, and adopted in many IT adoption and diffusion researches. In this study, the items used to measure PEOU, PU, attitude towards use, intention to use, and actual system use were adapted from Davis [5], Moon and Kim [12], and Teo et al. [16].

5. Data Analysis and Results

5.1 Respondents' Profile

Three hundred and twelve questionnaires were distributed and two hundred and forty-seven were returned. Of these returned questionnaires, six were partially completed and were therefore excluded from the data analysis, resulting in an effective response rate of 77.24 percent. These 241 respondents were all college graduates, with ninety-one of them have already had a masters degree. They ranged in age from 21 to above 45, but a majority of them (78.4%) are between 25 and 40. Distribution of gender was quite balanced, with 122 of them (50.6%) being female.

Their occupations, though varied extensively from medical doctors to business owners, could be classified into either middle management or professionals from marketing, finance, banking, and consulting sectors. They have an average of 7.6 years of working experience and have an average deposit balance of US\$12,000 at their principal bank. All of them have Internet experience, with most of them (46.5%) spending more than ten hours surfing the net per week. Not surprisingly, one hundred thirty-nine of them (57.7%) are Internet banking users, with 116 of them (83.5%) spending an average of less than five times in using Internet banking services per week. For these Internet banking users, ninety-seven of them (69.8%) spent an average of 3-10 minutes per use. Only fifteen (10.8%) users indicated they have spent more than 10 minutes per use.

5.2 Measurement Model Analysis

A confirmatory factor analysis using LISREL 8.5 was conducted to test the measurement model. The overall model fit was assessed using four goodness-of-fit indices, which are normalized fit index (NFI), non-normalized fit index (NNFI), comparative fit index (CFI), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), and root mean square residual (RMSR). The chi-square statistic was not used because of its sensitivity to sample size [10]. The results of these indices, along with their recommended values of common model fit, are depicted in Table 1. Although GFI index failed to meet the recommended minimum values, its value discrepancy of 0.01 made us believe that the model fit was reasonably adequate to assess the result for the structural model.

The measurement model was further assessed for its construct reliability and validity. Construct reliability was initially evaluated using Cronbach's alpha reliability test. As indicated in Table 2, the Cronbach's alpha values of all our variables are in the range of 0.90, which are significantly above the 0.7 level suggested for exploratory research, thus justifying the reliability of our measurements for model testing.

As far as the instrument's convergent validity is concerned, our measurement model has been assessed with average variance extracted for each item. The rule of thumb for this assessment is that a construct has to have a minimum of 0.5 average variance extract as evidence of convergent validity. Our test results, which are depicted in Table 2, show that all items surpassed the minimum recommended value. As the tests for average variances extract do not show any significant violations, thereby demonstrating adequate convergence validity of our model.

Additional discriminant validity test was performed using factor analysis. The varimax-rotated principal component factor analysis was conducted and the results are depicted in Table 3. As shown, a total of four factors were extracted, which matched with the number of constructs in our research model. A review of the loading coefficients also indicated that items intended to measure the same construct were converged as originally envisaged, thus suggesting adequacy of discriminant validity of our measurement model.

5.3 Model Testing Results

Prior to running the factorial invariance analysis, LISREL 8.5 was used to test our research model with the sample covariance matrix depicted in Appendix 2 as input. The results, as depicted in Table 1, show that all eight fit indices for our testing model (χ^2 /df=1.95, NFI=0.96, NNFI=0.97, CFI=0.98, GFI=0.92, AGFI=0.88, RMSR=0.06, and RMSEA=0.06) have clearly exceeded the minimum recommended values suggested for a good model fit, implying the adequacy of our model for further statistical analysis, including its causal link evaluation. Subsequently, the Internet banking TAM was run separately for adopters, non-adopters, and a combination of both adopters and non-adopters. The results of these three runs, which are depicted in Table 4, exhibit that TAM is an appropriate model for studying Internet banking acceptance. Of the three runs, adopters group provides the best support for TAM, with all variables significant at p<0.01. Interestingly, though all TAM variables of non-adopters group are significant from p<0.05 to p<0.001 levels, *PU* is found to have an adverse effect on *intention to use*. Due to this counteracting effect from the non-adopters group, the overall effect of *PU* on *intention to use* is found to be insignificant.

Upon the validation of our model's applicability, invariance analyses were then performed to determine the effect of gender and IT competency on the construct of our model. As a first step, form invariance test, which is the first requirement for comparing groups, was conduct to determine if male and female would use the same items to measure the same construct. If different genders use different items for the same construct, form non-invariance exists and further invariance analyses would become redundant. The results of our form analysis, which is shown in Table 5, suggest that the χ^2 and fit statistics of the constrained models (either male or female respondents alone) do not differ significantly from the unconstrained (female and male together) model, thus providing evidence of form invariance of the construct.

In the second step, factorial analysis was performed to determine if male and female conceptualize our Internet banking construct in the same way. If gender has an effect on the measurement equivalence of the construct, observed scores from male and female groups would be in different scale and therefore are not directly comparable. In such scenario, we then need to identify observed items that caused such non-invariance. In performing factorial invariance analysis, an unconstrained model was initially set up, followed by a fully constrained model. The $\Delta \chi^2$ and Δdf and fit statistics (in our case, NNFI, CFI, and RMSEA) of the two models were then calculated for comparison. According to the results depicted in Table 6, the changes in $\Delta \chi^2 \Delta df$ are not significant and the fit statistics of the two models are also quite comparable, thereby justifying the invariance of the unconstrained and constrained models. Following this comparison, partially constrained models that constrained individual construct (*PEOU, PU, attitude,* and *intention*) were set up for further factorial invariance analysis. The results, which are also depicted in Table 6, suggest that all $\Delta \chi^2$, Δdf , and fit statistics are not significantly different between models compared. Through these factorial invariance tests, it is concluded that our model fits the construct very well and the factor loadings for both male and female do not have any non-invariance, thus justifying the factorial invariance of our construct.

Upon the validation of our construct's factorial invariance, a theta-delta invariance test was carried out to ensure the error terms between male and female are non-invariant. Since theta-delta is related to reliability issues, therefore this invariance test could be considered as validating the reliability equivalence of gender groups. If theta-delta noninvariance exists in our construct, it may be caused by a different understanding of surveyed items between male and female in PEOU, PU, intention to use, and attitude towards the use of Internet banking. According to Table 7, $\Delta \chi^2$ was significant between unconstrained and fully constrained models, despite their comparable NNFI, CFI and RMSEA statistics. The source of non-invariance, which were tested using the partially constrained models, was clearly *intention to use* and *attitude toward use*. These findings suggest that the error term of intention to use and attitude towards use between male and female are different.

Subsequent to theta-delta invariance test, covariance matrix invariance test was performed to determine if the variance of the construct and the covariance between the latent variables are the same between female and male. First, the overall invariance test was performed, then followed by individual invariance tests. In other words, both ϕ_i and ϕ_j were tested for invariance. The results, as shown in Table 8, indicate that the covariance of *attitude* toward Internet banking was significant, meaning that attitude toward e-banking for male and female are very different. For the variance of the perceived ease of usefulness, perceived use and intention to use, there's no significant difference between male and female. So do the relationship between constructs.

From the test on coefficient invariance analysis, with the results shown in Table 9, we could see that male and female do have a different perception of some variables in the TAM model. Clearly, male and female's evaluation of TAM, in the context of Internet banking, resulted in a significant difference in the coefficient for the path peou->attitude, and PU -> attitude. Further investigations are needed to exlore the cause of such difference.

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