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The relationship between perceived e-service quality and brand equity: A simultaneous equations system approach

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ABSTRACT

Using the data collected from the online banking users in Taiwan, we build a hierarchical model of e-banking service quality and investigate the relationships among e-service quality, trust, satisfaction, loyalty, and brand equity. Moreover, the simultaneous equations system approach is also applied to transfer the traditional satisfaction-loyalty path into the simultaneous relationships between trust and loyalty, and between satisfaction and loyalty. As the structural form coefficients demonstrate the direct relations between our research constructs, the reduced form estimates further disclose the total impacts of the quality of e-banking service on trust, satisfaction, loyalty, and brand equity, respectively. The results indicate that the perceived quality formed through interaction with an online banking service positively affects customer trust and satisfaction, which in turn influence loyalty and brand equity. The significant simultaneous relationships between trust and loyalty, and between satisfaction and loyalty, are confirmed by our data, implying that these relationships must be determined simultaneously, rather than sequentially.

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1. Introduction

Electronic banking (e-banking) has changed customer banking behaviors and gradually become an indispensable banking tool. In 2012, one out of four global internet users assessed online banking websites and over 45 percent of the internet audience in North America had online banking service experiences; meanwhile, 5.1% e-banking penetration growth rate in Asia Pacific area also indicates that more and more Asian customers begin to learn and adopt e-banking services (comScore, 2012).

When customers produce services (e.g., check account balance, transfer money, and pay the bills) with self-service technologies (SSTs), their lack of direct interactions with employees during the e-service process would hinder companies from gaining control over service experiences (Sandström, Edvardsson, Kritensson, & Magnusson, 2008). Therefore, e-service providers should pay more attentions to the interactions between SSTs and their users in order to design and offer better services (Venkatesh, Chan, & Thong, 2012).

Served as the determinant of customer experience, service

quality plays an essential role in achieving important outcome including trust, satisfaction and loyalty (Ladhari, 2010; Zhao, Lu, Zhang, & Chau, 2012). To design and deliver suitable quality encounters and outcomes, e-service providers must understand how their decisions affect each “moment of truth” (Sampson & Menor, 2011). However, many technology-based self-services are designed without considering quality defined by user and cause customer dissatisfaction (Venkatesh et al., 2012). Besides, sufficient attention has not been paid to study and examine the formative nature of e-service quality. As suggested in previous studies (Collier & Bienstock, 2006; Ladhari, 2010; Parasuraman, Valarie, & Malhotra, 2005), e-service quality should be considered as customer's formed judgment on e-service offerings and be measured by formative rather than reflective indicators.

On the other hand, when e-service providers seek to differentiate themselves from competitors by enhancing brand values, the brand equity, which has gained significant attention in operations management and information systems studies (e.g., Davis, Golicic, & Marquardt, 2008; Lieb, 2008; Golicic, Fugate, & Davis, 2012; Nah, Eschenbrenner, & DeWester, 2011; Lin & Kao, 2014), has not been discussed and explored thoroughly in e-service. Besides, from the human–computer interaction perspectives, there is also a lack of empirical studies, testing whether hedonic or positive online experiences can lead to brand equity (Nah et al., 2011).

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Even though models of the satisfaction-loyalty chain have been proposed in previous studies, this traditional framework still cannot explain why many satisfied customers eventually switch to competitors (satisfied-defection) and why temporary dissatisfaction may not affect loyalty (dissatisfaction-loyalty) (Buell, Campbell, & Frei, 2010; Chiou & Droge, 2006). This implies that a simple direct causal or path relationship between satisfaction and loyalty may not be sufficient and that important elements might be omitted in this simple relationship. As online banking transactions contain many uncertainties and risks for the customers, trust in the e-banking service has become essential and indispensable. Therefore, we incorporate trust into the traditional chain of satisfaction-loyalty to investigate how this factor affects both satisfaction and loyalty.

In addition, the relationships among trust, satisfaction, and loyalty are always considered sequentially in previous studies; however, this sequential or path scenario could not be true and appropriate (Bennett & Rundle-Thiele, 2004). Instead, according to Lin and Shao (2000), the simultaneity or interdependence methodology may be superior since it allows us to investigate the proposition that the relationships among trust, satisfaction, and loyalty are determined simultaneously. As such, departing from the traditional path analysis, this research aims to develop a simultaneous equations model to investigate the major effects brought about by trust, satisfaction, and loyalty on brand equity.

The remainder of the paper is organized as follows. Section 2 discusses the theoretical background and establishes the hypotheses, while Section 3 develops the simultaneous equations system model. Section 4 describes the data and analyzes the results. Finally, Section 5 discusses managerial implications and concludes the paper with some remarks.

2. Theoretical background and research hypotheses

2.1. Conceptual framework

The cognition–affect–behavior (C–A–B) model provides the clue of the relationships between our research constructs (Buil, Chernatony, & Martínez, 2013; Chang & Chen, 2009; Chiou & Droge, 2006): customers' awareness of e-service quality leads to their attitudes which in turn influence loyalty and brand equity. Thus, customers' judgments of e-service quality (i.e., cognition) formed through interaction with an online banking website positively impact customer trust and satisfaction (i.e., the affect) and, hence, loyalty (i.e., the affect) and brand equity (i.e., behavioral intention). More importantly, the simultaneous relationships between trust and loyalty, and between satisfaction and loyalty must be considered because it is not appropriate to assume particular causal relationships for these attitudinal variables (Bennett & Rundle-Thiele, 2004; Lin & Shao, 2000). Six major constructs and their corresponding interrelationships are depicted in Fig. 1 as our

research framework.

2.2. Quality of e-services

When customers interact solely with user interfaces, quality is regarded as the most important determinant of long-term success in e-service (Zeithaml, Parasuraman, & Malhotra, 2002) because frequent use of e-services could cause the novelty of such offerings to fade away and make customers reluctant to accept inferior service quality (Fassnacht & Koese, 2006). Meanwhile, the paradigm shift from goods-centered to service-dominant logic also exposes the need for companies to deliver high levels of e-service quality in order to achieve superior performance (Klaus & Maklan, 2012). Thereby, consistent delivery of high e-service quality has become a primary source of competitive advantage (Fassnacht & Koese, 2006).

Nonetheless, research in the quality of e-service is still at the initial stage (Ladhari, 2010). According to Rabinovich, Maltz, and Sinha (2008) and Ladhari (2010)'s reviews, most e-service quality dimensions are conceptualized and developed from the perspective of delivery quality (e.g., efficiency, functional quality) and outcome quality (e.g., fulfillment). However, compared to process-oriented delivery quality, outcome quality has not obtained significant attention in this area (Collier & Bienstock, 2006; Fassnacht & Koese, 2006; Ladhari, 2010). Besides, the earlier works on defining e-service quality, including WEBQUAL (Lociacono, Watson, & Goodhue, 2007), SITEQUAL (Yoo & Donthu, 2001a), eTailQ (Wolfinger & Gilly, 2003), e-SERVQUAL (Zeithaml et al., 2002), and E-S-QUAL and E-RecS-QUAL (Parasuraman et al., 2005) have been criticized for not considering the formative nature of e-service quality as these scales are made up of reflective indicators rather than formed attributes (Collier & Bienstock, 2006; Ladhari, 2010). Collier and Bienstock (2006) further point out that using reflective indicators might also cause possible misspecification problems. Therefore, as suggested by Parasuraman et al. (2005), Collier and Bienstock (2006) and Ladhari (2010), it is more suitable to treat the first-order dimensions as formative indicators of the second-order latent constructs. Furthermore, among the e-service quality studies, only Collier and Bienstock (2006) (which investigate e-retailing industry), Fassnacht and Koese (2006) (which discuss homepage services, sports coverage service, and online shopping), and Lu, Zhang, and Wang (2009) (which study mobile service) have developed the hierarchical models to conceptualize quality of e-service. As a result, to fill these research gaps in previous studies, we consider formative constructs, including *delivery quality* and *outcome quality* and revise and distinguish dimensions in these studies to conform to reality in online banking.

2.2.1. Delivery quality

Delivery quality refers to the customers' interaction stage during e-service usage (Collier & Bienstock, 2006; Fassnacht & Koese,

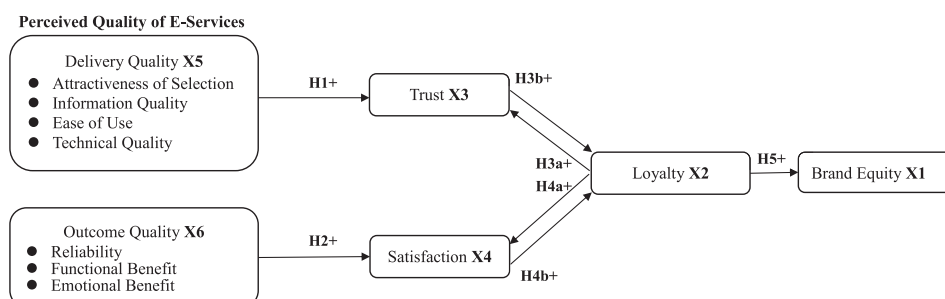


Fig. 1. Conceptual framework.

2006; Lu et al., 2009) and four related sub-dimensions to delivery quality are considered and refined. First, we define *attractiveness of selection* as service options that internet banking providers offer to their customers (e.g., dispute a transaction, order checks, or pay the bills). Second, *information quality* is adopted to measure the degree to which e-banking services could provide comprehensive, precise, and latest information for their users (e.g., account balance history, transaction information, or payment activity). Served as an essential factor in e-service studies, *ease of use* refers to the degree to which internet banking users can obtain information they need or complete the service without a great deal of effort (e.g., customer could pay their credit bills with few clicks). Lastly, we adopt *technical quality* to evaluate the stability of e-banking service that customers perceive during interaction process (e.g., page load speed).

2.2.2. Outcome quality

As service experience has become the essential factor of customers' service quality evaluation (Lee & Wu, 2011), we adopt and revise Fassinacht and Koese (2006)'s three sub-dimensions of *outcome quality*, which incorporates both functional and emotional elements in e-service quality measures, to evaluate customer fulfillment after service delivery process. First, we apply *reliability* to measure the extent to which internet banking service could provide consistent and stable service performance for their users. Next, *functional benefit* is adopted to detect the extent to which the e-banking service accomplishes purposes that it claims to serve. Last, *emotional benefit* is designed to capture user's service experience and to measure the extent to which the online banking service induces customers' pleasant emotions.

2.3. The relationship between delivery quality (X5) and trust (X3)

Acted as a precondition for patronage behavior and the development of long-term customer relationships (Papadopoulou, Andreou, Kanellis, & Martakos, 2001; Singh & Sirdeshmukh, 2000), trust could be even more important in an e-service than it is in a physical store since e-customers do not interact with a company or its staff in an online virtual environment (Chiu, Hsu, Lai, & Chang, 2012; Papadopoulou et al., 2001; Urban, Sultan, & Qualls, 2000). Hence, when customers do trust an online vendor, they are much more likely to share personal information and rely on service providers in an online environment (Jarvenpaa, Tractinsky, Saarinen, & Vitale, 1999; Reichheld & Scheffer, 2000).

Accordingly, Corritore, Kracher, and Wiedenbeck (2003) have defined online trust as "an attitude of confident expectation in an online situation or risk that one's vulnerabilities will not be exploited". For the vendor-buyer relationship in online settings, trust reflects customers' confidences in online services (Ribbink, Riel, Liljander, & Streukens, 2004) and refers to customer's belief that e-service provider is reliable and will not act opportunistically (Chiu et al., 2012).

While service quality in offline environment is considered in terms of the nature of the interaction between service providers and customers (Kelley, Donnelly, & Skinner, 1990; Parasuraman, Zeithaml, & Berry, 1988), delivery quality in e-service pertains to the customer–website interaction during service usage (Fassinacht & Koese, 2006). It is now widely accepted that delivery quality has positive effects on customer evaluations of an organization (Zeithaml, Berry, & Parasuraman, 1996) and Chiou and Droge (2006) also suggest a positive relationship between service quality and trust. Furthermore, in their customer self-service systems study, Huang and Kim (2007) clearly confirm and point out that quality in e-service delivery has positive impacts on e-trust.

While both process and outcome elements of services might

have an impact on customers' trust towards a financial service organization, the main effect of delivery quality on trust is shown to be stronger than outcome service quality (Andreas & Bell, 2008). This points out that the functional elements of service delivery are easier to interpret and are more relevant than the output elements in forming attitudes toward a given service organization. In other words, it can be assumed that service delivery quality has a stronger impact on gaining customer trust in e-banking service. Accordingly, we can hypothesize that:

H1. Delivery quality (X5) has a significant positive influence on customer trust (X3).

2.4. The relationship between outcome quality (X6) and satisfaction (X4)

Based on expectations-disconfirmation theory, customer satisfaction in e-services is seen as an affective response to a purchase or service and customers become satisfied when they are confident that a website would deliver what they expect (Chang & Chen, 2009). As a result, outcome quality serves as the primary determinant to trigger the transaction and to arouse customers' positive feelings of satisfaction (Chang & Chen, 2009; Collier & Bienstock, 2006).

While it might be true that delivery quality would affect customer satisfaction, in traditional service quality researches, Lassar, Manolis, and Winsor (2000) find that most of process-oriented factors in the SERVQUAL do not have significant impacts on overall satisfaction. Meanwhile, in mobile service, Zhao et al. (2012) have argued that after customers familiarize themselves with service procedure, they would switch their attention to the outcome of service process to evaluate and determine their cumulative satisfaction levels.

These researches point out that customers would primarily determine whether they are satisfied according to "what" they receive in the service process rather than "how" the service is delivered. To state equivalently, compared to service delivery, the superior service outcome that exceeds customers' expectations has more potential to create higher customer satisfaction. Therefore, the following hypothesis can be formulated:

H2. Outcome quality (X6) has a significant positive influence on customer satisfaction (X4).

2.5. Simultaneous relationships between trust (X3) and loyalty (X2), and between satisfaction (X4) and loyalty (X2)

In this research, we adopt a simultaneity or interdependent analysis suggested by Lin and Shao (2000). Traditional causal or path relationships do not suffice to analyze the convoluted situation in which different factors, including *trust* (X3), *satisfaction* (X4), and *loyalty* (X2) are interdependent and are actually jointly determined by the independent variables, namely, *delivery quality* (X5) and *outcome quality* (X6).

2.5.1. The relationships between trust and loyalty

Oliver (1997) defines loyalty as "a deeply held commitment to re-buy or re-patronize a preferred product or service consistently in the future despite situational influences and marketing efforts having the potential to cause switching behavior." The concept of e-loyalty extends the traditional loyalty concept to online consumer behavior (Gommans, Krishnan, & Scheffold, 2001). Loyalty in e-service can be seen as a commitment by a customer to a particular brand, website, or online service provider when alternate options

are available (Shankar, Smith, & Rangaswamy, 2003). Chang and Chen (2009) have also argued that online loyalty can be defined as customers' positive attitudes toward e-service websites that influence their repeating buying behaviors. Furthermore, online loyalty or e-loyalty implies that consumers will not switch to another website (Cyr, Bonanni, Bowes, & Ilsever, 2005; Flavián, Guinalíu, & Gurrea, 2006).

While online exchanges or transactions involve numerous risks to customers (Grabner-Kräuter & Kalusha, 2003), building customer trust becomes especially indispensable for companies to cultivate customer loyalty when the perceived risk is high (Anderson & Srinivasan, 2003). Valvi and Fragkos (2012)'s review of e-loyalty also indicates that numerous e-commerce studies (e.g., Chiou, 2004; Flavián et al., 2006) have confirmed the positive relationship between e-trust and e-loyalty. Furthermore, consumer trust in a website is fundamental to loyalty, including customers' online purchase intentions and willingness to buy from an online vendor (Flavián et al., 2006; Gefen, Karahanna, & Straub, 2003; Pavlou, 2003). On the other, in the organization behavior researches, loyalty has also been identified among the determinants of dyadic trust and considered as the antecedent of trust (Butler, 1991; Butler & Cantrell, 1984; Mayer, Davis, & Schoorman, 1995). These arguments and justifications lead to the following hypotheses given by:

H3a. Loyalty (X2) has a significant positive influence on customer trust (X3).

H3b. Customer trust (X3) has a significant positive influence on loyalty (X2).

2.5.2. The relationships between satisfaction and loyalty

Shankar et al. (2003) discover that the positive relationship between satisfaction and loyalty becomes even stronger online than offline. Similarly, Valvi and Fragkos (2012) also argue that e-satisfaction is considered to be the influential factor that affects e-loyalty. More importantly, they also recognize that the relationship between loyalty and satisfaction is reciprocal and interdependent in the online environment (Shankar et al., 2003). Likewise, Bennett and Rundle-Thiele (2004) mention that if both satisfaction and loyalty are conceptualized as latent constructs, the relationship between satisfaction and loyalty is dependent upon situational and psychological factors and they might be formed simultaneously, not sequentially. Therefore, the following hypotheses can be formulated:

H4a. Loyalty (X2) has a significant positive influence on customer satisfaction (X4).

H4b. Customer satisfaction (X4) has a significant positive influence on loyalty (X2).

2.6. The relationship between brand equity (X1) and loyalty (X2)

As *brand* represents a promise of benefits to a customer or consumer, *brand equity* can be seen as the perception or desire that a brand will meet a salient promise of benefits (Raggio & Leone, 2007). In this way, brand equity is considered as "a set of brand assets and liabilities linked to a brand, its name, and symbol, which add to or subtract from the value provided by a product or service to a firm and/or to the firm's customers" (Aaker, 1991, 1996; Merz, He, & Vargo, 2009; Nah et al., 2011). Considered as a multidimensional construct (Aaker, 1991; Keller, 1993; Nah et al., 2011; Pappu, Quester, & Cooksey, 2005; Washburn & Plank, 2002; Yoo & Donthu, 2001b), the customer-based brand equity is specific to consumers

and service users (Keller, 1993; Raggio & Leone, 2007; Rust, Lemon, & Zeithaml, 2004) and is defined as "a set of perceptions, attitudes, knowledge, and behaviors on the part of consumers that results in increased utility and allows a brand to earn greater volume or greater margins than it could without the brand name" (Christodoulides & Chernatony, 2010). Superior to traditional product-focused perspective of brand equity, the customer-based brand equity is therefore selected as our subject of inquiry, which stresses that brand equity is determined by customers through their perceived value-in-use rather than value-in-exchange and is consistent with foundational premises of service-dominant logic (Merz et al., 2009).

In fact, loyalty is the main driver of brand equity since loyalty is considered to be the path that leads to competitive advantages generated from brand equity (Aaker, 1991; Kim, Kim, Kim, Kim, & Kang, 2008). Further, loyal customers reveal more favorable responses to a brand than switching consumers (Grover & Srinivasan, 1992). As a result, loyalty prevent customers from switching to another brand and is known as a core dimension of brand equity (Aaker, 1991; Tong & Hawley, 2009). Based on the above suggested definitions and relationships in the literature, we hypothesize that:

H5. Loyalty (X2) has a significant positive influence on brand equity (X1).

3. Research model and estimation

3.1. The structural form of the SES

According to Lin and Shao (2000), the simultaneous equations system (SES) for this research can be constructed as follows:

$$X1_i = \beta_{10} + \beta_{12}X2_i + \nu_{1i}, \quad i = 1, 2, \dots, n \quad (1)$$

$$X2_i = \beta_{20} + \beta_{23}X3_i + \beta_{24}X4_i + \nu_{2i}, \quad i = 1, 2, \dots, n \quad (2)$$

$$X3_i = \beta_{30} + \beta_{32}X2_i + \beta_{35}X5_i + \nu_{3i}, \quad i = 1, 2, \dots, n \quad (3)$$

$$X4_i = \beta_{40} + \beta_{42}X2_i + \beta_{46}X6_i + \nu_{4i}, \quad i = 1, 2, \dots, n \quad (4)$$

where $X5$ and $X6$ are exogenous variables and refer to as *delivery quality* and *outcome quality*, respectively; $X1$, $X2$, $X3$, and $X4$ are endogenous variables and refer to as *brand equity*, *loyalty*, *trust*, and *satisfaction*, respectively, which are interdependent and have to be determined jointly; and ν_{1i} , ν_{2i} , ν_{3i} , and ν_{4i} are random errors. The simultaneous equations system composed of Equations (1)–(4) is identified because Equation (1) is over-identified while Equations (2)–(4) are just-identified.

3.2. The reduced form

In order to identify particular relationships between the endogenous variables and the exogenous variables, the reduced form of the simultaneous-equations model of this study can be derived as follows. First, we can express the structural form in a matrix formulation given by

$$BY_i + IX_i = V_i, \quad i = 1, \dots, n, \quad (5)$$

where:

$Y_i = (X1_i, X2_i, X3_i, X4_i)'$ is the 4×1 vector of endogenous (jointly dependent) variables;

$X_i = (1, X5_i, X6_i)'$ is the 3×1 vector of exogenous (independent) variables;

$V_i = (v_{1i}, v_{2i}, v_{3i}, v_{4i})'$ is the 4×1 vector of the random disturbances;

$$B = \begin{bmatrix} 1 & -\beta_{12} & 0 & 0 \\ 0 & 1 & -\beta_{23} & -\beta_{24} \\ 0 & -\beta_{32} & 1 & 0 \\ 0 & -\beta_{42} & 0 & 1 \end{bmatrix} \text{ is the } 4 \times 4 \text{ matrix of the un-}$$

known coefficients of the simultaneously determined dependent variables; and,

$$\Gamma = \begin{bmatrix} -\beta_{10} & 0 & 0 \\ -\beta_{20} & 0 & 0 \\ -\beta_{30} & -\beta_{35} & 0 \\ -\beta_{40} & 0 & -\beta_{46} \end{bmatrix} \text{ is the } 4 \times 3 \text{ matrix of the unknown co-}$$

efficients of the exogenous variables, where B is nonsingular, implying the existence of B^{-1} .

Second, pre-multiplying (5) through by B^{-1} , we can obtain the reduced form in a matrix formulation as follows:

$$Y_i = \Pi X_i + W_i, \quad i = 1, \dots, n, \quad (6)$$

where

$$\Pi = -B^{-1}\Gamma = \begin{bmatrix} \pi_{10} & \pi_{11} & \pi_{12} \\ \pi_{20} & \pi_{21} & \pi_{22} \\ \pi_{30} & \pi_{31} & \pi_{32} \\ \pi_{40} & \pi_{41} & \pi_{42} \end{bmatrix} \text{ is the } 4 \times 3 \text{ matrix of the reduced-}$$

form coefficients; and,

$W_i = B^{-1}V_i$ is the 4×1 matrix of the reduced-form disturbances.

Finally, Equation (6) indicates that the reduced form is composed of four equations, analogously to (1) to (4), given by

$$X1_i = \pi_{10} + \pi_{11}X5_i + \pi_{12}X6_i + \omega_{1i} \quad (7)$$

$$X2_i = \pi_{20} + \pi_{21}X5_i + \pi_{22}X6_i + \omega_{2i} \quad (8)$$

$$X3_i = \pi_{30} + \pi_{31}X5_i + \pi_{32}X6_i + \omega_{3i} \quad (9)$$

$$X4_i = \pi_{40} + \pi_{41}X5_i + \pi_{42}X6_i + \omega_{4i} \quad (10)$$

From these equations, we can observe the relationships between the endogenous variables ($X1$, $X2$, $X3$, and $X4$), the exogenous variables ($X5$ and $X6$), and the disturbances more clearly. Compared to structural form equations, which merely indicate *direct* relationship between research variables, the reduced form equations provide detailed information about *total* effects of the exogenous variables on an endogenous variable, which include not only the direct effects but also indirect effects of *delivery quality* and *outcome quality* on *brand equity*, *loyalty*, *satisfaction*, and *trust*. In other words, the reduced form coefficients give the full effects of the changes in the exogenous variables on an endogenous variable.

3.3. Estimation method

To estimate the SES model, the ordinary least squares (OLS) estimation method is not appropriate because the OLS estimators of the structural coefficients are biased and inconsistent due to the so-called simultaneity bias (or simultaneous equations bias) which would cause either the underestimation or the overestimation problem in coefficient estimation. Instead, the methods of two-stage least squares (2SLS) and three-stage least squares (3SLS) should be applied. According to Bowden and Turkington (1984), the methods of 2SLS and 3SLS are equivalent to the instrumental variables (IV) method. Even though there are still no clear guidelines for choosing proper instruments, Brundy and Jorgenson (1971) suggest that instrumental variables include the predetermined variables and composite variables constructed from the predetermined variables. Therefore, in this study, we choose the

exogenous variables ($X5$ and $X6$) as our instrumental variables since these exogenous instruments are uncorrelated with the error terms (v_{1i} , v_{2i} , v_{3i} , and v_{4i}) and highly correlated the endogenous variables ($X1$, $X2$, $X3$, and $X4$). Moreover, in order to avoid the problem caused by the “weak” instruments, we also test the strength of our instruments and find that the first-stage F-statistics of our instrument variables ($X5$ and $X6$) are all greater than ten (Staiger & Stock, 1997), implying that these instrumental variables are not poor predictors of the endogenous variables in the first-stage estimations.

According to Zellner and Theil (1962) and Lin and Shao (2000), the major difference between 2SLS and 3SLS lies in the fact that 2SLS is a single-equation method while 3SLS is a system procedure. If the random errors of these equations are highly correlated, then 3SLS is more appropriate than 2SLS because it would produce more efficient estimates. For purpose of comparison, the proposed SES model was estimated using OLS, 2SLS, and 3SLS.

3.4. Construct definitions and measurements

Six construct definitions are operationalized in this study: the two dimensions of the quality of e-services, including *delivery quality* and *outcome quality* and the related constructs, including *trust*, *satisfaction*, *loyalty*, and *brand equity*. A questionnaire is designed to measure these six research constructs; the items for delivery quality and outcome quality are mainly derived from Collier and Bienstock (2006) and Fassnacht and Koese (2006) with slight revisions. The scales for satisfaction and trust are adapted from Collier and Bienstock (2006) and Gefen and Straub (2003), respectively, while the items to assess loyalty and brand equity are based on Yoo, Donthu, and Lee (2000). Each item is measured on a seven-point Likert scale ranging from (1) Strongly Disagree to (7) Strongly Agree.

4. Data and estimation results

4.1. Sample characteristics

The empirical data was collected in the end of 2010 by an online survey, which targets internet banking users in Taiwan. This is a convenience sampling method and is particularly appropriate for research in human behavior on the Internet (Chang & Wang, 2008). After the pilot test, the formal questionnaire was launched on the online survey platform owned by Telecommunication Laboratories, Chunghwa Telecom Co., Ltd. Out of 351 responses, 59 questionnaires are eliminated due to incomplete answers or inconsistent manners identified in respondents' responses. Hence, the response rate is 83.1% (Fan & Yan, 2010), and 292 valid responses are used for further analysis. Table 1 presents sample characteristics measured in the survey. Among these respondents, 127 (43.5%) are female and their ages are under 30 (84.0%). It is also worth noting that 71% of participants have one to two years of e-banking experiences and most of respondents (82.0%) used online banking services in the past six months and their frequently used online banking features are balance inquiry and money transfer services (92%).

4.2. Empirical assessment of research constructs

Since our study consists of first-order and second-order factors, a series of confirmatory factor analyses (CFA) are adopted to develop an effective measurement model by using AMOS 18. We first examine the reliability and validity of the first-order factors, which represent the dimensions of the second-order constructs including *delivery quality* and *outcome quality*. In the next step, we apply the second-order CFA to test reliability and validity of our second-order factors along with other constructs including *trust*,

Table 1
Sample characteristics (N = 292).

Variable		Percentage (%)
Gender	Male	57%
	Female	43%
Age	Under 20	5%
	21–24	48%
	25–29	36%
	30–34	9%
	35–39	1%
	Over 41	1%
Education	Primary Education	0%
	Secondary Education	1%
	Vocational Education	51%
	Higher Education	49%
Salary (US dollar/Year)	Below 3600	43%
	3600 to 6000	18%
	6000 to 8400	8%
	8400 to 12,000	11%
	12,000 to 16,800	11%
	Over 16,800	9%

Note: N = 292.

satisfaction, loyalty, and brand equity. The results of the first-order and second-order CFAs are summarized in Tables 2 and 3, respectively.

In the first-order CFA measurement model, the chi-square is significant ($p < 0.001$) and $\chi^2/df = 2.318$, which suggests that the internal consistency between the observations and the theoretical model has been achieved. Meanwhile, CFI (=0.962), the GFI (=0.915) and NFI (=0.937) reach the recommended levels. The other indexes, including AGFI (=0.864), RMR (=0.058), and RMSEA (=0.067) are slightly lower or higher than the recommended value. In Table 2, most of composite reliability (CR) estimates are higher than 0.8, which indicates that a high degree of internal consistency exists among the corresponding indicators. Convergent validity is also achieved as all standardized loadings are relatively high and significant (from 0.724 to 0.925) and the average variance extracted (AVE) values of seven first-order constructs reach the

recommended 0.5 value (Bagozzi & Yi, 1988).

Moving on to the second-order CFA model, we find that the internal consistency is also achieved as the chi-square is significant ($p < 0.001$) and $\chi^2/df = 1.784$. While CFI (=0.953), GFI (=0.847), and RMSEA (=0.052) reach the recommended levels, NFI (=0.899), RMR (=0.078), and AGFI (=0.814) are slightly lower or higher than the recommended value. In Table 3, high reliability of our research constructs is attained as all standardized loadings are significant at the 0.01 level and most CR values are higher than 0.9 except for loyalty (0.831). Additionally, AVE values of the second-order factors and other research constructs including trust, satisfaction, loyalty, and brand equity are all higher than the recommended 0.5 levels.

Tables 4 and 5 display the square roots of the AVE values for both first-order and second-order constructs in the diagonal. Below the diagonal are the correlations between two different constructs. As all of the square roots of the AVE are greater than the correlations between any two constructs of interest, the discriminate validity is achieved and secured in our first-order and second-order measurement models.

After the reliability and validity of the constructs have been examined, the scaling of the seven intervals is quantified by assigning the values -3, -2, -1, 0, 1, 2 and 3 to the intervals (Bailey & Pearson, 1983). Following and revising the procedure proposed by Bailey and Pearson (1983) and Lin and Shao (2000), we compute scores (S_i) for our variable $X1_i, X2_i, X3_i, X4_i, X5_i,$ and $X6_i$ using the following formula:

$$S_i = \frac{1}{n} \sum_{j=1}^n R_{ij} \text{ and } R_{ij} = \frac{1}{k} \sum_{i=1}^k I_{i,j,k}$$

where R_{ij} is the reaction to factor j by individual i and $I_{i,j,k}$ is the numeric response of user i to item k of factor j .

4.3. Estimation results and test conclusions

Using the SAS 9.2 statistical software package, we have applied three estimation methods, OLS, 2SLS, and 3SLS, to estimate

Table 2
First-order confirmatory factor analysis and reliability (N = 292).

Construct	Standardized loading	t-value	Average Variance extracted ^a	Composite reliability ^b
Attractiveness of Selection				
DQ1: Internet banking offers a wide range of services.	.775	14.549	0.714	0.832
DQ2: Internet banking offers a complete selection of services.	.910	–		
Information Quality				
DQ3: Information provided is up-to-date.	.804	15.740	0.690	0.817
DQ4: Information provided is easy to understand.	.857	–		
Ease of Use				
DQ5: Internet banking provides all the information necessary.	.726	13.214	0.571	0.842
DQ6: Internet banking directs the customer step by step.	.728	13.242		
DQ7: When using internet banking, the customer has full control at all times.	.770	13.222		
DQ8: Only a few clicks are needed in order to complete the service through internet banking.	.797	–		
DQ9: It does not take much time to learn to handle internet banking.	.757	13.196		
DQ10: Internet banking is always up and running.	.752	14.715		
Technical Quality				
DQ11: Data transfer is stable.	.810	16.469	0.643	0.878
DQ12: Pages load properly.	.882	–		
DQ13: Pages load properly.	.882	–		
Reliability				
OQ1: Service performance of internet banking is as desired.	.828	15.719	0.656	0.792
OQ2: Service performance of internet banking is absolutely reliable.	.791	–		
Functional Benefit				
OQ3: Internet banking serves its purpose very well.	.898	16.404	0.713	0.832
OQ4: Internet banking is an easy way to do banking business.	.787	–		
Emotional Benefit				
OQ5: Using internet banking feels like staying on the internet banking site.	.724	11.529	0.690	0.814
OQ6: Using internet banking is fun.	.925	–		

^a AVE = average variance extracted ≥ 0.5 .

^b CR = Composite reliability ≥ 0.7 .

Table 3
Second-order confirmatory factor analysis and reliability (N = 292).

Construct	Standardized loading	t-value	Average Variance extracted ^a	Composite reliability ^b
Delivery Quality			0.751	0.923
Attractiveness of Selection	.786	–		
Information Quality	.915	13.607		
Ease of Use	.959	13.239		
Technical Quality	.769	11.929		
Outcome Quality			0.757	0.901
Reliability	.990	–		
Functional Benefit	.941	13.237		
Emotional Benefit	.659	11.562		
Trust			0.601	0.913
Tru1: Based on my experience with internet banking in the past, I know it is honest.	.738	–		
Tru2: Based on my experience with internet banking in the past, I know the bank cares about customers.	.799	13.748		
Tru3: Based on my experience with internet banking in the past, I know the bank is not opportunistic.	.683	13.173		
Tru4: Based on my experience with internet banking in the past, I know the bank provides good service.	.873	15.111		
Tru5: Based on my experience with internet banking in the past, I know it is predictable.	.840	14.591		
Tru6: Based on my experience with internet banking in the past, I know it is trustworthy.	.808	13.907		
Tru7: Based on my experience with internet banking in the past, I know it knows its market.	.644	10.859		
Satisfaction			0.842	0.941
Sat1: In general I (am/was) happy with the service experience.	.892	–		
Sat2: In general, I was pleased with the quality of the service that this internet bank provided.	.958	27.637		
Sat3: I was satisfied with the service this internet bank provided.	.900	23.783		
Loyalty			0.633	0.831
Loy1: I consider myself to be loyal to this internet bank.	.899	–		
Loy2: This internet bank would be my first choice.	.906	20.688		
Loy3: I will not use other bank brands if this internet bank is available.	.534	9.894		
Brand Equity			0.827	0.950
BE1: It makes sense to use this internet bank instead of any other brand, even if they are the same.	.867	–		
BE2: Even if another brand has same features as this internet bank, I would prefer to use this internet bank.	.910	21.901		
BE3: If there is another brand as good as this internet bank, I prefer to use this internet bank.	.963	20.128		
BE4: If another brand is not different from this internet bank in any way; it seems smarter to use this internet bank.	.894	21.145		

^a AVE = average variance extracted ≥ 0.5.

^b CR= Composite reliability ≥ 0.7.

Table 4
Discriminate validity analysis (first-order CFA).

First-order CFA construct	Inter-construct correlations ^a						
	AS	IQ	EU	TQ	RE	FB	EB
Attractiveness of Selection (AS)	0.845						
Information Quality (IQ)	0.802	0.831					
Ease of Use (EU)	0.761	0.809	0.756				
Technical Quality (TQ)	0.680	0.753	0.742	0.802			
Reliability (RE)	0.730	0.727	0.726	0.714	0.810		
Functional Benefit (FB)	0.651	0.660	0.686	0.742	0.800	0.844	
Emotional Benefit (EB)	0.514	0.566	0.655	0.479	0.658	0.647	0.831

^a Diagonal elements (in italics) represent the square roots of the AVE's for individual constructs.

simultaneous Equations (1)–(4). While R squares of Equations (1)–(4) can be computed in OLS and 2SLS, the system weighted R² is provided in the 3SLS model (Table 6). The estimation results by OLS, 2SLS and 3SLS are summarized in Fig. 2, Tables 6 and 7. We can observe from Table 6 that the simultaneous equation bias appears

in the OLS estimates since most of them are overestimated and, consequently, are higher than those counterparts of both the 2SLS and 3SLS estimates. Furthermore, when comparing the OLS estimates with those of 2SLS and 3SLS (Fig. 2), we also find that the simultaneity bias creates different significant patterns, suggesting

Table 5
Discriminate validity analysis (second-order CFA).

Second-order CFA construct	Inter-construct correlations ^a					
	DQ (X5)	OQ (X6)	SAT (X4)	TRU (X3)	LOY (X2)	BE (X1)
Delivery Quality (X5)	0.867					
Outcome Quality (X6)	0.795	0.870				
Satisfaction (X4)	0.783	0.848	0.917			
Trust (X3)	0.748	0.674	0.753	0.775		
Loyalty (X2)	0.605	0.586	0.601	0.584	0.796	
Brand Equity (X1)	0.545	0.430	0.506	0.577	0.711	0.909

^a Diagonal elements (in italics) represent the square roots of the AVE's for individual constructs.

that the OLS estimation cannot effectively solve the simultaneous equation bias problem and the bias not only leads to the biased and inconsistent estimates but also creates the overestimation phenomenon. Therefore, as expected, 2SLS and 3SLS are more appropriate than OLS to estimate the structural coefficients in Equations (1)–(4).

Comparing the estimates obtained from 2SLS and 3SLS, we find that the coefficient estimates of 3SLS tend to be more significant than 2SLS; and this confirms that 3SLS is more efficient than 2SLS as the random errors of the structural Equations (1)–(4) are significantly correlated (see Table 8). In other words, 3SLS estimates are more efficient than their 2SLS counterparts. Therefore, the following conclusions of hypothesis testing are drawn from the 3SLS estimates.

First of all, in Hypotheses 1 and 2, which are relative to the effects of quality of e-service on trust and satisfaction, we find that delivery quality has a significant effect ($\beta_{35}^{3SLS} = 0.371^{**}$; $p < 0.01$) on trust, thereby H1 is empirically supported. Similarly, the outcome quality does have significant effect on satisfaction ($\beta_{46}^{3SLS} = 0.248^{**}$; $p < 0.01$) and, consequently, H2 is also confirmed.

For Hypotheses 3a and 3b, which aim to test whether the simultaneous relationships exists between trust and loyalty, our results indicate that loyalty has a positive relationship with trust ($\beta_{32}^{3SLS} = 0.413^{**}$; $p < 0.01$) and trust exerts positive impact on loyalty ($\beta_{23}^{3SLS} = 0.390^*$; $p < 0.05$); hence, our H3a and H3b are not rejected. Since the simultaneous relationships do exist, the relationships between loyalty and trust are determined simultaneously rather than sequentially. This evidence strongly suggests the appropriateness of the simultaneous equations system approach. These simultaneous relationships simply cannot be discovered and confirmed by the traditional path or regression analysis approach.

Turning to our Hypotheses 4a and 4b, we again observe the similar results as shown in H3a and H3b. In other words, the simultaneous relationships between loyalty and satisfaction were also confirmed by the 3SLS estimates ($\beta_{42}^{3SLS} = 0.979^{**}$, $p < 0.01$; $\beta_{24}^{3SLS} = 0.494^{**}$, $p < 0.01$).

Finally, we could identify from significant β_{12} (with $\beta_{12}^{3SLS} = 0.993^{**}$; $p < 0.01$) that the loyalty has a positive and significant effect on brand equity; thus, this evidence supports our Hypothesis 5. Table 9 summarized the 3SLS estimates with their corresponding t-values and the test conclusions.

4.4. Total effects of exogenous variables on the jointly dependent variables

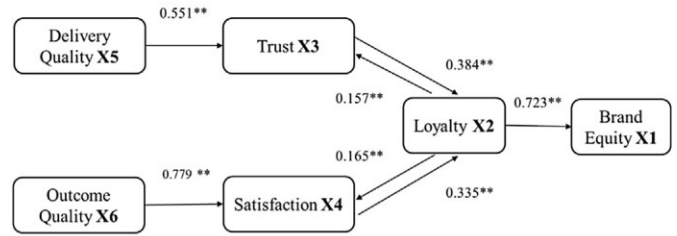
As we have mentioned above, the simultaneous equations system approach can not only deal with the problem of simultaneity bias but also provides the information concerning the total effects of exogenous variables on the jointly dependent variables. Both the 2SLS and 3SLS reduced-form coefficients are given in our Table 10. We first notice from this table that the signs of both the 2SLS and 3SLS estimates are all correct. Nonetheless, when comparing the reduced form coefficients of both 2SLS and 3SLS, we identify that in

Table 6 R squares of OLS, 2SLS, and 3SLS models.

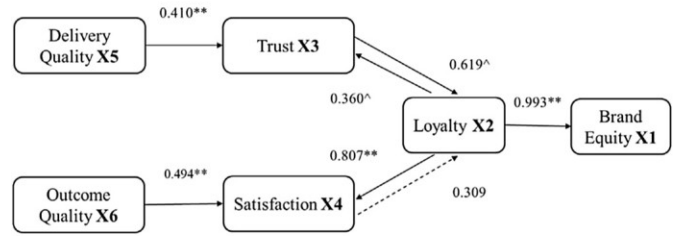
Equation	1	2	3	4	System
OLS	0.4945	0.3002	0.6125	0.4875	N.A.
2SLS	0.3132	0.2722	0.4383	0.4465	N.A.
3SLS	N.A.	N.A.	N.A.	N.A.	0.5425

Note: N.A. = Not Available.

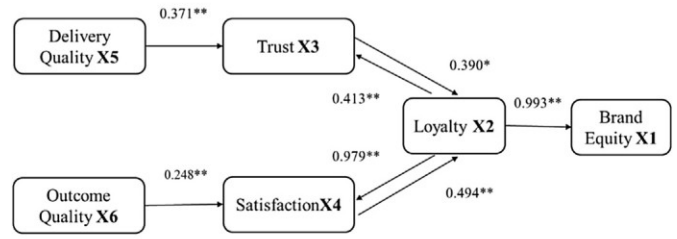
1. OLS



2. 2SLS



3. 3SLS



^ significant at the 0.1 level, * significant at the 0.05 level, and ** significant at the 0.01 level.

Fig. 2. Results of OLS, 2SLS, and 3SLS estimations.

Table 7 Estimates of the structural coefficients.

Hypothesis	1	2	3a	3b	4a	4b	5
Coefficient	β_{35}	β_{46}	β_{32}	β_{23}	β_{42}	β_{24}	β_{12}
OLS	0.551**	0.779**	0.157**	0.384**	0.165**	0.335**	0.723**
2SLS	0.410**	0.494**	0.360 [^]	0.619 [^]	0.807**	0.309	0.993**
3SLS	0.371**	0.248**	0.413**	0.390*	0.979**	0.494**	0.993**

[^]p < 0.1; *p < 0.05; and **p < 0.01.

3SLS, the total effects created by outcome quality and are greater than their 2SLS counterparts. This means that without considering the correlations among residuals, 2SLS underestimates the total effects produced by outcome quality, suggesting that 3SLS is more efficient and more appropriate than 2SLS.

Table 8 Correlations of the structural equation errors.

Error term	Correlations			
	ν_1	ν_2	ν_3	ν_4
ν_1	1			
ν_2	-0.486***	1		
ν_3	0.407***	-0.872***	1	
ν_4	0.356***	-0.710***	0.456***	1

*p < 0.05; **p < 0.01; and ***p < 0.001.

5. Managerial implications and concluding remarks

5.1. Managerial implications

As little research examines the relationship between service quality and brand equity in the online banking environment, this study intends to bridge the gap by proposing a hierarchical model to conceptualize the quality of e-service and investigating relations among perceived e-service quality, trust, satisfaction, loyalty, and brand equity. Since it is inappropriate to assume particular causal relationships for psychological factors, including trust, satisfaction, and loyalty, we have proposed the simultaneous equations system approach to expand the traditional path pattern of the satisfaction-loyalty chain to analyze the simultaneous relationships between trust and loyalty, and between satisfaction and loyalty. The significant simultaneous relationships are confirmed by our data and suggest that these relationships must be determined simultaneously, rather than sequentially. The major findings and managerial implications are summarized and stated as follows.

First, the hierarchical model of e-service quality has been supported and confirmed by our data, suggesting that quality of e-banking service should be treated as a formed attribute and measured by formative constructs, including delivery quality and outcome quality. Hence, when increasing the reliance on customers, internet banking service providers should review the key design of their self-services periodically to compare customers' expectations with delivered attribute performance and remove the deficiencies in the provision of superior service quality, since the features of e-services would consequently affect users' formative judgments on their perceived quality of e-banking service.

Second, superior to the traditional path-regression method, the SES approach allows researchers to not only observe the direct relationships between research constructs but also obtain the total effects of the exogenous variables on the endogenous variables. In other words, while the structural form coefficients demonstrate the direct relations between six constructs, the reduced form estimates further disclose the total impacts (direct effects and indirect effects) and the full effects of a change brought by the quality of e-service on the endogenous variables including trust, satisfaction, loyalty, and brand equity, respectively.

The significant structural paths among perceived e-service quality, trust, and satisfaction suggest that delivery quality and outcome quality exert direct positive influences on customer trust and satisfaction, respectively. On the other hand, the reduced-form estimates indicate that increases in the delivery quality and the outcome quality could generate positive values for the e-service brand and influence brand equity. Compared to outcome quality, delivery quality reveals greater total impacts on trust, loyalty, and brand equity, indicating that e-service delivery (e.g., selection of services; information quality; ease of use) would make customers have a biased overall e-service quality evaluation before service outcomes occur since delivery quality offers the customers very

Table 10

Estimates of the reduced-form coefficients.

Coefficient	Method	
	2SLS	3SLS
π_{10}	-0.442	-0.521
π_{11}	0.476	0.406
π_{12}	0.223	0.344
π_{20}	-0.492	-0.571
π_{21}	0.480	0.409
π_{22}	0.224	0.346
π_{30}	0.317	0.284
π_{31}	0.582	0.540
π_{32}	0.081	0.143
π_{40}	0.317	-0.031
π_{41}	0.582	0.400
π_{42}	0.081	0.587

initial expectations of e-service providers' capabilities of fulfilling their service needs. Meanwhile, e-banking managers should also improve outcome quality (e.g., functional benefit; emotional benefit) since customers would move their attentions to service outcomes and determine their cumulative satisfaction levels after they become familiar with e-banking process.

The SES approach also allows us to examine the simultaneous relationships between trust and loyalty, and between satisfaction and loyalty. Our results indicate that not only trust and satisfaction have positive impacts on loyalty but loyalty itself can also enhance trust and satisfaction. As a result, the traditional satisfaction-loyalty path is neither sufficient nor adequate, thus supporting the viewpoint of [Delgado-Ballester and Munuera-Alemán \(2005\)](#) that not to control for the effect of trust on loyalty could result in attributing excessive importance to satisfaction when trust is the key variable in maintaining the long-term relationship; therefore, trust should be considered in this simple relationship in order to explain the satisfied-defection and dissatisfaction-loyalty scenarios. More importantly, our results also suggest that the impacts of trust, satisfaction, and loyalty should be determined simultaneously rather than sequentially. In other words, it is not appropriate to assume particular causal relationships for these attitudinal variables ([Bennett & Rundle-Thiele, 2004](#); [Lin & Shao, 2000](#)). Managers should, therefore, consider interrelated effects among trust, satisfaction, and loyalty simultaneously, for their relationships might be convoluted and mixed, and cannot be discovered by the traditional path or regression analysis approach.

Lastly, brand equity in e-banking could be considered as an outcome of customer learning procedures: customers perceive service quality through interaction with online banking websites; these online service experiences then affect their trust and satisfaction toward e-banking service, which influence their wills and likelihood to develop loyalty. Finally, loyalty will lead to brand equity, which allows online banking providers to obtain superior performance and earn greater margins. As a result, this framework could be served as a useful guide for e-banking managers who seek

Table 9

Results of hypothesis testing.

Hypothesis	Causal Path	Path coefficient	t-value	Supported? Yes or No
H1	Delivery Quality → Trust	0.371	3.72**	Yes
H2	Outcome Quality → Satisfaction	0.248	3.12**	Yes
H3a	Loyalty → Trust	0.413	2.93**	Yes
H3b	Trust → Loyalty	0.390	2.22*	Yes
H4a	Loyalty → Satisfaction	0.979	7.93**	Yes
H4b	Satisfaction → Loyalty	0.494	4.05**	Yes
H5	Loyalty → Brand Equity	0.993	11.57**	Yes

*p < 0.1; *p < 0.05; and **p < 0.01.

to differentiate their services and enhance the values of their brands, for not only does it display the sequences of brand equity building events but it also discloses the relations between e-service quality and brand equity.

5.2. Directions for future research

This study has developed a simultaneous equations system model and provided some important implications for assessing e-banking service quality and enhancing brand equity. In closing, we can offer some extensions to this study for future investigations. First, our research hypotheses are tested using the data from internet banking users in Taiwan. There are still other e-services that are not covered in this study. As a result, researchers may investigate other e-service sectors (e.g., e-government) using the research model proposed here. Additionally, different results might be obtained when the proposed research method is applied to other countries since cultural differences might cause the diverse customers' perceptions of the quality of e-services.

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