Testing the predictive power of PLS through cross-validation in banking

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Con formato: Fuente de párrafo predeter.

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Abstract

This paper aims to predict the relationship quality (satisfaction, trust, and commitment) of a customer with a Spanish saving bank by using both the quality of service operations and the usage of e-banking, on the relationship quality (satisfaction, trust, and commitment) of a customer with a Spanish saving bank. ~~This paper aims to analyze the effects of the quality of service operations, combined with the usage of e-banking, on the relationship quality (satisfaction, trust, and commitment) of a customer with a Spanish saving bank.~~ A competitive strategy follows testing three alternative models employing PLS path modeling with a primary dataset obtained through both an online survey and internal bank databases of almost one thousand customers. This study includes the predictive validation of models using hold out samples and testing for casual asymmetry. The results indicate that both the quality of service operations and the customer's use of e-banking successfully and independently contribute to predict the customer's relationship quality. The face-to-face service encounter is still the major contributor of relationship quality, but the use of e-banking tools also improves the relationship quality of customers in the banking industry. This model is consistent across a multi-group of customers.

Keywords: *banking; quality of service operations; relationship quality; mediation analysis; e-banking.*

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Banks are constantly seeking new ways to add value to their services because financial services compete in a global marketplace with generally undifferentiated products. In this regard, technological changes are causing banks to rethink their strategies for services offered to customers, providing new ways to differentiate themselves from the competition (Hossain & Shirely, 2010). The process of developing and enhancing relationships traditionally takes place through personal interaction. However, the information revolution provides alternative ways of creating and maintaining relationships with customers (Rust & Kannan, 2003). Indeed, the impact of technology on relationship quality (RQ) brings new opportunities for researchers and practitioners alike (Lang & Colgate, 2003). The former one channel branch network has changed to a "multi-channel" configuration where branches coexist with other service delivery channels (Martínez, Ortega & Román, 2007).

By developing technological channels, banks can lower costs, attract new customers, and increase income from existing customers. At the same time, financial customers gain in convenience, since they can carry out operations without time and place constraints, as well as obtaining lower commissions or better interest rates. Nevertheless, activities to promote e-banking should take into account that most customers do not rely on a single channel, but a combination of channels (Martínez et al., 2007).

Some evidence exists of the role that RQ plays in adopting e-banking. For instance, Rotchanakitumnuai and Speece (2003) find that trust is the key factor influencing the adoption of electronic banking. Similarly, as satisfaction has a significant impact on trust and commitment, they altogether enhance the likelihood to use e- banking (Rexha, Kingshott & Aw, 2003). On the other hand, customers using e-banking represent a very attractive segment as they own more financial products than traditional customers. How does this usage level of e-banking affect the customer relationship with the bank? What is the relative influence of face-to-face operations when a multichannel setting is in place? Do significant differences

exist between customers showing high levels of usage of electronic banking and those showing low levels of usage of this channel? Do any other differences exist among customers due to socio-demographic or economic variables? Actually, few authors have investigated whether the usage of IT-based channels may have detrimental or positive effects on a firm's RQ with its customers (Lang & Colgate, 2003).

The main research objective of this paper is to analyze the predictive role that ~~of~~ both the use of e-banking and ~~in combination with~~ the quality of face-to-face service operations have in the prediction of the customers' RQ variables (satisfaction, trust, commitment). To address this research aim, the proposal of three alternative models follows a competitive strategy. The first model considers the customer's level of usage of e-banking as a mediator between the quality of service operations and RQ. The second model explores if the customer's level of usage of e-banking moderates the relationship between the quality of service operations and RQ. Finally, the third model examines what is the independent effect of the customer's level of usage of e-banking and the quality of service operations on RQ. ~~The methodology employs PLS path modeling with a primary dataset provided by a major savings bank in Spain, including the predictive validation of models using hold out samples and testing for casual asymmetry.~~

To carry out the above objective this paper used partial least squares (PLS) path modeling (Henseler, Hubona & Ray, 2016), including the predictive validation of models using 10-fold cross-validation procedure and testing for casual asymmetry. Through this research design and procedures this study seeks foster and enhance the use of PLS from a predictive point of view.

2.1. Service ~~q~~Quality and the use of e-banking

Perceived quality is one of the highly debated topics in marketing theory (Spreng & Mackoy, 1996). In today's world, the key to sustainable competitive advantage for service companies lies in delivering high quality service that will result in satisfied and loyal customers (Shemwell, Yavas & Bilgin, 1998), because service quality is an essential pillar in service value creation (Martín, Gremler, Washburn & Cepeda, 2008). Since the competition finds it difficult to imitate service quality (Parasuraman & Grewal, 2000), this component represents a source of differentiation (Berry, 1995) and competitive advantage (Reichheld & Sasser, 1990).

Banks delivering superior service quality can have a distinct marketing edge since improved levels of service quality yield higher revenues, increased cross-selling ratios, higher customer retention (Bennett & Higgins, 1988), and an expanded market share (Bowen & Hedges, 1993). Banks should focus on delivering service quality as a core competitive strategy (Chaoprasert & Elsey, 2004) in order to improve customer loyalty (Newman, 2001), and attract new customers through positive word of mouth (Wang, Lo & Hui, 2003).

Meanwhile, the recent technological revolution has changed the way to access many services and, in consequence, how customers evaluate service quality through electronic channels. In this sense, researchers nowadays try to conceptualize and measure electronic service quality in an attempt to understand how customers perceive and evaluate online services (Barrera & Cepeda, 2014).People currently use Information Technology in almost every field of life including the banking sector (Rasheed & Latif, 2011). A definition of e-service quality is "the customer's overall evaluation and judgment of the excellence and quality of e-service offering in the virtual marketplace" (Santos, 2003). When face-to-face encounters are difficult to arrange, the relationship develops through technological interfaces.

Studies show that availability, efficiency fulfillment, and privacy positively influence the intention to use e-banking (Parasuraman, 2000; Liao & Cheung, 2002; Akinci, Aksoy & Atilgan, 2004). The physical separation of the bank office and the customer, as well as the overall environment of perceived insecurity when carrying out electronic transactions on the Internet, provide unique challenges to online banks in the developing of e-business relationships. Indeed, the use of technology also raises concerns of confidentiality, anxiety, and stress for some customers (Bitner, Brown & Meuter, 2000).

2.2. Predicting r~~R~~elationship quality

Given that the core service offered by banks may be essentially the same, developing long-term relationships with customers can provide successful differentiation. In financial services, the view of loyalty is in relation to the length of time a customer remains with its service provider, the number of services used and the frequency of service usage (Fragata & Moustakas, 2013). By keeping a loyal base of customers, banks obtain three benefits. Firstly, the cost of acquiring customers should decrease, since replacing deserters with new customers as a result of word-of-mouth is cheaper than attracting customers through marketing efforts. Secondly, loyal customers are less price-sensitive, which enables the obtaining of higher profit margins if necessary. Finally, a loyal customer is likely to respond better to a bank's cross-selling strategies, generating more profits for the company (Barcellos, Fossati & Silva, 2009).

Banks understand that customers are likely to be loyal if they receive a superior value from them than from their competitors (Dawes & Swailes, 1999). On the other hand, banks can obtain higher profits if they are able to position themselves better than the competition within a specific market (Davies, Moutinho & Curry, 1995). To enhance loyalty, banks must satisfy customer demands, which are increasing given the growing competition in internet banking.

Indeed, both the banks providing e-banking services and their customers can benefit from a high quality relationship (Alawneh, 2012).

The focus of RQ is on long-term relationships rather than on short-term transactions. RQ refers to the overall assessment of the strength of a relationship between two parties (Palmatier, Dant, Grewal & Evans, 2006). Commonly, RQ represents a multidimensional construct, and a high-order combination of customer satisfaction, trust and commitment (Hennig-Thurau, Gwinner & Gremler, 2002; Ulaga & Eggert, 2006). According to Garbarino and Johnson (1999), satisfaction, trust, and commitment have different roles in determining the future of the customer relationship.

Satisfaction is "an evaluation of the perceived discrepancy between prior expectations and the actual performance of the product" (Oliver, 1999). The satisfaction component of RQ is about the users' evaluation of the relationship with the service provider. Similarly, dissatisfaction among customers using e-banking services might happen due to technological failure, technology design problems, or service design problems, which may result in a negative perception of the service's functional quality (Meuter, Ostrom, Roundtree & Bitner, 2000). Dissatisfied customers are more prone to defect than satisfied customers (Barcellos et al., 2009).

Customer commitment is the enduring desire to maintain a valued relationship (Palmatier et al., 2006). A committed customer invests time and effort in the relationship with a service provider, shows affection for this relationship, and is willing to maintain it in the future. Committed customers are more likely to become long-term loyal customers, since a committed partner wants the relationship to endure indefinitely and is willing to work at maintaining it. Commitment has an instrumental component of some sort of investment, an attitudinal component or psychological attachment, and a temporal dimension indicating that the relationship exists over time (Morgan & Hunt, 1994). As commitment entails

vulnerability, the parties only seek trustworthy partners.

Trust is the cornerstone of a strategic partnership. Trust exists when one party has confidence in an exchange partner's reliability and integrity (Morgan & Hunt, 1994). The literature on trust suggests that a trustworthy party is reliable, consistent, competent, honest, fair, responsible, helpful and benevolent. As a result, trust is an important indicator of RQ, since a relationship where one party is not willing to rely on its partner is limited (Moorman, Deshpandé & Zaltman, 1993). Trust is difficult to foster, and can be extremely hard to build after being damaged (Schneidermann, 2000). In the context of this study, trust refers to the customer's willingness to rely on the bank providing e-banking services to perform several transactions. Privacy is a key element in building trust in e-banking services (Kim, Ferris & Rao, 2009).

2.3. Model development

The major objective of this research is to combine the quality of service operations (i.e., the service delivery process at the bank's office) with the usage level of e-banking services, in order to ~~examine and~~ predict ~~the joint effect on~~ the relationship between the customer and the bank. The combination of both channels should improve the prediction of the RQ between them. In order to do so, three alternative models consider a different role of the usage level of e-banking (LUEB).

According to Figure 1, the first model (model A) examines LUEB as a mediating variable in the relationship between quality of service operations (QSOP) and a customer's RQ. The second model (model B) considers LUEB as a moderator in the focal relationship between QSOP and RQ. Finally, the third model (model C) represents both LUEB and QSOP as independent variables influencing RQ.

The first step is to establish which model has the stronger predictive power of the

dependent variable. Then, the second step analyzes the consistency of that model across a multi-group setting of different clusters of customers, taking into account sociodemographic and economic variables, since evidence exists that customers with different motivations differ in how and how often customers use specific banking innovations (Barczak, Scholder & Pilling, 1997).

3. Data and Research Methodology

3.1. Sample and data collection

The empirical research analyzes a data set that contains financial, commercial and personal information of 946 customers of a Spanish banking company with 449 branches. To address the potential of common method bias in the empirical analysis, following to Podsakoff, MacKenzie, & Lee (2003) this research uses two data sources. First of them is an online survey that the ~~To collect data,~~ customers answered ~~an online survey~~ during September-October, 2009. Second of them are the internal databases that have the analyzed bank in which collects objective data (number of products, total liabilities, etc.) from each customer.

Table 1 displays the descriptive statistics of the sample. The average age of the customers is around 40 years old, yielding an average profit margin around 1,703 euros. The majority of the customers are men - 67.76% of the total. Moreover, 62.47% of the sample's customers live outside the city center.

[Table 1 here]

3.2. Description of variables

3.2.1. Quality of ~~s~~Service ~~o~~Operations (QSOP)

The literature defines several lists of quality attributes. Parasuraman, Zeithaml, and Berry

(1991) identify five dimensions of service quality: tangibility, reliability, responsiveness, assurance and empathy. Yetalthough the perceptions of service quality rely on multiple dimensions (Zeithaml, Parasuraman & Berry, 1990), a general agreement as to what the content and nature of these dimensions is does not exist (Brady & Cronin, 2001). For example, retail banking supports a three-component mode, including technical quality (the service product), functional quality (the service delivery), and the service environment (McDougall & Levesque, 1994). Another conceptualization of service quality identifies interaction quality, physical environment quality, and outcome quality as the first-order dimensions in a hierarchical approach to service quality, with nine sub-dimensions acting as second-order attributes of service quality. What is clear is that customers form their service quality perceptions on the basis of an evaluation of performance at multiple levels, and ultimately combine these evaluations to arrive at an overall service quality perception (Brady & Cronin, 2001).

The study focuses on the quality of service operations, employing four indicators to measure this quality: (1) availability to do operations; (2) confidentiality of operations; (3) agility of operations; and (4) utility of information. These four indicators represent answers of customers to the questionnaire using a 10-degree scale. Similar items are in Miguel-Dávila et al. (2010). With reflective measures, researchers expect all indicators to covary with each another. That is, indicators in reflective models should be interchangeable (Jarvis, MacKenzie & Podsakoff, 2003). Then, the quality of the service operations battery adopts a reflective approach since these four items are clearly the consequence and not the cause of this construct.

3.2.2. Level of use of e-bank (LUEB)

This study proposes four indicators to measure the level of use of e-banking: (1) ease

of browsing in e-banking operations (a 10-degree item); (2) use of e-mail (value 0 if the customer never uses e-mail for e-banking and value 1 otherwise) -these first two items are in Al-Hawari, Hartley, and Ward (2005), and Miguel-Dávila et al. (2010); (3) number of e-bank operations per year; and (4) average amount of e-bank operations (euros). According to Martínez et al. (2007), a relation exists between the ownership of more financial products and services and the use of the Internet for banking transactions. This information comes from the internal operation database of the bank.

3.3.3. Relationship quality (RQ)

In line with the literature (Palmatier et al., 2006), the study applies the following four indicators as measures of RQ: (1) customer satisfaction; (2) trust; and (3) commitment, which has two proxy indicators: (a) the number of years being a customer of the bank; and (b) the number of financial products the customer owns. Both customer satisfaction and trust are 10-degree general items. On the other hand, the customer's commitment proxy indicators come directly from the bank's internal records.

Next, Table 2 displays the descriptive statistics of the model's measures. Interestingly, among clusters of customers significant differences do not exist in terms of service quality operations, level of use of e-banking and relationship quality.

[Table 2 here]

Con formato: Izquierda

The aim of the cross-validation procedure is to reduce the implicit bias that using the same data to estimate the path coefficient of the measurement model involves and to test their generalization or predictive capacity. Cross-validation therefore allows assessing how a model's results generalize an independent data set. To implement the *k*-fold cross-validation,

the paper splits the data into k-equally sized segments (or folds). Subsequently, the carrying out of *k* iterations of training (that is, to estimate the PLS model's coefficients) and validation (that is, to test the model's predictive capacity) takes place in such a way that within each iteration the validation of a different fold of the data is through a hold out-, while learning is via the use of the remaining *k-1* folds (following the literature this study considers *k*=10). Indeed, the training set is useful for each parameter configuration, using the test set for the assessment of the generalization error of the final chosen model. The advantage of this method is that every data point is in a test set exactly once, and in a training set 10 times (i.e., throughout this procedure the empirical study considers all the data for training and testing the model), which favors the robustness and reliability of accurate evaluation. To perform the PLS analysis, this paper employs both SmartPLS software 3.0 version and R software (function *plspm*), implementing the cross-validation procedure by means of the use of R software.

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4. Results

According to Figure 1, Models A and C present a statistical significance of the path coefficients. Notwithstanding, results from Model B do not show a moderator effect of the construct LUEB in the focal relationship between QSOP and RQ. Accordingly, the results in the next sections only consider Models A and C.

[Figure 1 here]

4.1. Measurement model

According to Roldán and Sánchez-Franco (2012), this research employs the individual item reliability, construct reliability, convergent validity (Table 3) and discriminant validity (Table 4) in order to assess the measurement model for reflective constructs. Table 3 shows that (i) all indicators have factor loading greater than 0.70 and, (ii) the composite reliability is

higher than 0.80. Therefore, the two PLS models have internal consistency reliability. Secondly, values of the average variance extracted (AVE) greater than 0.50 also confirm the existence of convergent validity. In Table 4, the traditional Fornell-Larcker criterion confirms the discriminant validity of the model's constructs (Fornell & Larcker, 1981; Henseler, Ringle & Sarstedt, 2015). Note that as only one reflective construct exists, the carrying out of the Heterotrait-Monotrait ratio of correlations (HTMT) does not ensue.

[Table 3 here]

[Table 4 here]

4.2. Structural model

To evaluate the structural model, this paper uses path coefficients, the R^2 of endogenous latent variables and~~,~~ standardized root mean square residuals (SRMR) (Henseler et al., 2014)~~ and goodness-of-fit (GoF) (Tenenhaus, Vinzi, Chatelin & Lauro, 2005)~~. Additionally, both the bootstrapping procedure with 5,000 resamples (Hair, Ringle & Arstedt, 2011) and the percentile bootstrap 95% confidence interval (Chin, 2010) show the statistical significance of the path coefficients (Table 5 and Figure 1). Finally, following Iacobucci, Saldanha, ~~and~~ & Deng (2007), this study also uses the variance accounts for values (hereafter VAF) for the model that incorporate a mediating effect (Model A).

[Table 5 here]

First of all, since the moderation effect that LUEB introduces between QSOP and RQ is not significant, the elimination Model B follows (see Figure 1, Model B). Thus, hereafter the present research only focuses on the analysis of the other two models (Model A and Model C).

In accordance with the path coefficients of the two PLS models (Model A and Model C),

the results suggest that both QSOP and LUEB have a positive influence on RQ (see Figure 1). These positive relationships occur due to direct and indirect effects. They confirm that higher levels of quality in service operations and the usage of e-banking improve the quality of the customers' relationship s in the banking industry.

In Model A, the relationship between QSOP and RQ is significant at 1% (path coefficient 0.75), explaining 66.75% of the variance of RQ – this explained variance increases to 68.40% in the model without mediation (Model C). Conversely, the explanatory power that the use of e-banking (LUEB) has on RQ is more limited (explained variance 14.44% for both models: A and C). Nonetheless, -this explanatory power also has a significant influence (p-value < 0.01) which contributes substantially to predict RQ in banking.

In summary, the results of both PLS models indicate that the two predictor constructs (QSOP and LUEB) predict RQ in the banking sector by more than 80% in terms of R-squared. Note that the SRMR value is lower than 0.80 (by 0.05), which also indicates the goodness-of-fit of the overall performance of the PLS models here (Henseler et al., 2014).

On the other hand, Figure 1 also summarizes the results of each model's predictive capacity, the model without mediation or moderation (Model C) obtaining the highest accuracy performance (R^2 = 82%). The low importance of the mediation between QSOP and RQ via LUEB (VAF=16.14%) supports this finding. Note that if the VAF is lower than 20% - path coefficient 0.14, t-student 5.90; p-value lower than 1% and percentile bootstrap at 95% confidence interval [0.09; 0.20]- this indicates the inexistence of mediation. However, since the accuracy performance of both PLS models is similar in terms of the predictive capacity of RQ (the difference in R-squared is lower than 1%), implementing a validation strategy which acts as a robustness check is necessary in order to confirm Model C's superiority over Model A (see Section 4.3.).

4.3. Analysis of the model's predictive capacity

This work applies a 10-foldcross-validation by using *R* software to analyze the PLS model's predictive capability. Table 6 summarizes the results of the validation procedure in terms of ~~GoF,~~ R^2_{inner}~~,~~ and R^2_{RQ} (Henseler & Sarstedt, 2013). In accordance with Table 6, the accuracy performance of each one of the three PLS models in each test sub-sample is similar to the training sample, which supports the robustness and stability of their predictive capacity and highlights the theoretical and methodological relevance of the findings.

According to Table 6, the average accuracy ability of Model A is 55.7% (std. dev. = 0.05), 68.9% (std. dev. = 0.09) and 80.7% (std. dev. = 0.08) in terms of ~~GoF,~~ R^2_{inner}~~,~~ and R^2_{RQ}, respectively. Nevertheless, Model C is the one which obtains the best accuracy performance:~~-average GoF = 55.8% (std. dev. = 0.05),~~ average R^2_{inner}=69.0% (std. dev. = 0.09)~~,~~ and average R^2_{RQ}=81.1% (std. dev. = 0.08). Thus, before implementing this validation procedure, Model C obtained the best predictive capacity, its continuous performance being better than Model A's under this approach.

The implications from a methodological view of the results of the validation procedure are especially important, since they enhance the use of the PLS method with a predictive orientation due to its high predictive performance (higher than 80% in terms of the R-squared of the dependent construct) and contribute to foster the utility of PLS as a predictive statistical method.

[Table 6 here]

4.4. Testing the causal asymmetry

Although this issue is not central to the paper, in order to confirm and complement the PLS results with respect to the relationship between the constructs, this study implements a fuzzy-set qualitative comparative analysis (fsQCA) (Fiss, 2011; Woodside, 2013) since set-theoretic

approaches are the means to gain deeper insights into management issues (Seny Kan, Adegbite, Omari & Abdellatif, 2015). In this sense, the analysis of the data using fsQCA allows exploring the multipath relationship in greater detail, showing how a certain set of conditions (endogenous constructs, QSOP and LUEB) relate to the outcome of interest (the exogenous construct, RQ). The fsQCA really tests the asymmetric causality through the use of the software package fsQCA 2.5., which requires several steps. The first step demands transforming the scale data (the unstandardized latent variable scores) to fuzzy-set membership values from 0 (full non-membership) to 1 (full membership) using the calibrate procedure (Ragin, 2008). Considering (i) the cross-over point as the median of the unstandardized latent variable scores, (ii) the threshold for full membership at the 95th percentile, and (iii) the threshold for full non-membership at the 5th percentile, Table 7 shows the results of the truth-table for presence/absence (complex, parsimonious, and standard solutions). Moreover, this table suggests that each one of the two endogenous constructs (conditions) is a core condition (Fiss, 2011), that is, a condition that has a strong link to the exogenous construct (outcome), which leads to a high RQ fit with single and overall consistencies higher than 0.80. According to the values of both consistency and coverage indexes, the findings confirm the fit from causal asymmetry analysis, which supports the predictive capacity of both QSOP and LUEB for RQ in the banking industry.

[Table 7 here]

4.5. PLS mAulti-group analysis

According to Henseler, ringle & Sarstedt (2015), the second analysis phase consists of a multi-group analysis using PLS-SEM. The MICOM (measurement invariance of composite models) procedure provides the method for studying the invariance prior to the multi-group

analysis. After confirming the existence of invariance, the next step is to apply the multi-group analysis, comparing the explained variance for each group.

Therefore, t~~T~~he present research also tests the existence of significant differences across several clusters by using the PLS multi-group analysis. The multi-group study follows Model C due to its better performance according to the results of the previous sections.

The first analysis studies the relationships between QSOP-RQ and LUEB-RQ through the comparison of the gender-based differences among customers (women or men). Table 8 shows that no statistically significant differences between women and men regarding the QSOP-RQ path exist. In contrast, the results show that the influence of the usage of e-banking on RQ is greater in men, but this difference is not statistically significant at 10% either (p-value 0.11).

The second multi-group analysis considers the place where the office is located (city center or suburbs) in order to seek differences of behavior between banking customers. The findings establish that the influence of QSOP on RQ is more important for the customers from the city center, this difference being significant at 5%. Conversely, the effect of LUEB on RQ is lower for the city center customers than those of suburban offices.

Finally, the last multi-group compares the big savers group with the rest of the customers. For this cluster, the use of e-banking is more limited since their banking operations require personalized advice and preferential treatment from investment advisors in order to know the investment alternatives that the bank can offer them. Accordingly, LUEB has less influence on RQ than for the rest of the banking customers, this difference being high and substantially significant (p-value 0.00).

[Table 8 here]

5. Concluding Remarks, Discussion, and Limitations

A business' key resource to achieve success lies in its customers. Firms need to develop sustainable competitive advantages to satisfy and keep loyal and profitable customers. Technological advances have caused a huge expansion of Internet use, which is changing the way to access many services and influencing how the relationships between firms and customers develop. In particular, the use of e-banking in the banking industry represents an important mechanism to improve the value of the service through higher convenience and lower prices. E-banking allows customers to perform many operations without having to be physically at the bank office, to use a service which is always open and has no waiting times. In addition, this channel enables lower prices because of its cost-efficiency and increased service productivity. All the same, the traditional channel remains active for a majority of customers.

This study focuses on predicting the RQ in a bank with a multichannel setting. To do so, this research considers both the quality of service operations and the customer's level of usage of e-banking as predictors of RQ, testing three alternative models. In this vein, Model A considers the mediating effect that LUEB has on the relationship between QSOP and RQ, while Model B tests a moderating influence of LUEB in this relationship. Model C analyzes the direct effect of both QSOP and LUEB on RQ. According to each model's predictive capacity, the results show that Model C achieves the highest accuracy performance in both the model developing and the validation step. So, from a methodological point of view, Model C outperforms the other two models in terms of R^2 ~~and GOF~~. Additionally, from a theoretical perspective these findings confirm that in banking both QSOP and LUEB are two relevant and independent predicting variables of RQ. They are different channels to access the service. Therefore, the main implication of this paper is for banks; they must substantially foster both the quality of face-to-face service operations and the use of e-banking to improve the quality

of their relationship with customers.

This research contributes to the literature in three ways. First, results show that the quality of service operations successfully predicts the level of a customer's RQ. This finding is in consonance with the previous literature which indicates that banks can build satisfaction, trust and commitment from continuous successful service encounters with customers. The weight of QSOP on RQ is similar to that of previous research addressing this construct as an endogenous variable (Miguel-Dávila et al., 2010).

Secondly, the findings also suggest that the customer's use of e-banking significantly influences the development of RQ with the bank. Consequently, the use of technology is an important instrument to improve RQ with those customers who are more likely to use this channel. In this regard, the results of the multi-group analysis show that for big savers the use of e-banking does not influence their RQ, as they require the power of personalized attention in banking services. This result also confirms the idea that there are different clusters of customers in terms of needs, behaviors and motivation when it comes to the use of e-banking (Martínez et al., 2007).

Thirdly, from a methodological point of view, these findings support the use of PLS as a predictive method, obtaining a powerful accuracy performance of the exogenous construct (RQ in banking). Additionally, this article also advances in the implementation of a validation procedure (10-fold cross-validation) in the *R* environment in order to test the robustness of the model's accuracy ability. This use of *R* software and a cross-validation procedure in order to fit a predictive-oriented PLS model is new.

Finally, the study has some limitations that also lead to future lines of research. First, the data set does not contain information from customers who defected from the bank. In other words, actual customer loyalty is not available in the study; a very interesting line for future research would be to address how RQ predicts actual loyalty behavior in this context.

Secondly, as the study focuses on one bank, a generalization of the results is limited. Third, part of the data collection process uses an on-line survey (information regarding the customer's perceptions) that leaves out those customers who do not use e-banking services, leading to partially-biased information. Fourth, the study focuses only on quality of service operations, meaning that other dimensions of service quality are beyond the scope of the study (the outcome of service encounters, the service environment, and the personal relationship). Including them, as well as other customer-based variables (i.e., time-sensitivity), would enrich the study.

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Table 1. Characteristics of the sample

Variable	Mean (N=943)	Std. deviation	Cluster1 (N=378)	Cluster 2 (N=369)	Cluster 3 (N=57)	Cluster 4 (N=139)	t-value
Age	40.40	11.50	39.70	40.70	43.20	40.80	0.26
Profit Margins (euros)	1,703	1,846	99.10	1,360	-89.80	1,939	0.00
Total assets	54,289	49,190	2,261	58,324	334	56,394	0.00
Total liabilities	17,916	7,213	7,798	22,480	44,672	864	0.00
Variable	N	Percentage	Cluster1 (N=378)	Cluster 2 (N=369)	Cluster 3 (N=57)	Cluster 4 (N=139)	t-value
Gender (male)	634	67.76%	66.70%	65.30%	66.70%	71.90%	NA
Gender (female)	312	32.24%	33.30%	34.70%	33.30%	28.10%	NA
City center office	355	37.53%	35.19%	38.75%	38.60%	41.01%	NA
Suburbs office	591	62.47%	64.81%	61.25%	61.40%	58.99%	NA

NA: not applicable

Table 2. Descriptive analysis of the items in the Models

Variable	Mean	Std. deviation	Cluster1 (N=378)	Cluster 2 (N=369)	Cluster 3 (N=57)	Cluster 4 (N=139)	t-value
SQ1. Availability to do operations	8.13	2.01	8.20	8.21	7.50	7.92	0.06
SQ2. Confidentiality of operations	8.36	1.83	8.31	8.45	7.80	8.44	0.12
SQ3. Agility of operations	8.09	1.90	8.17	8.12	7.70	7.92	0.35
SQ4. Utility of information	7.83	2.09	7.87	7.94	7.34	7.69	0.25
LUEB1. Easiness of navigation in e-banking operations	8.06	1.98	8.13	8.06	7.72	7.99	0.67
LUEB2. Use of e-mail (Y/N)	0.87	0.34	0.85	0.89	0.89	0.87	0.36
LUEB3. Number of e-bank operations per year	155.50	176.60	140.90	171.90	153.90	152.40	0.21
LUEB4. Average amount of e-bank operations (euros)	2,208	17,034	1,546	3,135	2,762	1,327	0.72
RQ1. Satisfaction	8.10	1.77	8.18	8.19	7.63	7.86	0.07
RQ2.Trust	8.34	1.86	8.30	8.44	7.82	8.36	0.16
RQ3. Number of years being customer of the bank	5.08	4.20	5.07	5.06	5.70	4.83	0.73
RQ4. Number of products	7.52	3.34	4.98	10.4	8.37	6.20	0.00

Table 3. Measurement for each Model

Items description (construct/indicator)	Loadings	Variance inflation factor (VIF) & confidence intervals	Weights	Composite reliability (CR)	Average variance extracted (AVE)
	Models A Model C	Models A Model C	Models A Model C	Models A Model C	Models A Model C
Quality of Service Operations (QSOP)				0.90 0.90	0.88 0.88
QSOP1: Level of availability to perform customer's operations	0.85 0.85				
QSOP2: Level of confidentiality of the bank in customer's operations	0.79 0.81				
QSOP3: Level of agility of personnel of the bank performing customer's operations	0.85 0.84				
QSOP4: Level of utility in bank's information of services	0.85 0.84				
Level of use of e-bank (LUEB)				NA	NA
LUEB1: Usefulness of e-banking		1.01, [0.98;0.99] 1.00, [0.97;0.99]	0.98 0.99		
LUEB2: Use of mail for e-banking		1.03, [0.02;0.12] 1.03, [0.03;0.15]	0.07 0.09		
LUEB3: Number of e-bank operations per year		1.05, [0.01;0.08] 1.05, [0.01;0.07]	0.05 0.06		
LUEB4: Average amount (in €) of the operations made by the customer in online banking		1.02, [0.01;0.10] 1.02, [0.01;0.11]	0.02 0.02		
Relationship quality (RQ)				NA	NA
RQ1: Level of satisfaction of the customer with respect to the bank		1.83, [0.65;0.82] 1.83, [0.63;0.80]	0.74 0.72		
RQ2: Level of trust of the customer with respect to the bank		1.82, [0.24;0.45] 1.82, [0.26;0.47]	0.34 0.37		
RQ3: Number of years as customer		1.03, [0.01;0.04] 1.03, [0.01;0.04]	0.01 0.02		
RQ4: Number of products owned by customer		1.01, [0.01;0.04] 1.01, [0.01;0.04]	0.02 0.02		

NA: Not applicable

Table 4.Discriminant validity assessment for each Model

Model A

	QSOP	LUEB	RQ
QSOP	0.94		
LUEB	0.76	NA	
RQ	0.89	0.76	NA

QSOP: Service quality; LUEB: Level of use of e-bank; RQ: Relationship quality.
NA: not applicable

Model C

	QSOP	LUEB	RQ
QSOP	0.94		
LUEB	0.76	NA	
RQ	0.90	0.76	NA

QSOP: Service quality; LUEB: Level of use of e-bank; RQ: Relationship quality.
NA: not applicable

Table 5. Effects on endogenous variables for each PLS model

Model A

Effects on endogenous variables	Theoretical sense (support)	Direct effect (path coefficient)	t-Value (bootstrap)	Percentile 95% confidence intervals	Explained variance
LUEB (R^2 = 81.40%)					
QSOP (a_1)	+ (Yes)	0.76***	33.60	[0.71;0.80] Sig	57.76%
RQ (R^2 = 57.90%)					
QSOP (c´)	+ (Yes)	0.75***	25.42	[0.69;0.80] Sig	66.75%
LUEB (b_1)	+ (Yes)	0.19***	5.96	[0.13;0.26] Sig	14.44%

QSOP: Service quality; LUEB: Level of use of e-bank; RQ: Relationship quality.*p < 0.10; **p < 0.05; ***p <0.01 (based on t(4999), two-tailed test); t(0.10; 4999) = 1.65; t(0.05; 4999) = 1.96; t(0.01; 4999) = 2.58. Sig. denotes a significant direct effect at 0.10.

Model C

Effects on endogenous variables	Theoretical sense (support)	Direct effect (path coefficient)	t-Value (bootstrap)	Percentile 95% confidence intervals	Explained variance
RQ (R^2 = 82.00%)					
QSOP (a_1)	+ (Yes)	0.76***	25.63	[0.70;0.81] Sig	68.40%
LUEB (b_1)	+ (Yes)	0.19***	5.55	[0.12;0.25] Sig	14.44%

QSOP: Service quality; LUEB: Level of use of e-bank; RQ: Relationship quality.*p < 0.10; **p < 0.05; ***p <0.01 (based on t(4999), two-tailed test); t(0.10; 4999) = 1.65; t(0.05; 4999) = 1.96; t(0.01; 4999) = 2.58. Sig. denotes a significant direct effect at 0.10.

Table 6. Results of 10-fold cross validation for each Model

Model A

k-fold	R^2_{inner}	Com	$R^2_{average}$	R^2_{QSOP}	R^2_{LUEB}	R^2_{RQ}
1	59.4%	0.40	46.4%	-	45.8%	72.9%
2	77.2%	0.52	43.3%	-	68.9%	85.6%
3	72.5%	0.48	45.8%	-	62.8%	82.3%
4	64.1%	0.43	42.3%	-	43.7%	84.5%
5	76.1%	0.51	46.1%	-	63.1%	89.1%
6	76.7%	0.51	49.9%	-	66.6%	86.8%
7	74.4%	0.50	46.8%	-	63.4%	85.3%
8	57.7%	0.39	44.2%	-	51.9%	63.4%
9	56.0%	0.37	41.3%	-	40.4%	71.6%
10	75.0%	0.50	45.6%	-	64.7%	85.4%
Mean	68.9%	0.46	45.2%	-	57.1%	80.7%
Std. dev.	0.09	0.06	0.03	-	0.11	0.08

Tabla con formato

Model C

k-fold	R^2_{inner}	Com	$R^2_{average}$	R^2_{LUEB}	R^2_{QSOP}	R^2_{RQ}
1	59.5%	0.40	46.3%	-	45.8%	73.2%
2	76.9%	0.51	43.3%	-	68.1%	85.8%
3	73.0%	0.49	45.8%	-	63.1%	82.9%
4	64.7%	0.43	42.3%	-	44.5%	84.9%
5	76.2%	0.51	46.1%	-	63.0%	89.3%
6	77.0%	0.51	49.9%	-	66.7%	87.3%
7	74.2%	0.50	46.9%	-	62.6%	85.8%
8	57.7%	0.39	44.2%	-	51.4%	64.1%
9	55.9%	0.37	41.3%	-	39.9%	71.9%
10	75.0%	0.50	45.7%	-	64.4%	85.7%
Mean	69.0%	0.46	45.2%	-	56.9%	81.1%
Std. dev.	0.09	0.06	0.03	-	0.10	0.08

Tabla con formato

Table 7. Truth-table fsQCA

	Raw coverage	Unique coverage	Consistency
Quality of Service Operations (QSOP)	0.90	0.09	0.92
Level of use of e-bank (LUEB)	0.85	0.05	0.86

Note: frequency cutoff: 80.00; consistency cutoff: 0.83; solution coverage: 0.95; solution consistency: 0.85.

Table 8. Results of multi-group analysis

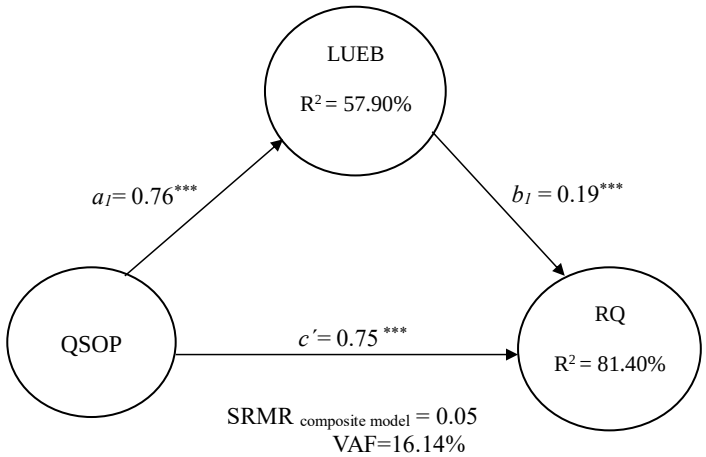
Relationship	Groups	Comparison	Path coefficients	Difference	P-value parametric	P-value permutation
QSOP → RQ	Women & men	Men	0.75	0.06	0.84	0.32
		Women	0.81			
	City center & suburb offices	City center	0.81	0.009	0.005	0.14
		Suburb	0.72			
	Big savers & other customers	Big savers	0.88	0.14	0.97	0.06
		Other customers	0.74			
LUEB → RQ	Women & men	Men	0.21	0.09	0.11	0.19
		Women	0.11			
	City center & suburb offices	City center	0.14	0.08	0.90	0.21
		Suburb	0.22			
	Big savers & other customers	Big savers	0.02	0.20	0.00	0.02
		Other customers	0.22			

	QSOP → RQ	**LUEB → RQ**
WOMEN & MEN		
Path coefficients for men	0.75 (p-value 0.00)	0.21 (p-value 0.00)
Path coefficients for women	0.81 (p-value 0.00)	0.11 (p-value 0.08)
Path coefficients differences	0.06 (p-value 0.84) p-value permutation 0.32	0.09 (p-value 0.11) p-value permutation 0.19
CITY CENTER & SUBURB OFFICES		
Path coefficients for city center	0.81 (p-value 0.00)	0.14 (p-value 0.00)
Path coefficients for suburbs	0.72 (p-value 0.00)	0.22 (p-value 0.08)
Path coefficients differences	**0.09 (p-value 0.05)**	0.08 (p-value 0.90)

	p-value permutation 0.14	p-value permutation 0.21
BIG SAVERS & OTHER CUSTOMERS		
Path coefficients for big savers	0.88 (p-value 0.00)	0.02 (p-value 0.76)
Path coefficients for other customers	0.74 (p-value 0.00)	0.22 (p-value 0.08)
Path coefficients differences	0.14 (p-value 0.97) p-value permutation 0.06	**0.20 (p-value 0.00)** p-value permutation 0.02

Figure 1. Structural Models

Model A

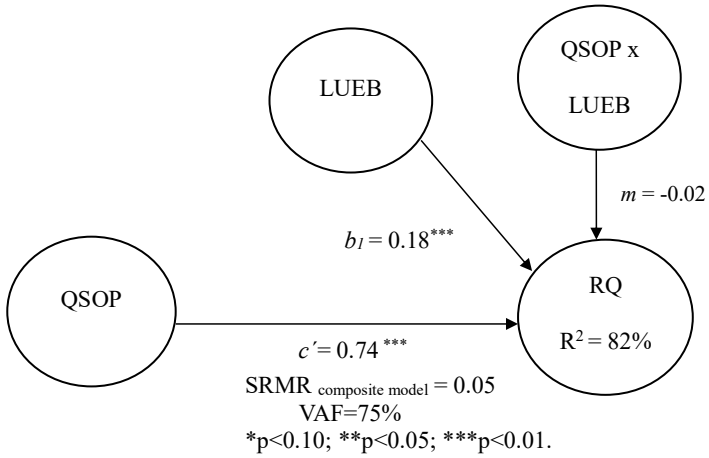


*p<0.10; **p<0.05; ***p<0.01.

QSOP: Quality of service operations; LUEB: Level of use of e-bank; RQ: Relationship quality.*p < 0.10; **p < 0.05; ***p <0.01

Con formato: Izquierda

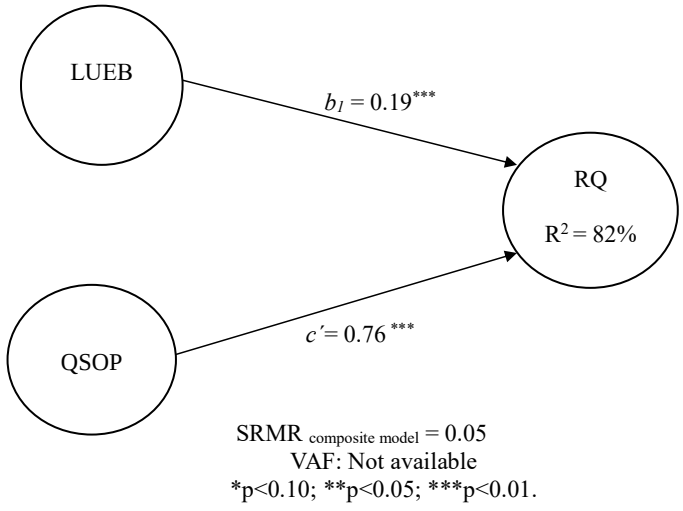
Model B



QSOP: Quality of service operations; LUEB: Level of use of e-bank; RQ: Relationship quality.*p < 0.10; **p < 0.05; ***p <0.01

Con formato: Izquierda, Sangría: Primera línea: 0 cm

Model C



QSOP: Quality of service operations; LUEB: Level of use of e-bank; RQ: Relationship quality.*p < 0.10; **p < 0.05; ***p <0.01

Con formato: Izquierda, Sangría: Primera línea: 0 cm