

How Internet has Reshaped the User Experience of Banking Service?

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Abstract

The changes new technologies have brought to banking over the past decade are enormous in their impact on the ways of doing business and providing customer services, most notably in the areas of customer service channels. Banks have been trying to move away from the traditional, branch-based and costly staff-assisted channels toward self-assisted channels, i.e. internet banking and mobile banking, to drive down costs and improve customer loyalty. How internet and mobile have reshaped the user experience of banking service channel? To provide valuable insights for this question, this research investigates and compares customer's channel choice behavior and profit changes from bank's branch closure. Applying the propensity scoring matching method, the results of analysis demonstrates that the mobile channel can be a realistic alternative to conventional branches. Also, the reserch result shows banks can reduce conventional branches while experiencing a positive implications on their profits from the customers. Another significant implication from the research is, to accelerate the shift to digital channels, banks need to put more efforts on developing functions in the mobile channel that will allow friendly interaction with customers and consultation, such as video consultation, interactive chat, and location-based product recommendation.

Keywords: Banking Service Channel Choice, Mobile Banking, Propensity Scoring Matching, FinTech, Bank Digitization

1. Introduction

The changes that new technologies have brought to banking over the past decade are enormous in their impact on the ways of doing business and customer services. Advances in technology are allowing banks to enhance not only the accuracy and timeliness of transactions but also productivity by applying new technologies for product development and risk management, resulting in significant improvements across the board. One of the most prominent areas benefited from technology development in banking is the customer service channel, which is represented by Automatic Teller Machine (ATM) in the late 1960s and internet banking in the mid 1990s.

This makes sense as continued investment in, and utilization of, technologies for customer service channels have translated into revenue growth by improving loyalty through increased convenience for the customer [1] and reducing transaction cost by more than 80%. Previous study shows that the cost process an account transfer is \$1.07 through a branch, \$0.27 by an ATM, \$0.01 through internet banking [2]. With these reasons, banks have been trying to move away from the traditional, costly staff-assisted channels including branch and toward self-assisted channels, most notably, internet banking, mobile banking and smartphone banking in a strategic move to drive down costs and improve customer loyalty.

The eclipse of staff-assisted channels by self-assisted channels intensifies, as evidenced by the facts that security-conscious, complexity-averse customers, who were reluctant to use internet banking in the early years [3, 4], are increasingly opting for online channels. In Korea, for example, online and mobile channels combined account for 82% of all transactions performed with the fast emergence of mobile technologies and ensuing spread of smartphones and tablet PCs [5], and that the number of smartphone banking customers in Korea has jumped from 9,000 in 2010 to 28.07 million in 2013 [6] (See Fig. 1 and Fig. 2).

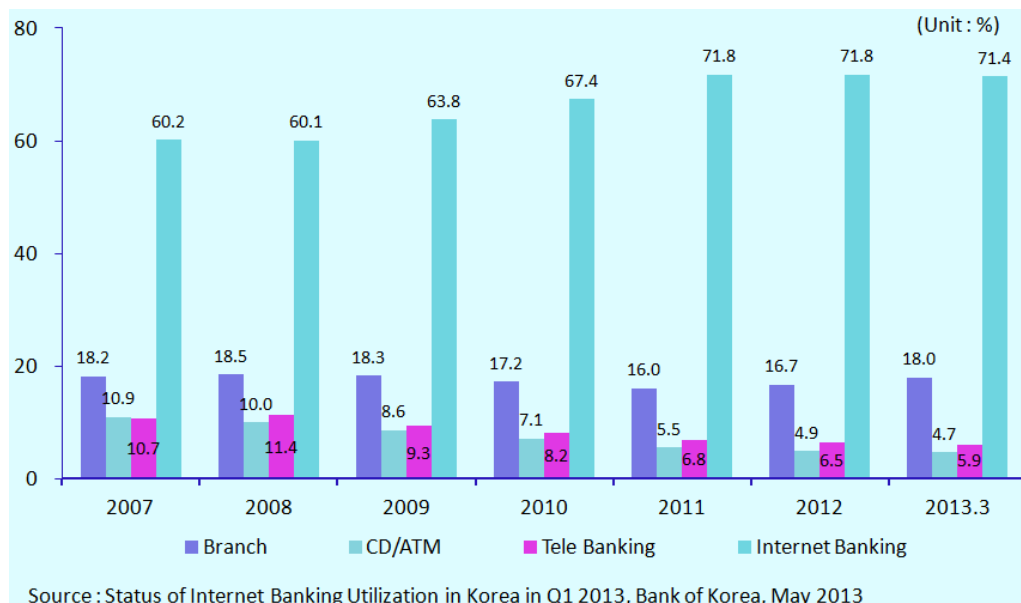


Fig. 1. Proportion of Each Banking Channel Adopted for Transactions in Korea

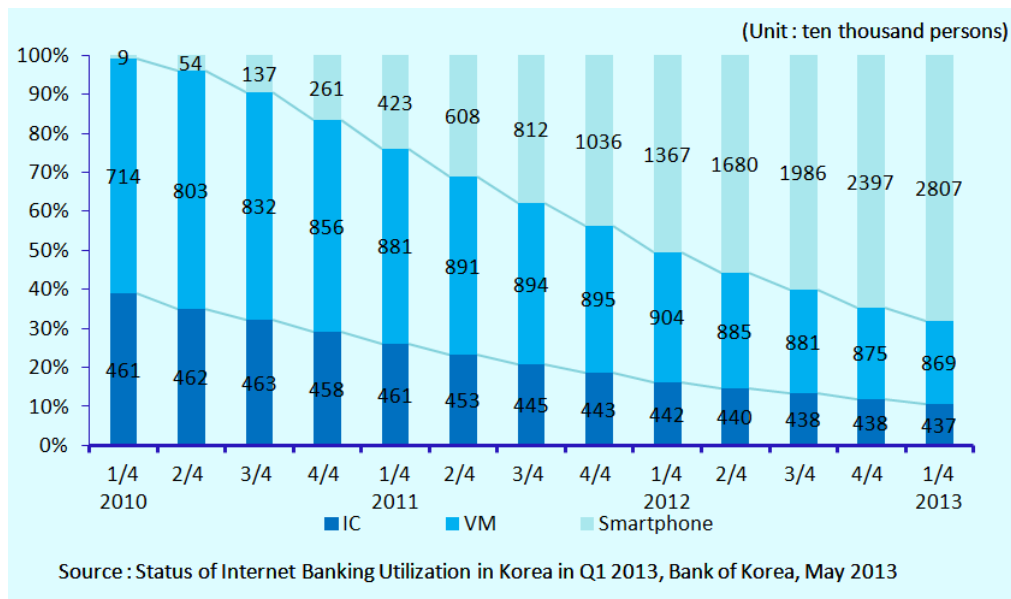


Fig. 2. Trends in the Number of Mobile Banking Users in Korea

As shown in the below table (See **Fig. 3**), banks in advanced countries continue to reduce their number of branches: as of 2013, the number of branches per million population has shrunk fast in the United Kingdom, France, Japan and the United States, by 79.2 %, 33.8 %, 7.8 % and 2.8 %, respectively [7]. This trend in the banking industry is also in line with their response to the emerging financial technology space, dubbed FinTech, which offers whole new financial services based on innovative mobile technologies and channels - corporate investments into FinTech reaching USD 19.7 and 1,129 FinTech businesses Operating as of April 2015 [8], - and is expected to accelerate going forward.

Country	No. of Branches		Variation	in Percentage	No. of Branches per Million Population		Variance
	2007	2011			2007	2011	
	(Unit: branch, %)						
UK	27,277	22,364	-4,913	-18.0	447.3	368.1	-79.2
France	39,402	38,171	-1,231	-3.1	619.5	585.7 ^{Note 1)}	-33.8
Japan	55,747	54,960	-787	-1.4	436.3	429.2 ^{Note 2)}	-7.1
US	115,105	118,190	3,085	2.7	382.1	379.3	-2.8
CPSS Average	866,824	730,725	-135,559	-15.6	232.6	301.6	69.0

Note 1) as of 2009 Note 2) as of 2010
 Source: Comparative tables of Statistics on Payment and Settlement Systems of International CPSS countries,

Fig. 3. Number of Bank Branches in Major Countries

Therefore, it has become all the more important for banks to perform research on consumers' channel choice behavior, especially the choice of self-assisted channels, i.e. digital channels. In particular, it has now become essential for banks to understand the followings in order to develop strategies: 1) the impact from the adoption of the rapidly developing digital channels including mobile channel, 2) the impact from the closure of branches, the conventional offline channel and 3) the impact on banks' performance from the provision of new channels brought by such recent technology development.

This study intends to explore the customers' channel behavior changes and analyze the

performance impact of the bank from the adoption of digital channel and branch closure by analyzing long-term empirical observation data.

This study provides useful implications and contributes to researchers and practitioners as follows. First, accurately capturing and understanding bank customers' channel choice behavior from the recent channel and technology trend and changes by using long term and large number of observation data. This is an important contribution because this study minimizes result bias from self report and cross sectional analysis, which is rarely seen in the prior researches. Second, validating current bank's direction for technology investment on customer service and channel strategy, such as reducing number of branches. Third, suggestions for the future research on invigoration of digital channels as well as banks' efforts to design and establish enhanced channels to accommodate the future, such as FinTech.

2. Literature Review

The customer experience on online channels is also of increasing importance to businesses and academia [9]. Previous studies indicate that the creation of compelling online experiences for web users will have numerous positive impacts for retailers [10]. Klaus [11] highlights the importance of the online customer experience on the overall customer experience and customer behavior in a positive way. These findings naturally lead bank's self-assisted channel strategy discussion - banks see tremendous opportunities from providing self-assisted channel such as internet banking and mobile banking, i.e. the multi channel environments [12] and there's a belief that the environments will lead to increase in customer loyalty [13]. To validate the belief, studies have been a focus on determinants of customer loyalty in online contexts [14]. The focus expands to develop a theoretical framework and typology [15] to investigate online channel strategies and their applicability for enhancing customer loyalty and segmentation practices in a multi-channel environment. This becomes an important issue for scholars, and bank managers.

Naturally there have been many previous studies on bank customers' channel choice and they have been overly focused on two areas: one is studies from a marketing perspective on interaction between a bank and customers in a multi-channel environment and the other is studies focused on acceptance and resistance of new technology, such as internet or mobile.

Marketing perspective studies include study on the efficiency of the online channel from customers' viewpoint [16, 17], study on businesses' adoption of the online channel and the competition between online and offline channels [18, 19], and study on multi-channel management and multi-channel selection [20, 21]. On the other hand, examples of mobile technology acceptance studies are studies through TAM (Technology Acceptance Model) by Davis [22, 23], studies using IDT (Innovation Diffusion Theory) [24, 25], and studies on factors that determine acceptance of mobile technology based on the unified theory of acceptance and use of technology (UTUAT) [26]. The analysis of previous studies has indicated that three theories – TAM, IDT, and UTUAT – form the basis of 71% of all studies on mobile banking acceptance conducted from 2005 through May 2014 [27].

With the recent rise of importance of the self assisted banking service channel, especially mobile, the research topics are expanding to include consumer awareness [28], personal involvement such as trust [29], and policies and regulations [30]. However, study on the customer's channel choice behavior or study on the consequent performance of banks from the recent bank branch closure trend has not yet been conducted.

In addition, all 55 studies on mobile banking acceptance undertaken from 2005 through May 2014 used methods such as survey, interview, and triangulation [31], which indicates that

researches have been dependent on self-report and at a certain point for analysis.

As it becomes a norm to provide internet banking and mobile banking channels in banking industry, some scholars have argued [32, 33, 34, 35] that internet experience is important in understanding customers' perceptions, attitudes, and behavior in online environments and internet banking adopters are significantly different from the general customer population, and that they tend to be more profitable after their adoption of internet banking [36, 37].

However, at the same time, due to the lack of 'touch' and 'interaction' from the nature of the self service channel, there are also concerns on decreasing customer satisfaction and loyalty. Some scholars argue that no systematic evidence were found that banks were benefited by having internet banking [38] or internet banking was too small a factor to have affected bank profitability [39]. Lang and Colgate [40] concluded that technology may not always have a positive impact on the relationship between supplier and customer, while Lee [41] suggested a need for the availability of both a 'high-tech' and a 'high-touch' approach where the human service dimensions are considered as important as the technology enabled remote service interactions.

In line with Lee's suggestion, there is an opinion that more bank customers use the convenience of the internet transactions but when it comes to applying for credit or opening or closing an account, customers still prefer the branch [42]. The question also relates to the recent researcher's argue on 'number of internet banking users has not risen as strongly as expected' [43].

As for studies on banks' mobile technology, as stated earlier in this paper, most literature on mobile banking is about exploratory analysis of factors impacting people's adoption of mobile banking. As stated, most of such studies are based on TAM developed by Davis. TAM, as a general model that explains how users come to accept and use IT technology, has been widely used to project users' acceptance of not only mobile banking but also other technologies. TAM presents two factors that influence attitude toward using a technology - perceived usefulness and perceived ease of use. Perceived usefulness is the degree to which a person believes that using a particular system would enhance his or her job performance, whereas perceived ease of use is the degree to which a person believes that using a particular system would be free from effort. The key point of TAM is that perceived usefulness directly influences attitude toward using and behavioral intention to use while perceived ease of use directly influences perceived usefulness and attitude toward using.

Determinants whose influence on behavioral intention to use mobile banking service has been relatively clearly proven up to now are perceived usefulness, perceived ease of use, cost, quality, trust, risk, social impact, security, previous experiences.

In this study, we use propensity scoring matching approach as an alternative method to estimate causal treatment effects. There has been a number of studies employed the propensity scoring methods in financial industry, including equity offerings [44], spin-offs [45], internet-based credit unions [46], mergers and acquisitions [47] but there was limited study on banking channel choice behavior, especially, customer's channel choice behavior change analysis from the branch closure treatment effect can't be found.

3. Methodology

According to Cochran, an observational study is defined as an empirical investigation in which the 'objective is to elucidate cause-and-effect relationships, in settings in which, it is not feasible to use controlled experimentation, in the sense of being able to impose the procedures

or treatments whose effects it is desired to discover, or to assign subjects at random to different procedures'.

An obvious and clear way to answer this research's questions is to compare the profits and channel choice behaviors of the customers that provided the branch with those for a bank that has not provided the branch, if we can control for all other variables.

However, in non-experimental settings like this study, the treated subjects often differ systematically from untreated subjects. It is well recognized that the estimate of a causal effect obtained by comparing a treatment group with a non-experimental comparison group could be biased because of problems such as self-selection or some systematic judgment by the researcher in selecting units to be assigned to the treatment.

Therefore, an unbiased estimate of the average treatment effect cannot be obtained by directly comparing outcomes between the two treatment groups. To overcome the issue, this study employed propensity score matching approach.

3.1 Propensity Score Matching

Propensity Score Matching (PSM) is a method that balances as many propensities as possible across treatment and control groups in order to minimize selection bias, the biggest weakness of a quasi-experiment. Rosenbaum & Rubin [48] implemented Multivariate Matching Method based on Propensity Score to minimize selection bias in a quasi-experiment. PSM has been widely used in research in various fields such as medicine, economy, education, sociology [49]. Propensity score refers to the conditional probability inferred from observed covariates that are used to predict a person's condition. Observed covariates are variables predictive of receiving the treatment as well as the outcome. Propensity scoring, employs a particular set of covariates to calculate the conditional probability of being assigned to the treatment group. That probability is called the propensity of exposure to the treatment. In a non-randomized trial, the propensity score function is unknown and must be estimated from the observed data by using a model, such as the logit.

The propensity score matching methods is a widely used for situations (like an experiment) in which a group of units is exposed to a well-defined treatment, but (unlike an experiment) no systematic methods of experimental design are used to maintain a control group. Hence this method fits well with our study. We used PSM method to analyze customers' banking channel choice behavior change and the impact of bank's profit from bank's branch closure.

PSM is performed as follows;

First, whether to participate in the experiment is coded as a dummy variable, and logit is performed to estimate propensity scores from conditional probability.

Second, observations with the most similar propensity scores in treatment and control groups are matched. As for matching methods, 1 to 1 matching method matches each individuals whereas 1-to-N subclass matching method divides and matches subclasses. Also depending on applied algorithms, there are methods such as nearest neighbor matching, caliper / radius matching, kernel or local linear weight match. In the matching stage, members of the control group who have propensity score higher than the highest propensity score of the treatment group or lower than the lowest propensity score of the treatment group are excluded so that the overlapped part of the treatment group and the control group can be chosen [50].

The third stage assesses how close the empirical covariates of the two groups are distributed, that is, how well balanced they are. Resenbaum & Rubin [51] determined that the balance is ensured when the F value of the main effect and the interaction effect of the treatment group is small in two way ANOVA, and proposed adding an interaction term or a quadratic term if

balance is not ensured.

And then, the outcome variables of the two matched groups are compared. The effects are estimated as follows: The difference in the outcome variables between treatment and control groups in each subclass is calculated. Using the difference, with the proportion of the number of treatment group samples to the whole population in each subclass as a weighting, a weighted average is calculated and is regarded as an estimated effect.

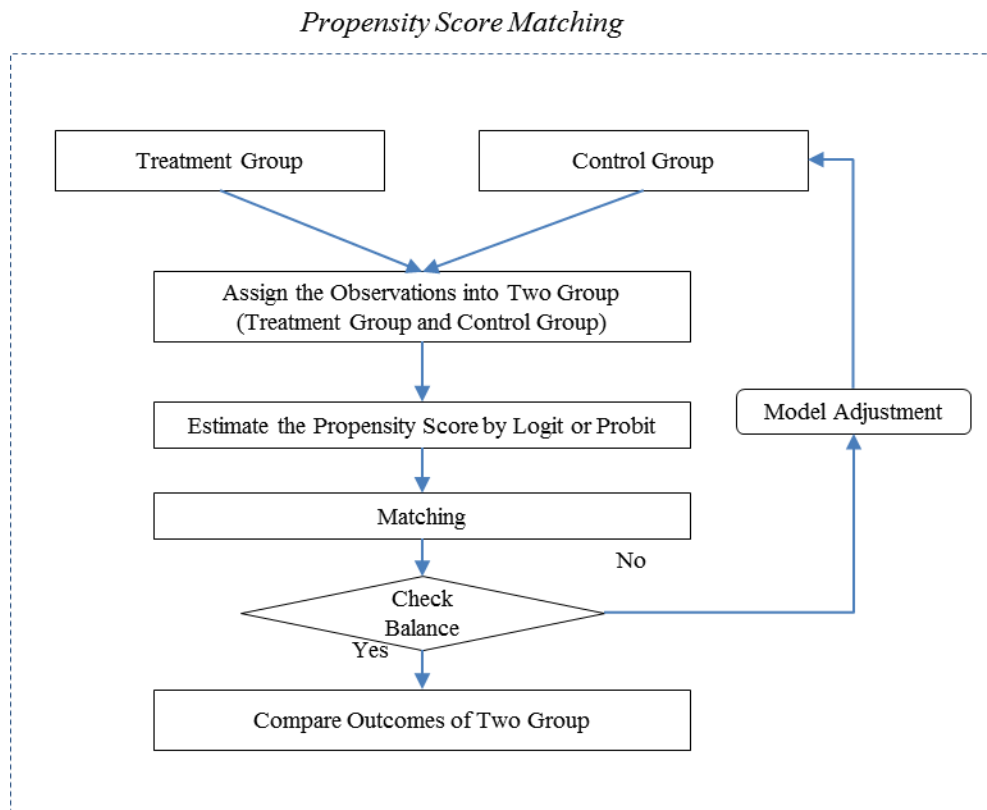


Fig. 4. Research Flow

3.2 Data Collection

For our study, one of the biggest retail banks in Korea was chosen. The bank served more than 50 million retail customers at the point of the research through multiple channels, including branch, internet banking, mobile banking, ATM, and call center. The selection of the bank was also supported as the bank have closed more than 50 branches in the last two years, which account for more than 17% of their total number of branches. Also, for the past two years of the time of the study, the bank has begun to provide new mobile banking, which allows customers use their smart phone to execute financial transaction requirements including checking balance, transferring money to other accounts, and even buying products by simply downloading mobile banking application. Further, the case bank started to offer tablet banking to increase customer's access ability to the bank. The case bank was chosen because it was one of the most aggressive banks to try the digital channel transformation in relation to bank closure.

To investigate the effect of branch closure, we selected customers from two branches: One

from an active branch and the other from one year long closed branch. The active branch was carefully chosen considering similarity with the closed branch in terms of customer population distribution, income level and geographical proximity. The branches were also carefully selected with the consideration of channel accessibility including IT infrastructure for internet banking and mobile banking, and branch. Under those considerations, two branches in metro city with the similarity were selected. Two branches combined have 5,556 customers (3,654 from the active branch and 1,902 from the closed branch) and all transaction data of the customers during the period from June 2014 to June 2015 were collected.

Data refinement was made for this research, in order to measure changes in customer profit contribution to the bank and channel choice behavior after branch closure, while ensuring robustness in the design, objectives and procedures of this study, customers of the closed branch that fall into any of the following category during the defined period were excluded from the analysis: 1) those with no banking transaction history across all channels, 2) those not active in internet/mobile channels as the focal point of the study is on the digital banking channel, 3) those in their 10s or aged over 65 who tend to engage in a limited range of economic activities, 4) corporate and small and medium enterprise customers as this study is focused on retail customers, and 5) those with missing values. As a result of data refinement, 3,762 customers from the reference branch and 250 customers from the closed branch were used for the analysis.

3.3 Variables

The estimation of the propensity score, which is defined as the conditional probability given covariates observed, plays a fundamental role in PSM. Covariates used to estimate the propensity score in this research can be categorized into three groups: demographic covariates that could impact banking channel choice and performance, including age and gender; banking service related covariates including customer segment, number of products held, average balance, total number of transactions performed with the bank and internet banking subscription duration; and covariates indicative of customer behavior in the six months before branch closure, such as individual customer's contribution to the bank's profit, number of branch visits, number of ATM transactions, number of internet banking transactions and number of mobile banking transactions.

For dependent variables that could show changes before and after branch closure, profit in the six months after branch closure and the number of transactions performed via different banking channels, which indicates changes in customer behavior of channel choice, are used as dependent variables. Banking channels customers can select from are categorized into branch visits, ATM, internet banking and mobile banking, and the number of transactions performed via respective channels in the six months post branch closure was adopted as variables. For mobile banking, which refers to banking services offered through a mobile banking application for portable devices, the total number of banking services performed on a smartphone, tablet PC or any other mobile devices combined was tallied. Other than the aforementioned channels, telebanking through voice network may be an alternative banking channel for customers, but is excluded from this research as its share in the entire banking transactions is insignificant. Similarly, call center is another representative customer-facing channel of banks, but is excluded in this research as it supports customers for their financial transactions rather than providing a framework for direct transaction execution.

The **Table 1** describes variables used and how they are measured for the analysis:

Table 1. Description of Variables

Variables	Description
Covariate	
AGE	Customer's age (in #)
SEX	Male = 0, Female = 1
SEGMENT	SEG 1 = 0, SEG 2 = 1, SEG 3=2 SEG1 being highest profit contribution to the bank, while SEG3 being lowest profit contribution to the bank
TOTAL_USAGE	Total number of financial transactions during the defined period (in #)
JOIN_INTERNET	Internet banking subscription duration [Present(2015)- year of subscription]
#_PRODUCTS	Number of products held per customer
(LN)BALANCE	Log (average balance)
PROFIT_0	Average profit from a customer in the six months before branch closure. The profit is obtained from bank's internal source, which includes net margin and some cost factors. Net margin includes interest profit and fees and cost includes FTP (fund transfer pricing), reserve fund cost and direct branch staff cost.
BRANCH_0	Number of branch visits in the six months before branch closure
ATM_0	Number of ATM transactions in the six months before branch closure
INTERNET_0	Number of internet banking transactions in the six months before branch closure
MOBILE_0	Number of mobile banking transactions in the six months before branch closure
Outcome Variable	
PROFIT_1	Average profit in the six months after branch closure
BRANCH_1	Number of branch visits in the six months after branch closure
ATM_1	Number of ATM transactions in the six months after branch closure
INTERNET_1	Number of internet banking transactions in the six months after branch closure
MOBILE_1	Number of mobile banking transactions in the six months after branch closure

3.3.1 Age and Gender

Demographic variables of age and gender were chosen to analyze the impact on choice of each banking channel. This is intended to verify that younger people access and adopt internet and mobile technology more actively and such access to technology can impact channel choice, and also to validate whether gender influences people's banking service channel choice.

3.3.2 Customer Segment

Customer segment was defined as a variable to find out what impact the customer segment, which is the classification of customers based on their contribution to the bank's profit, has on bank service channel choice. This is to verify the assumption that a branch, a staff-assisted channel, i.e., branch, is highly preferred for profitable products such as loan or derivatives, including bancassurance and mutual fund, as they require 'face to face' consultation, and, if this assumption is proven true, to analyze what impact the customer segment and the type of instruments have on banking service channel choice. The result from this variable will provide implications for what investment should be made in the digital channel and what technology should be adopted in the future to improve customers' digital channel adoption. For this study,

customers are categorized into three segments based on their contribution to the bank's profitability.

3.3.3 Number of products held and average balance

A customer with growing need for banking service will surely look for the most reasonable service channel, which could influence their decision on banking service channels.

Typically there is a positive correlation between the number of banking transactions of a customer and the number of products he or she holds and the amount they transact with a bank. The number of products held and average monthly balance - one of the most typical indicators of transaction amount - were selected as variables to analyze their impact on customer banking service channel choices.

3.3.4 Internet banking subscription duration

According to Kim et al. [52], a customer's experience with internet banking is identified as the single most critical variable that influences his or her use of mobile banking services. The conclusion drawn here may sound so obvious when considered together with a previous study [53] revealing that the longer a customer uses internet banking or mobile banking, the more frequently he or she uses the medium. Therefore, internet banking subscription duration was included in the model as a variable given that mobile banking is a relatively new channel that is less utilized than other channels and that data are incomplete with missing values.

3.3.5 Customer profit and behavior in the six months prior to branch closure

Average profit from the customer and number of transactions performed on respective channels in the six months running up to branch closure were included as covariates in the analysis in order to control influences of customer behavior patterns - i.e., whether a customer shows a light transaction volume or heavy transaction volume - based on the assumption that a customer's behavior pattern in using banking services will stay consistent, not affected by branch closure.

4. Analysis Results

4.1 Estimating the Propensity Score

As stated earlier, the first step towards econometric analysis after dividing the treatment group and control group for observation is to estimate the propensity score. Propensity score indicates the ratio of people who will fall under the treatment group out of the entire observation pool, and is usually represented by the conditional probability calculated by using either probit or logit regression, among the discrete choice models.

This research adopted logistic regression for the analysis with covariates such as age, sex, customer segment, number of financial transactions over the defined period, number of products, average balance, elapsed time since subscription to the internet banking channel, profit from the customer for the 6 months leading up to the branch closing, and number of usage per channel, which are the factors that are expected to affect the profit from the customer and customers' channel choice behavior with regard to bank channels. The conditional probability deduced from the logit analysis was then used as the propensity score for the PSM.

4.2 Matching & Checking Balance

After estimating a unique propensity score for each observed covariate, identical or very

similar scores were matched between the treatment group and control group. The matching helps control the influence of covariates on outcome variables and allows analysis of the treatment's net effect.

For the matching algorithm, this research employed nearest neighbor matching with replacement. As the most straightforward matching estimator, the algorithm chooses an individual from the control group as a matching partner for a treated individual that is closest in terms of propensity score.

Table 2. Descriptive statistics of covariates: before and after PSM

Variables	Before Matching				After Matching			
	Control Group (N=3762)	Treated Group (N=250)	p-Value	Std. Mean Diff.	Control Group (N=409)	Treated Group (N=227)	p-Value	Std. Mean Diff.
AGE	42.08	38.40	0.000	0.43	39.13	38.37	0.290	0.09
SEX0	0.50	0.53	0.443	0.05	0.52	0.54	0.615	0.03
SEX1	0.50	0.47		0.05	0.48	0.46		0.03
SEG1	0.04	0.08		0.15	0.06	0.06		0.02
SEG2	0.04	0.01	0.109	0.36	0.00	0.01	0.938	0.05
MARGIN_0	1497346.90	237359.60	0.036	3.53	235678.06	242435.14	0.866	0.02
BRANCH_0	3.30	0.89	0.058	1.43	0.87	0.92	0.787	0.03
ATM_0	114.67	147.34	0.014	0.19	139.00	142.49	0.513	0.02
INTERNET_0	179.20	312.24	0.000	0.10	197.45	188.35	0.722	0.01
MOBILE_0	106.23	219.26	0.000	0.41	151.66	191.07	0.018	0.14
TOTAL_USAGE	851.27	1412.73	0.000	0.23	1019.50	1144.62	0.028	0.05
JOIN_INTERNET	7.63	10.26	0.000	0.42	10.25	9.74	0.410	0.08
#_PRODUCTS	2.96	2.78	0.295	0.09	2.63	2.69	0.604	0.03
(LN)BALANCE	15.32	14.69	0.000	0.35	14.79	14.72	0.472	0.04

With the effect of covariates properly controlled, the outcomes of treated and control observations were compared and standard mean difference analyzed, specifically in terms of the average margin on customers, number of visits to the branch, number of ATM/Internet banking/mobile banking usage for the 6 months before and after the treatment (branch closing). Comparison between the treated branch and control branch for the 6 months before the closing, in addition to the 6-month post-treatment period, was necessary to make the analysis more systematic. The propensity score matching found matching results between 227 samples from the treated branch and 409 samples from the control branch. **Table 2** illustrates statistics of the covariates included in the algorithm model before and after the matching.

Standard mean difference (SMD) for each covariate shows that after the matching, there is no difference among the covariates in terms of significance probability, which indicates that the covariates were properly controlled and balance between the treated branch and control branch had been improved.

4.3 Treatment Effect

After the propensity score matching, the treatment's effect on the margin and channel use behavior was analyzed based on the standard mean difference of outcome variables. (See

Table 3)**Table 3.** Treatment Effect

Variables	Control Group (N=409)	Treated Group (N=207)	p-Value	Std. Mean Diff.
PROFIT_1	293281.04	429963.96	0.00	0.23
BRANCH_1	1.67	0.00	0.00	0.42
ATM_1	127.52	139.33	0.50	0.06
INTERNET_1	183.89	207.79	0.31	0.08
MOBILE_1	185.74	274.67	0.00	0.24

Comparison of average margin and number of usage per channel between the treated branch and control branch for the 6 months after the closing demonstrates a significant increase in the profits of the treated branch ($p=0.00$, $SMD=0.23$). Visit to the control branch during the analyzed period shows an increase by 1.67 compared to that of the treated branch, which may indicate that customers of the treated branch have moved to the control branch but could also be a natural result of branch closing since visiting a closed branch is impossible. The number of ATM usage has remained steady regardless of the branch closing whereas mobile channel usage has shown a significant change. Increase in the number of mobile channel usage is evident among customers of the treated branch ($p=0.00$, $SMD=0.24$), which can be interpreted as the spread to mobile channel as the mobile channel replaces branch visits. Meanwhile, the number of internet banking usage offers no significant difference after the branch closing.

4.4 Post-hoc Analysis (Difference in Difference Test)

For a more systematic evaluation of the impact branch closing had on the customers' channel choice behavior, this research conducted a Difference In Difference (DID) test as post-hoc analysis and estimated the Average Treatment Effect on the Treated (ATET). The ATET is the difference between the actual outcomes of the treated and the estimated outcomes of the treated that they had not been treated. In other words, it does not just compare the treatment group to the control group but also measures the difference between before and after the treatment as outcome variables, thereby more tightly controlling the effect of average profit on customer and service channel choice behavior before the treatment.

Table 4. Outcome variables for Post-hoc Analysis

Variables	Description
D_PROFIT	Average customer profit for 6 months after the closing – Average customer profit for 6 months before the closing The profit is obtained from bank's internal source, which includes net margin and some cost factors. Net margin includes interest profit and fees and cost includes FTP (fund transfer pricing), reserve fund cost and direct branch staff cost.
D_BRANCH	Number of branch visits for 6 months after the closing – Number of branch visits for 6 months before the closing
D_ATM	Number of ATM usage for 6 months after the closing – Number of ATM usage for 6 months before the closing
D_INTERNET	Number of Internet banking usage for 6 months after the closing – Number of Internet banking usage for 6 months before the closing
D_MOBILE	Number of mobile banking usage for 6 months after the closing – Number of mobile banking usage for 6 months before the closing

The DID test result is as follows. (See **Table 5**)

Table 5. Result of Post-hoc Analysis

Variables	Control Group (N=443)	Treated Group (N=227)	<i>p</i> -Value	Std. Mean Diff.
D_PROFIT	56013.32	187528.82	0.00	0.30
D_BRANCH	0.79	-0.92	0.00	0.39
D_ATM	-4.27	-3.16	0.90	0.01
D_INTERNET	-12.21	19.44	0.07	0.15
D_MOBILE	42.41	83.59	0.01	0.20

The result indicates that the variance in average customer profit before and after the closing is greater in the treated branch than in the control branch ($p=0.00$, SMD=0.30). The control branch showed an increase in the number of branch visits whereas the treated branch experienced decreases in branch visits ($p=0.00$, SMD=0.39). For the usage of ATM, there was no significant difference between the treated branch and control branch, which proves that branch closing has no impact on the customers' pattern of ATM usage.

As for the internet banking, unlike the earlier assessment that found no significant impact from branch closing, this analysis found a significant difference between the two branches ($p=0.07$, SMD=0.15). Specifically, the control branch showed a decrease in the number of internet banking usage after the treatment, while the treated branch experienced an increase, demonstrating that branch closing has a significant effect on the customers' behavior of internet banking usage. Mobile channel showed very important result where the change after the treatment was greater in the treated branch than in the control branch ($p=0.01$, SMD=0.20), which means not only customers' choice of mobile channel was significantly affected by the branch closing but also mobile channel shows the biggest difference from the treatment among digital channels.

5. Conclusion

5.1 Research Summary and Discussion

Widespread use of the internet and growing popularity of mobile devices and applications have led to digitalization of traditional, face-to-face banking services. Today banks are faced with new strategic options involving expansion of digital means at the very low price of conventional branches, and consequently there is a growing need for an empirical study into the effect of branch closing on the usage of self assisted digital channels. Against this backdrop, this research analyzed the impact of closing branch, a conventional staff-assisted channel, on the customers' choice of banking service channels and focused on assessing implications for banks with regard to banking service digital channel technology and their channel strategy. Furthermore, this study explored correlation between shifting banking service channels to digital and bank's performance from the change, which would serve as a good motivation for banks to continue to invest in information technology.

In this study, two branches with a combined customer base of 5,556 individuals were selected as the treated branch and the control branch. The treated branch is the one closed and the control branch is the one identified to be most comparable to the treated branch in terms of the customer base and environmental aspects. To gain the most accurate outcome possible, this research matched the comparison targets the same as much as possible to compare the behaviors and consequences from the behavior differences, by employing propensity score matching method. We measured the impact of branch closing on average customer profit, profit variance, number of usage per channel, and per-channel usage variance while keeping

all covariates effectively controlled. The research analyzed banking transaction data of all target customers over a 12-month period, 6 months each before and after the branch closing, and found that the branch closing resulted in greater profits from the customer, considerable impacts on the customer's pattern of service channel choice, and strongly promoted the use of internet banking and mobile banking channels, especially mobile channel.

This research provides an important contribution including 1) minimizing any potential bias from self report by employing relatively new research propensity scoring matching approach in MIS field, 2) providing comprehensive channel choice behavior understanding by providing combined channel behavior analysis. The result carries several important implications;

First, branch closing had a significant effect of boosting the use of self-assisted digital channels. The mobile channel, in particular, stood out as a realistic alternative to conventional branches as demonstrated by the increase in the number of mobile channel usage as well as the variance before and after the closing. Another currently widely used self-assisted channel, internet banking, also showed a large difference in usage before and after the closing in the test, despite contrastingly insignificant result in the analysis of the number of channel usage. What this result implies is that 1) internet banking is already widely used and adopted thus the impact of branch closing was not as marked here as in the case of mobile channel and 2) mobile channel, with no constraints of time and space, is preferred by customers over internet banking. Thus, it is suggested that banks' information technology efforts should be focused on the mobile channel services targeting mobile devices which are capable of providing ubiquitous services. In other words, mobile channel is the focus area of the future, even among the digital channels.

Second, branch closing had a significant effect of reducing the number of branch visits by a relatively wider margin. Also noteworthy is that in the pre- and post-treatment analysis, the level of decrease in the number of branch visits exceeded the level of increase in the use of digital channels. While it may seem natural that visit to a branch falls after branch closing, previous studies thus far have suggested to the contrary that bank as a high touch industry, the need for visiting a branch would remain unaffected in the face of branch closing. It demonstrates that banks would be able to gradually reduce the need for conventional branches by providing advanced forms of digital channels and services best represented by mobile technologies.

Third, it was found that branch closing had a positive effect on bank's performance, more specifically on profits from the customer. Previous researches have offered conflicting views on this. One side argued that the provision of self-assisted channels positively affects customer behavior, leading to improved performance whereas the other side claimed that either the positive effect has not been verified or it would negatively affect bank's performance as the reduced interaction with customers, a key element of the banking industry, would undermine customer loyalty. This research attempted to verify the effect from adopting digital channels on bank's profitability by introducing a treatment, i.e. branch closing and the result it produced indicates that digital channels help to realize improved performance to banks. This is an important finding for scholars and managers both, as the branch closure has been implemented from banks' managers as 'trial and error' basis due to conflicting views. With this test result, bank managers can accelerate the conversion from staff assisted channel, more precisely branch, to digital channel.

This research bears out the positive impact banks can enjoy by adopting the approach of greater mobile channels and less traditional branches. This research outcome demonstrates that the mobile channel can be a realistic alternative to conventional branches and banks can

reduce conventional branches while experiencing a positive effect on their profits from the customers. With this strategy, banks will be able to serve mass segments more profitably by taking out expensive branch costs and secure investment capacity for information technology.

However, banks will only be successful if they redesign their distribution channels to deal with the digital revolution, and work towards a finer segmentation of customers, a more tiered product line and customized mobile technology.

For example, to accelerate the conversion while mitigating any side effects of branch closing, banks are required to introduce changes to the way they develop banking technologies. While banks' mobile services thus far have focused on speed, stability and security, they now have to channel their efforts into developing functions that will allow friendly interaction with customers and consultation to substitute traditional bank functions - video consultation, interactive chat, location-based product recommendation are some of the examples. Furthermore, banks need to focus on making sure the digital channels are intuitive, efficient and convenient. Executing the details well will be critical.

5.2 Limitations of the study and direction for future research

Despite such theoretical and practical contributions, this study has several limitations.

First, the sample analysis is limited to branch closure in a certain area and similarities between two branches, and thus might not properly reflect the environmental factors of the area. Environmental factors manifest themselves as income disparity and the consequent disparities in traffic conditions and access to technology, which can impact customers' bank channel choice patterns and profits. Therefore, to generalize the result of this study, future research should expand the scope of analysis to cover customers of as many branches as possible and thereby properly control environmental factors.

Second, only the number of use per channel was considered to measure variables used to analyze the usage pattern per channel, though the analysis of the number of use per channel, changes in preference for each channel were analyzed to some extent. The conclusion on consumer demand mechanism for each channel and demand substitution therethrough is rather intuitive, and a quantitative conclusion is hard to draw. In order to reach a more systematic and clearer conclusion regarding such issues, not only the number of usage per channel but also transaction volume (value of transaction), transaction type (inquiry, transfer, purchase of a financial instrument), and time and location of use can be measured and analyzed. If such quantitative analysis is performed, a socio-scientifically more meaningful conclusion can be reached regarding how the development of digital channels influences bank customers' service channel choice.

Third, by employing PSM, this study analyzed the impact of branch closure on the customer profit and the number and usage variance per channel, but did not analyze in detail the impact of each explanatory variable on outcome variables. In other words, to apply PSM, explanatory variables were input as covariates to control the variance and effect of these variables, but analyzing the impact of these variables on customer profit and usage patterns might have significant implications in both theoretical and practical aspects. For example, the highest segment customers may have high expectations of service and have high demand for interaction and consultation as they hold hybrid financial products. Analysis of channel selection behavior per customer segment would also bear significance. Therefore, for future research and discussion, the causal relationship and impact between each variable can be investigated through regression analysis or other empirical models.

Fourth, this research does not cover other potential alternative channels, which receive large

tractions from customers such as social media tools. As more and more banks are considering and started to use social media as their way of communication with customers, this research suggests that future research should be extended. FinTech also needs to be strongly considered for the future research.

Fifth, in this research, bank's profitability has only analyzed from customer profitability, except some direct cost factors including direct staff cost of the branch. While this is a good indication of estimating bank's performance, factoring proper cost factors into the analysis will make the case stronger. Cost factors includes each channel's running and implementation cost, includes premise cost, infrastructure building cost, system development cost and system supporting human cost.

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