

When the Bank Comes to You: Branch Network and Customer Multi-Channel Banking Behavior

Completed Research Paper

Dan Geng

Singapore Management University
80 Stamford Road,
Singapore 178902
dan.geng.2012@phdis.smu.edu.sg

Vibhanshu Abhishek

Carnegie Mellon University
5000 Forbes Avenue,
Pittsburgh, PA 15213
vibs@andrew.cmu.edu

Beibei Li

Carnegie Mellon University
5000 Forbes Avenue,
Pittsburgh, PA 15213
beibeili@andrew.cmu.edu

Abstract

Customers today increasingly interact with their banks using digital channels, lifting the necessity for banks to rethink the distribution of physical branches and customer behavior in a multi-channel environment. Using approximately 1.2M anonymized individual-level data from a large commercial bank in US over 6 years, our paper investigates the traditional channel – bank branches – and the impact of its network change (branch opening or closure) on customer multi-channel preferences and other banking behavior. Our results show that both branch opening and closure are associated with decreasing transactions through offline channels and increasing transactions in online banking. Hence, branch network change is likely to result in customer migrating from offline channels to online banking. In addition, we find that opening branch is associated with customers' adoption of additional banking products in a short term. Interestingly, closing a branch does not lead to more account closures by customers.

Keywords: branch network, online banking, multi-channel, propensity score matching, difference-in-differences model

Introduction

The rapid advances of technology in financial services industry has given rise to the popularity of digital channels such as internet banking, leading to sharp decline in branch traffic. A national tracking survey shows that 61% of internet users adopt online banking in 2013, rising from 58% in 2010 after a steeper growth during the last decade (PewResearch 2013). Meanwhile, the percentage of customers preferring branch channel for routine transactions continues to decline from 34% in 2011 to 23% in 2014 (Novantas Research 2014). Customers are migrating from traditional channels to digital channels because the electronic banking service delivery system enables them to conveniently manage their finance from anywhere at any time.

The current situations bring about great opportunities to financial institutions. Since the average transaction cost for the physical channel are approximately 20 to 40 times higher than digital channels (CEB TowerGroup 2013), banks can significantly reduce their operation costs and improve the efficiency ratio by up to 7 percentage points by transforming the physical distribution networks and migrating transactions to digital channels (McKinsey 2014). In fact, leading banks in U.S. are taking steps in recent years to scale down their retail banking branch network, in response to the shrinking customer traffic and high-cost infrastructure of physical banking locations that lead to rapidly decreasing cross-channel profitability for branches. Most banks are closing their branches more aggressively than opening new ones. For example, Bank of America has become the most aggressive by shutting down approximately 148 branches in 2014 following about 300 closures 2013. In 2014 alone, banks in U.S. have shut 2,599 branches against 1,137 openings, leading to net decline of 1,462 (1.5%) branches overall (CNBC 2014). On the other hand, as customer preferences under the multi-channel settings differ largely across transaction types (PWC 2012, Novantas Research 2014 and EY 2014), branches remain popular with most customers when they perform specific types of transactions. That is, while routine transactions such as deposit and withdraw are leaving the branch channel rapidly, customers prefer face-to-face interactions when it comes to advice seeking or complex product sales. Moreover, most banks still view branches as the most efficient channel to build and manage long-term customer relationship. Given the complicated situation currently, it is important for banks to understand customer preferences and performance in the multi-channel service delivery system to restructure their branch network in a more efficient way.

Indeed, several prior literatures started from customer adoption of online banking and found different effects on the usage of each offline channel (Campbell and Frei 2009, Xue et al. 2007 and Xue et al. 2011). However, few researches have systematically studied the restructuration of the physical store network and its effects on the online banking. In this paper, we aim to complement current research by addressing the impact of branch network change on customer multi-channel usage and banking behavior. We are interested in the following research questions: What are the effects of branch opening and branch closure on customer multi-channel usage? What are the short-term vs. long-term impacts on customer multi-channel usage after the branch network change? Does the physical presence of a bank improve cross-selling performance?

We validate our study by empirically investigating branch network change using approximately 1.2M anonymized individual-level data from 20,786 customers over 73 months from a retail bank in US. In particular, we separately examine the effects of branch opening and branch closure on customer multi-channel usage as well as the cross-selling performance. We begin by constructing a control group with the treated group to form a sample of customers using propensity score matching method. We then formally specify a difference-in-differences model that controls for individual heterogeneity in transaction behavior to explore our research questions.

Our main results show that when a new branch opened, customers tend to decrease their transaction consumptions through offline channels including automated teller machine (ATM), voice response unit (VRU) and call center (call center) and increase transaction consumptions through online banking. Somewhat surprisingly, after a nearby branch closed, customers do not reversely move back to offline channels. While VRU has a slight increase in customer traffic and ATM is not significantly affected, there is a larger decrease in transaction volume through the call center. Meanwhile, customers are more likely to perform transactions using the online banking. The results suggest that branch network change is likely to result in customer migrating from offline channels to online banking. We perform robust analysis by dividing the sample customers into heavy branch users, light branch users and non-branch users based on

their dependence on the branch channel. While the directions of effects on each channel are consistent with our main results, we find that after the branch opening or branch closure, heavy branch users increase their transactions through online banking more substantially compared with light branch users and light branch users tend to decrease their offline transactions to a larger extent compared with heavy branch users. Non-branch users behave in a distinct way after the branch network change. To explore the long-term effects of branch network change, we replicate our main analysis using customer transaction data within 3 months, 3-6 months, 6-9 months, 9-12 months and over 12 months after the branch opening or branch closure respectively. Our post-treatment analysis shows that branch opening leads to rather short-term boost on online banking usage and long-term substitution effect on offline channel usage, while branch closure tends to constantly decrease customer transactions through offline channels and increase customer transactions on online banking in a long run. In our cross-selling analysis, we find that branch opening is associated with adoption of additional banking products in a short term. Interestingly, closing a branch nearby does not lead to more account closures by customers.

Our paper contributes to current literatures on customer behavior under the multi-channel setting in the financial services industry. Prior research has focused on the effects of emerging channels such as online banking on multi-channel usage and customer behavior (Campbell et al. 2009, Xue et al. 2007 and Xue et al. 2011). However, what banks should do with their existing physical branch networks, especially considering the cost-effective tradeoff among alternative operation channels, is unclear. In this paper, we start from a different perspective and examine the impact of physical branch network change on customer multi-channel banking behavior. Furthermore, our paper contributes to the empirical literature that investigates the impact of the physical store entries on customer behavior in retailing industry (Forman et al. 2009, Pauwels et al. 2011). Prior literatures mainly focus on the effects of retailer store entries on various customer behavior and institution revenue. However, with the fast technology penetration in different industries, companies are more aggressively shutting down their physical stores than opening new ones. Thus it is also important to understand complex customer behavior with physical store closures. Building on prior literature, our work provides further insights on physical facility network change by exploring branch opening and branch closure separately.

Related Literatures

Our work is related to streams of multi-channel studies from financial services, retailing and advertising industries. In each context, there are a considerable amount of researches investigating service distribution among online and offline channels and examining their effects on customer multi-channel usage and other behavior.

Online Banking Adoption in Multi-channel Financial Services

The emergence and popularity of the online channel in service industry has caught researchers' attention in recent years. Specifically in financial services industry, the explosive evolution of online banking since last decade has stimulated prior researches to examine customer channel preferences and banking behavior prior and post to the online banking adoption. Hitt and Frei (2002) started to explore the demographical differences between online banking users and traditional channel users and found that customers in the former group are more profitable and have higher retention. Xue et al.(2007) incorporated channel usage and found causal relationship between higher customer efficiency in online banking and greater profitability and complex retention and product utilization behavior. Xue et al.(2011) further investigated the drivers of online banking adoption and pointed to higher transaction demand, customer efficiency and local penetration as customer motivations. By exploring post adoption customer banking behavior, Xue et al.(2011) found that customers are likely to significantly increase their banking activity, acquire more products and perform more transactions after adopting online banking. The authors conclude that the lower transaction costs in online banking and customers' adoption of more banking products after using online banking encourage them to increase the overall transaction activity.

Campbell and Frei (2009) particularly studied customer channel usage after adopting online banking and empirically identified substitution effects of online banking on self-service channels such as ATM and VRU and augmentation effects on human-service channels such as branch and call center. Their results suggest that substitution is most likely to happen between channels offering similar mix of services, and improved customer controls on their own finance after adopting online banking enhance their willingness

to access all available service channels, leading to increasing transactions through other channels. The finding are supported by Hernando and Nieto (2006), who performed firm level empirical analysis and concluded that the banks use online banking as a complement instead of a substitute for physical branches.

Online and Offline Interrelationship in Multi-channel Retailing

Started earlier than financial services, multi-channel retailing has achieved higher popularity and better integration between online and offline channels. Based on general understanding of the power and speed of technology disruptions, studies in various retailing industries have been focusing on quantifying the pressure on physical channels with the introduction of the online channel. Deleersnyder et al. (2002) applied data in newspaper industry and suggested that the general concerns on the cannibalization of the online channel are overstated. Biyalogorsky et al. (2003) used data from Tower Records and concluded similarly that the addition of online channel does not significantly substitute away sales away from offline channels. Instead, Biyalogorsky et al. (2003) implied that the use of online channel amplifies the share of purchase overall. The stimulus of online channel usage in overall sales is also supported by Ansari et al. (2008). Researchers suggested that connecting to the online channel help firms to build stronger customer relationship, which enables customers to respond more strongly to marketing strategies. Meanwhile, there might be only little overlap between physical channel users and online channel users, and consumer characteristics might be largely different between two groups as well, thus transactions through the physical channels are unlikely to be substantially substituted away by the introduction of the online channel.

In the meanwhile, several research are interested in physical store entries and its impact on customer multi-channel preference. Researchers consistently found that the presence of a retail store increases physical store sales (Avery et al. 2012, Bell et al. 2015 and Kumar et al. 2014). Cost structures have been widely used to explain the results in existing literature. Customers incur different transaction costs when purchasing from different channels (Chintagunta et al. 2012). The transaction costs mainly include transportation costs, travel time and in-store shopping time costs, product searching costs, basket-carrying costs, quality inspection costs, and inconvenience costs (Bell et al. 1998 and Chintagunta et al. 2012). As physical store entries increase the density of physical facility network, customers are more accessible to local stores due to reduced transaction costs. Hence, physical store entries are likely to result in increased store transactions.

However, prior research show unclear results on the effects of physical store entries on the online channel usage. On the one hand, some research suggest that the large online disutility costs and decreased distance to offline stores are likely to shape customers' channel choice of switching from the online channel to physical stores after store entries. For example, using data of top-selling books from Amazon.com, Forman et al. (2009) found that when a physical store opens locally, customers substitute away from the online purchasing. Brynjolfsson et al. (2009) also identified intense competition between the online channel and offline channels when selling mainstream products. On the other hand, some other research empirically identifies that transaction consumptions through the online channel actually increase after physical store entries. Kumar et al. (2014) analyzed data from a large US fashion apparel and accessories multi-channel retailer and revealed that store openings result in higher volume of online purchase. Avery et al. (2012) proposed a conceptual framework and empirically proved that the introduction of a retail store increases sales from the Internet channel over time. Bell et al. (2015) used quasi-experimental data on showroom openings by WarbyParker.com and found that introducing a showroom increases consumer demand through the online channel. The rationales of the augmentation effects are primarily explained in three aspects. First, store entries reduce the customers' risk of purchasing online by providing them a physical place for product evaluation and after-sale trouble resolution. Second, repeated exposure to retail stores strengthen consumers brand awareness and associations, which can transfer to other channels as a halo effect (Jacoby et al. 1984, Keller 1993 and Kwon et al. 2009) and increase sales in other channels over time. Furthermore, the physical presence of a retailer is beneficial for establishing long-term customer relationship and improving customer loyalty, which would in turn increase customer purchase with the retailer across all delivery channels.

Effects of Online Ads on Traditional Media in Multi-channel Advertising

Another stream of research in multi-channel studies focus on the marketing effects of online advertising on traditional media. Industry practitioners generally emphasize the synergies between online and offline advertising channels by arguing that traditional media generate interests and online ads engage people by satisfying their interests (Elliott 2010, DynamicLogic 2007, IAB 2011). However, there are different voices regarding the cannibalization or synergies in academic studies. On the one hand, Lambert and Pregibon (2008) and Wilbur, Joo, and Zhu (2010) suggested in their papers that offline media can generate searches on search engines. Naik and Peters (2009) and Dinner, Heerde and Neslin (2011) developed analytical models estimated with marketing data and supported that cross-media synergies exist in multi-channel advertising. On the other hand, other theoretical research has assumed substitution effects between online advertising and traditional media (Athey and Gans 2010, Bergemann and Bonatti 2010). Based on prior theoretical analysis, Goldfarb and Tucker (2010) used data on the advertising prices paid by lawyers for Google search terms and empirically identified that online advertising substitutes for offline media.

The discussion reveals that prior research commonly started from the online channel usage and looked at its effects of offline channel usage on customer multi-channel behavior. However, studies focusing on physical channels are not sufficient. Although some research applied the context of retailing investigated the physical store entries, the results on how customer behave after a physical store opens is unclear. Also, no prior research has implied the effects of store closures, which is important to better understand consumer behavior as banks and retailer are closing their physical stores more aggressively than opening new ones. Moreover, customer multi-channel preference in banking industry might be significantly distinct from that in retailing and advertising industry for two reasons. First, banks usually serve their customers with multiple channels rather than two channels, making their multi-channel system more complex than that with retailers. Second, since products and services provided through different channels by banks are less integrated than those provided by retailers and advertisers, customers might have higher switching costs among different channels or even be completely blocked from switching to other channels for particular transactions. Hence, our work tries to complement existing research by using the context of financial services and exploring customer multi-channel behavior after branch openings and branch closures. Furthermore, although various industry reports have indicated that branch still remains the most efficient facility in complex product sales (PWC 2012), no academic research has empirically studied the cross-selling performance after branch network change. The possible reasons for increasing banking product sales with the physical presence of a bank lie in two aspects. First, since branch entries reduce transportation costs and quality evaluation costs (Pauwels et al. 2011), customers are more likely to visit a branch and be exposed to new products for future purchase. Second, physically presented stores induce more frequent contacts and face-to-face interactions between customers and firms, strengthening psychological bonds between customer and firm and increase the probability that they adopt additional products within the firm (Steinfeld et al. 1999). Thus, we also extend our research by investigating the effects of branch network change on the cross-selling performance of the bank.

Context, Data and Variables

The data for this study consists of anonymized individual-level transactions from a large commercial bank in the United States. The bank offers diverse financial services through branches and ATM machines, together with other electronic channels such as telephone banking. It is also in one of the earliest batch of financial institutions to introduce online banking services. The leading position of the bank in multi-channel financial services makes it a suitable research site for our study.

With emerging technological disruptions in financial service industry in recent years, the bank is making great effort to accommodate changing customer preferences, including a migration from physical channels to lower cost digital channels for routine transactions. Over the last several years, the bank acted aggressively to restructure its traditional service delivery systems in order to reduce operating costs and enhance profits. It took steps to scale down its retail banking branch network, following a substantial expansion previously. In the meanwhile, the bank also intends to expand its footprint by opening new branches in places with few or no physical network exposures. As a result, there are a considerable number of branches opened and closed during the timeframe of our study from October 2007 to October

2013, ensuring a significant variation in our main effects variables that quantifies the bank branch network change.

Data Collection

To create a rigorous basis for our empirical analysis, we construct a unique panel data set from 45,000 sample customers from the bank using propensity score matching method. The sample customers consist of 15,000 randomly selected customers who experienced branch network change and another 30,000 randomly selected customers who experienced no branch network change in their residential districts during our study time period. The matching process is illustrated in detail in section 4.1 and it yields the panel data set containing complete customer-location-month information of 20,786 customers. Specifically, a customer-location-month observation contains anonymized monthly data of a customer on his transaction behavior (e.g. number of transactions performed by each channel, total number of channels used, total transaction amount), banking status (e.g. total number of accounts and total amount of balances by each account type), nearby branch network change (e.g. number of branches opened and closed, number of first branches opened and last branches closed) and characteristics (e.g. age, tenure, state and low income identifier). In this paper, we define locations using zip codes that represent customers' residential districts. We observe 4,070 zip code levels, with the number of bank branches ranging from 0 to 7 within each area. The data covers an overall time period of 73 months from October 2007 to October 2013. In the next three sub-sections we will describe how we construct the dependent variables, independent variables and control variables in our econometric analysis. Variable definitions and descriptive statistics are provided in Table 1.

Variable	Description	Obs.	Mean	Sdv.	Min	Max
Dependent Variables						
Offline	Offline transaction volume.	1,178,586	6.80	11.93	0	2,174
Online	Online banking transaction volume.	1,178,586	26.84	60.80	0	9,398
ATM	ATM transaction volume.	1,178,586	3.35	5.47	0	223
VRU	VRU transaction volume.	1,178,586	1.52	7.75	0	419
CallCenter	Call center transaction volume.	1,178,586	0.59	3.78	0	2,166
Branch	Branch transaction volume.	1,178,586	1.34	2.44	0	146
BranchWithin	Number of transactions through branches within the customer's residential location.	694,256	0.43	1.23	0	36
BranchOutside	Number of transactions through branches out of the customer's residential location.	694,256	0.58	1.47	0	60
#Channels	Number of all channels used.	1,178,586	3.64	2.36	0	9
#Non-branch Channels	Number of non-branch channels.	1,178,586	3.15	2.17	0	8
Main Effects Variables						
#BranchOpened	Number of branches opened.	1,178,586	0.48	0.75	0	6
#BranchClosed	Number of branches closed.	1,178,586	0.16	0.40	0	3
#FirstBranch	Number of first branches opened.	1,178,586	0.10	0.31	0	3
#LastBranch	Number of last branches closed.	1,178,586	0.02	0.13	0	1

Table 1. Data Description and Summary Statistics

Dependent Variables

Number of Transactions by Channel. We use the count number of transactions to capture multiple channel usages by customers. Basically, customers from the bank can perform transactions from ten different channels including automated clearing house (ACH), automated teller machine (ATM), bank by phone (BBP), branch, point of sale by check card (PCC), point of sale by debit card (PDC), telephone bill payment (TBP), call center, voice response unit (VRU) and online banking.

For the interest of this study, we focus on five major channels including ATM, branch, call center, VRU and online banking. We exclude BBP and TBP in our analysis for the reason of extremely low transaction traffic and ACH, PCC and PDC due to unintegrated services offered. For example, ACH are only used for debit and credit money, and PCC and PDC are designed for purchase and return transactions with retailers. We follow the structure of multi-channel distribution in retail banking suggested by Campbell et al. (2009) and define online banking as the sole online channel, ATM, VRU and call center as offline channels, but look at the branch channel separately. We then examine the impact of branch network change on customers' transaction consumptions through the three types of channels (offline, online and branch) as well as through each single channel. We also test the effects on the number of channels and non-branch channels used respectively to further investigate whether branch network change will lead to customers' adoption of new channels or quit from old channels.

Adoption of Banking Products. To examine the impact of branch network change on cross-selling performance, we use a binary variable that indicates whether a customer has opened or closed any bank account. Customers from the bank are assigned with a basic demand deposit account in the first place. They can subsequently adopt other banking products and services such as savings, credit card accounts, installment loans and investor brokerage based on their financial demand. There are 17 such banking products that are categorized into deposit, loan, investment and other accounts in our data. On average, each customer in the bank holds 3.47 accounts, 60.47% of which are deposit accounts, 15.52% are loan accounts and 2.87% investment accounts. Apparently, deposit accounts make up the major proportion of banking accounts customers hold, and they generally have lower demand for loan accounts and investment accounts. So we use the change in the number of all accounts instead of in each type of accounts held by customers to measure the cross-selling performance in our study. We also use the change in the number of deposit accounts for robustness check.

Bank Branch Network

Branch Opening and Branch Closure. To have a thorough understanding of customer behavior in response to branch network change, we look into cases of branch opening and closure, and explore their effects on customer multi-channel preferences separately. Our access to information of each bank branch, including its opening date, monthly status, closing date (if exists) and location, allows us to construct our main effects variables such as the number of branches opened and closed by neighborhood every month. That is, through the 73-month study time period, #BranchOpened and #BranchClosed are discrete variables that have increment values with additional branch opening and closure. According to the overview of branch network change shown in Figure 1, 681 (16.73%) locations with 8,137 (39.15%) customers experienced branch opening, 146 (3.59%) locations with 2,292 (11.03%) customers experienced branch closure, 237 (5.82%) locations with 4,571 (21.99%) customers experienced both and 3,006 (73.86%) locations with 5,786 (27.84%) customers experienced neither during our study time period.

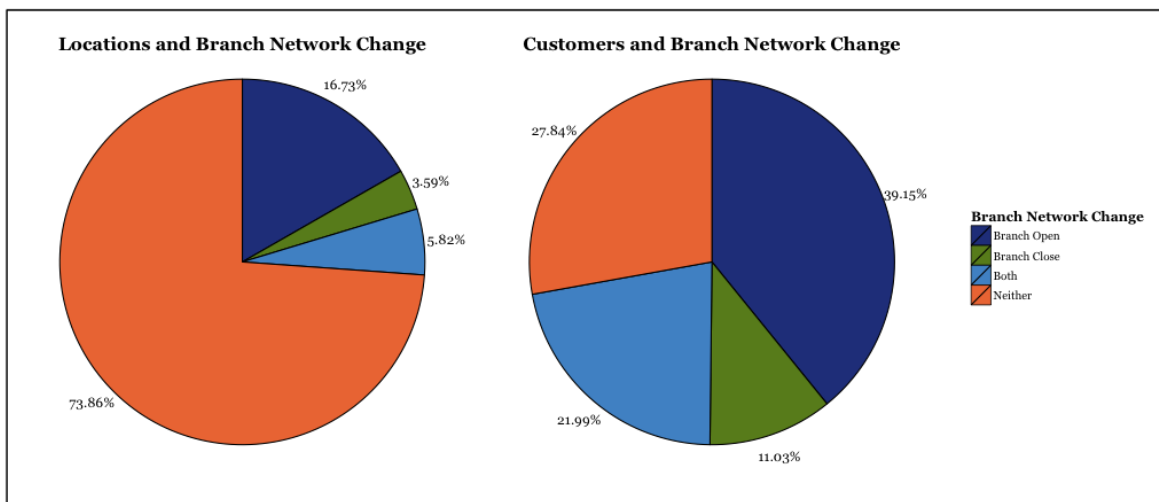


Figure 1. Branch Network Change Overview

First Branch Opening and Last Branch Closure. Banks show strong ambition to establish local markets in an area by opening a first branch, which is likely to bring strong branding effects to the local customers. Analogically, closing the last branch implies banks' intention to completely exit a local market. Thus, we believe there are extra effects with the first bank branch opened and the last bank branch closed. In order to capture the extra effects, we implement two variables #FirstBranch and #LastBranch, referring to the number of occurrences of first branch entries and last branch exits (inclusive of abandonment and re-entry) respectively. Overall, we observe 739 (18.16%) locations with 4098 (19.72%) customers experienced first branch opening, 151 (3.71%) locations with 1318 (6.34%) customers experienced last branch closure and 79 (19.41%) locations with 808 (3.89%) customers experienced both.

Control Variables

We include a variety of individual-level control variables to account for heterogeneity across customers in terms of their transaction behavior and characteristics. Specifically, in the propensity matching process, we use time-constant customer characteristics including age, tenure, states and income level and time-variant transaction behavior including the number of channels, number of transactions by channel, transaction amount, number and balances of accounts by account type. In the difference-in-differences model, we control for heterogeneous customer transaction behavior using their monthly transaction amount and number of account types held. We further control for the number of transactions by service type, while services not offered on the examined channel are omitted. Time invariant heterogeneity is assumed as individual-location fixed effects in our model. More details about control variables are discussed in section 4.

Model and Methodology

To compare customer multi-channel preferences before and after the branch network change between the treated group and the control group, we formally specify a difference-in-differences model. Since branch network change might be endogenously motivated by customer profiles of the bank like the number of customers, demographics and other observed and unobserved factors in a certain zip code area, we first apply propensity score matching method to resolve the potential customer endogeneity with branch network change. The matching process yields a control group, whereby customers didn't experience branch network change within their residential location throughout the study time period but have comparable characteristics and transaction patterns with customers who experienced branch network change. We then apply the matched data set on the difference-in-differences model to control for observed monthly banking behavior and unobserved fixed effects such as customer characteristics and banking environments. Furthermore, since the effects of branch network change on cross-selling performance take longer time to manifest and vary less frequently, we use logit models on cross-sectional data instead of difference-in-differences models on panel data. In the following subsections we will explain in detail the propensity score matching process followed by the difference-in-differences model specification.

Addressing Customer Endogeneity with Branch Network Change

Rather than open or close branches at a random place, banks usually follow their marketing strategy to restructure the branch network. From the branch network change overview we provide in Figure 1, we find that branch network change are more likely to happen in areas with higher population. Banks might also consider their own customer profile distribution, competitors and local banking environment when making decisions. In order to resolve customer endogeneity with branch network change, we use propensity score matching method to construct an unbalanced control group at the first stage of our analysis. We use the logistic model specified in Equation below to estimate the probability of a customer having branch network change in a particular month. Specifically, we model the propensity score as a function of the customer characteristics including age, state, income level and tenure and the average transaction behavior and account status within 6 months prior to the branch network change including transaction amounts, number of channels, transaction volumes through each channel, and numbers and balances of accounts held by account type. We compute the estimated propensity scores and match a control group whereby customers didn't experience branch network change with the treated group in which customers experienced either branch opening or closure during the study time period. In this way,

we intend to narrow down the pre-treatment distance in terms of customer characteristics and transaction patterns between the treated group and control group and assure the only significant difference between the two groups is the main effects – branch network change – that we are interested in.

$$Pr(\text{BranchOpen}_{it} / \text{BranchClose}_{it} = 1 | \cdot) = F(\text{Age}_i, \text{State}_i, \text{LowIncome}_i, \text{Tenure}_i, \text{LogTransaction}_{it}, \#\text{Channels}_{it}, \text{BRH}_{it}, \text{ATM}_{it}, \text{VRU}_{it}, \text{CCT}_{it}, \text{Online}_{it}, \#\text{DepositAccounts}_{it}, \#\text{LoanAccounts}_{it}, \#\text{InvestmentAccounts}_{it}, \#\text{OtherAccounts}_{it}, \text{\$DepositAccounts}_{it}, \text{\$LoanAccounts}_{it}, \text{\$InvestmentAccounts}_{it}, \text{\$OtherAccounts}_{it}, \text{Month}_t).$$

Since the bank continuously opened and closed branches in different districts over 73 months, we apply time-dependent propensity scores and perform the matching process at each time point to resolve the staggered treatments in our case. The time-dependent propensity score matching method allows us to balance the distribution of observed covariates in the matched treated group and control group at every time point (Lu 2005). We start the matching process from a random sample of 15,000 customers who experienced branch network change from April 2008 to October 2013. Among these customers, 12,708 experienced branch opening and 6,863 experienced branch closure in their residential areas. There is an overlap of 4,571 customers who received both branch opening and closure treatments. We then randomly select another 30,000 customers who didn't experience branch network change throughout the study time period. Since we believe that banks follow different marketing strategies for branch opening and closure plans, we match the untreated customers with customers treated with branch opening and closure separately. The matching process is performed at each time point with replacement, and it yields a final sample that consists of 20,786 customers for our econometric analysis.

Effects of Branch Network Change on Multi-Channel Usage

We formally estimate the impact of branch network change on customer multi-channel preferences with a difference-in-differences model. We follow Imbens et al. (2007) and use the counterfactual framework from the treatment effects literature to derive our model, with adjustments in model specification considering several specific issues. First, while most locations in our data have at most one branch opened, some areas experienced more than one branch opened during our study time period. The highest number of branches opened in a certain location during the 67 months is 6 in our data. Similar situation exists with branch closures. Thus, repeated treatments happen in our case and a general difference-in-differences model using a binary variable to identify the treated group does not accurately capture the average treatment effects. Hence, we use count variables – the number of branches opened and closed – instead of binary variables in our main analysis to estimate the average effects of each additional branch opened and closed.

Second, since the banking network serves all customers from a certain location as a whole, there are likely to be fixed differences across locations. For example, customers living in locations with higher density of branches and ATMs may depend more heavily on physical channels than customers living in locations with lower density of physical branch network. In contrast, customers living in locations with better technology implementation are more likely to choose electronic channels rather than physical channels for routine transactions. Furthermore, customers with different demographic characteristics such as age, gender and income will have different banking habits. Therefore, we implement an individual-location fixed-effects term in our model, which controls for all time-invariant individual and locational heterogeneity in customer banking behavior.

Last, our main response variables, the number of transactions by channel, have discrete values. That means linear regression models are not applicable in our case. Instead, we use a Poisson model to deal with the count data for our outcome variables. The model is formally specified as

$$y_{ijt} = C_{ij} + \beta_1 \#\text{BranchOpened}_{jt} + \beta_2 \#\text{BranchClosed}_{jt} + \beta_3 \#\text{FirstBranch}_{jt} + \beta_4 \#\text{LastBranch}_{jt} + \phi X_{it} + \varepsilon_{ijt}.$$

Here y_{ijt} is the outcome variable referring the number of transactions through each channel by customer i in location j at month t . To fully examine the effects of branch network change on customer multi-channel preferences, we estimate the model separately for each channel including branch, ATM, VRU, call center and online banking. We also test the impact of branch network change on the overall usage of offline channels (ATM, VRU and call center), the total number of channels used and the number of non-branch channels used. $\#\text{BranchOpened}_{jt}$ and $\#\text{BranchClosed}_{jt}$ are two discrete variables representing the number

of branches opened and closed in location j at or before month t respectively. We assume that banks make independent decisions to open or close branches, which allows us to incorporate $\#BranchOpened_{jt}$ and $\#BranchClosed_{jt}$ in one model. We also assume that the first branch opened and the last branch closed in a certain area has significant nonlinear effects on the outcomes. So we use $\#FirstBranch_{jt}$ and $\#LastBranch_{jt}$, which are the number of first branches opened and number of last branches closed in location j at or before time t to capture the extra effects. X_{it} is a set of control variables including transaction amount, the number of account types and the number of transactions by available transaction type on the estimated channel. C_{ij} is customer-location fixed effects and ε_{ijt} is idiosyncratic error term.

Effects of Branch Network Change on Cross-selling Performance

As we observe from the data, new banking product adoptions do not frequently happen, leading to little variation in the number of banking accounts a customer holds over time. Also, we believe the effects of branch network change on cross-selling performance take longer time to manifest. So we use logit model on cross-sectional data instead of difference-in-differences model on panel data to test the effects of branch network change on cross-selling performance. Specifically, we create another sample of customers using similar propensity score matching process, but include only customers who experienced at most one branch opening or closure throughout the study time period. This allows us to eliminate the extra effects caused by multiple branch openings or closures. We also ignore branch network change in the last 12 months from November 2012 to October 2013 in the propensity score matching process so that we observe full transaction behavior of each customer within one year after the treatment took place. We then specify the cross-sectional logit models as

$$\begin{aligned} Pr(D_OpenAccounts_i = 1 | \cdot) &= F(\beta_0 + \beta_1 D_BranchOpen_i + \beta_2 D_FirstBranch_i + \beta_3 Age_i + \beta_4 Tenure_i + \beta_5 LowIncome_i); \\ Pr(D_CloseAccounts_i = 1 | \cdot) &= F(\beta_0 + \beta_1 D_BranchClose_i + \beta_2 D_LastBranch_i + \beta_3 Age_i + \beta_4 Tenure_i + \beta_5 LowIncome_i). \end{aligned}$$

Here $D_OpenAccounts$ and $D_CloseAccounts$ are two indicators referring to whether the customer opened and closed any account within 3 months after the branch network change. We also test customers' adoption of banking accounts using 6 months, 9 months, 12 months and more than 12 months timeframes. $D_BranchOpen$ and $D_BranchClose$ indicate whether the customer experienced branch opening and branch closure during the study time period. $D_FirstBranch$ and $D_LastBranch$ indicate whether the branch opened is the first branch and whether the branch closed is the last branch in the area. We include a set of control variables including age, tenure and low income.

Results

In this section we discuss the results from estimating our difference-in-differences models and logit models. We lay out the effects of branch network change on customer multi-channel banking behavior, followed by detailed discussion on customer segmentation and post-treatment time trends. We then discuss the effects of branch network change on a bank's cross-selling performance.

Customer Multi-channel Migration Patterns with Branch Network Change

Table 2 summarizes the main results of the branch network effects on customer multi-channel banking behavior. Each column in Table 2 represents a set of estimated coefficients of the difference-in-differences model with transaction consumptions through specified channels and number of channels as dependent variables. The first two rows show the coefficients of the main effects variables that represent the number of branches opened and closed respectively. Both the coefficients of the number of branch opened and the number of branch closed are negative and significant for transactions through offline channels ($\#BranchOpened = -0.078$, $\#BranchClosed = -0.028$; $p < 0.001$) and positive and significant for transactions through online banking ($\#BranchOpened = 0.024$, $\#BranchClosed = 0.098$; $p < 0.001$). This implies that a nearby branch opening will reduce customer transaction costs such as transportation costs and waiting time costs through branches, thereby substitute customers away from other offline channels, especially for certain types of transactions.

	Branch	Offline	Online	BranchWithin	BranchOutside
#BranchOpened	-0.030*** (0.002)	-0.078*** (0.001)	0.024*** (0.000)	0.116*** (0.004)	-0.231*** (0.005)
#BranchClosed	-0.032*** (0.003)	-0.028*** (0.001)	0.098*** (0.001)	-0.002 (0.006)	-0.106*** (0.008)
#FirstBranch	0.023*** (0.005)	-0.002 (0.002)	0.069*** (0.001)	0.400*** (0.013)	-0.046*** (0.010)
#LastBranch	-0.062*** (0.009)	-0.017*** (0.004)	-0.068*** (0.002)	-2.038*** (0.045)	0.493*** (0.018)
Observations	1,178,586	1,178,586	1,178,586	694,256 ^a	694,256 ^a
	ATM	VRU	CallCenter	#Channels	#Non-BrhChls
#BranchOpened	-0.029*** (0.001)	-0.211*** (0.002)	-0.110*** (0.003)	-0.011*** (0.001)	-0.009*** (0.001)
#BranchClosed	-0.001 (0.002)	0.023*** (0.003)	-0.182*** (0.005)	-0.007*** (0.002)	-0.002 (0.002)
#FirstBranch	-0.017*** (0.003)	0.045*** (0.005)	-0.030*** (0.007)	0.003 (0.003)	0.004 (0.003)
#LastBranch	0.043*** (0.006)	-0.014 (0.009)	-0.063*** (0.013)	0.015*** (0.005)	0.024*** (0.006)
Observations	1,178,586	1,178,586	1,178,586	1,178,586	1,178,586
Controls —LogTransaction\$ —#AccountTypes —#Transactions (on available transaction types)					

Notes. Standard errors are in parentheses. Regressions include individual-location fixed effects.

^a Customers whose branch transaction location cannot be detected are excluded.

*Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Table 2. Effects of Branch Network on Customer Multi-channel Banking Behavior

However, the results show that a new branch entry is unlikely to significantly narrow the gap of transaction costs with online banking but is more likely to enhance brand awareness and customer loyalty, bringing higher transaction traffic through online banking. The finding is consistent with that of other multi-channel studies using sales data from a single retailer (Kumar et al. 2014, Avery et al. 2012, Bell et al. 2015), suggesting that physical stores serve as complements, rather than substitutes, to the online channel. Surprisingly, we find that after a nearby branch closed, customers do not move in inverse directions from online banking to offline channels. They will instead take the major convenience of online banking and increase their transaction consumptions in a large magnitude. The results reveal an interesting customer migration pattern from offline channels to online banking after branch network change.

The consistency exhibited by the estimates for separate offline channels (ATM, VRU and Call Center) provides strong support for this finding. Specifically, all of the offline channels have reduced numbers of transactions after the branch opening (#BranchOpened = -0.029, -0.211 and -0.110 for ATM, VRU and Call Center respectively; $p < 0.001$ for all). After the branch closure, although VRU has a slight increase of 2.3% in transaction traffic, there is no significant effect on ATM and a large decrease of 18.2% in the number of transactions through call center. Besides, we observe that the substitution effects of branch network change on offline channels are generally larger on human-service channels (call center) that are closer to the physical channel in terms of banking services offered than on self-service channels (ATM and VRU).

The negative coefficient of the number of branches opened on transactions through the branch channel suggests that the overall transaction traffic in branch suffers from a slight decrease of 3.0% after the branch opening. This shows different insights to prior retailing papers suggesting that the presence of a retail store increases physical store sales due to reduced transaction costs (Avery et al. 2012, Bell et al. 2015 and Kumar et al. 2014). To understand the counter-intuitive result, we separately estimate customer transactions with branches in their residential areas and out of their residential areas. We find that branch opening in a certain zip code area drives residents back from transacting at outside locations, leading to a substantial decrease of 23.1% in their transactions through outer branches and an increase of 11.6% in transactions through inner branches. In addition, the decrease in transaction traffic through the

branch channel subsequent to a nearby branch closure ($\#BranchClosed = -0.032$; $p < 0.001$) basically stems from lower usage of outer branches ($\#BranchClosed = -0.106$; $p < 0.001$). Customers tend to find substitute branches in their neighborhoods and will move on to outside branches only when the last branch in their residential area is closed ($\#BranchClosed = 0.493$; $p < 0.001$).

Furthermore, the significant coefficients of the first branch opened and the last branch closed support our earlier assumption that entering a new market and exiting an existing market bring about extra effects on customer multi-channel banking behavior. Also, customers seem to drop some other channels in use ($\#BranchOpened = -0.009$; $p < 0.001$) after the branch opening but are not likely to adopt new channels after the branch closure. Thus with the support shown from the estimating results, we preliminarily conclude that branch network change facilitates customer migration from offline channels to online banking.

Comparison of Multi-channel Banking Behavior Among Customer Segments

To explore the differences in effects of branch network change among different customer groups, we categorize the sample customers into heavy branch users, light branch users and non-branch users according to their dependency on the physical channel. Heavy branch users are defined as customers whose average number of transactions through the branch channel is above the median of all customers; light branch users refer to customers whose average number of transactions through the branch channel is equal to or lower than the median of all customers; and non-branch users are those who didn't use the branch channel at all throughout the study time period. We then estimated the difference-in-differences model with each customer group. We plot the average treatment effects of branch opening and closure against different channels in two separate bar charts in Figure 2. Three columns in each group represent the effects of branch network change on the focal channel usage by heavy branch users, light branch users and non-branch users, respectively.

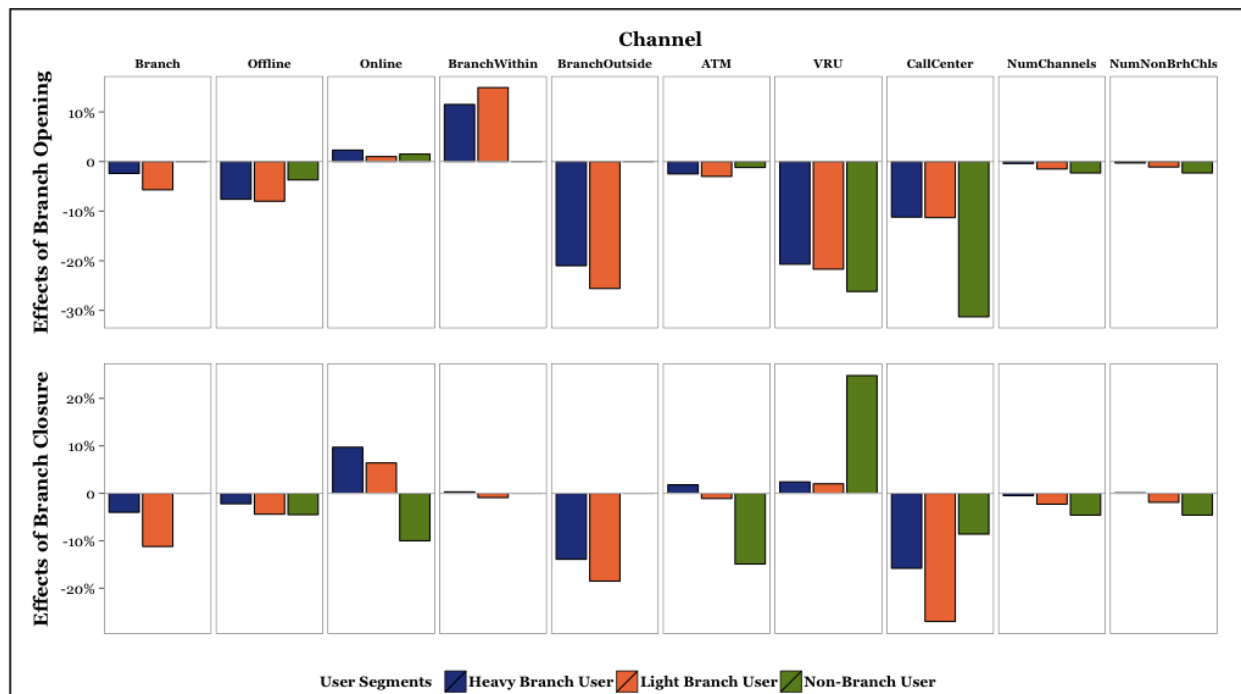


Figure 2. Multi-channel Usage with Customer Segmentation

Comparing the effects on different channels among customer segments, we find that heavy branch users are more sensitive with their online banking transactions while light branch users mostly change their offline banking behavior in response to the branch network change. Specifically, we observe that controlling for customer characteristics and other banking behavior, light branch users will decrease their offline transactions by 8.0% after a nearby branch opened, which is slightly higher than the reduction for

heavy branch users (#BranchOpened = -0.076; $p < 0.001$). But they will decrease their offline transactions by about twice (#BranchClosed = -0.044; $p < 0.001$) the reduction rate of heavy branch users (#BranchClosed = -0.022; $p < 0.001$) after a nearby branch closed.

One of the reasons for this discrepancy may lie in the original close tie to the physical channel for heavy branch users, so they are less likely to be affected by the change of branch network on other channel usage. However, another interesting fact we observe is that heavy branch users will increase their online banking transactions by 2.3%, compared with 1.0% for light branch users after branch opening. Meanwhile, heavy branch users tend to increase their online banking usage by 9.7%, compared with a lower growth of 6.4% for light branch users after branch closure. The intensive enhancement in online banking usage for heavy branch users after branch network change reveals that the physical presence of a bank is helpful for building close customer relationship, leading to more significant online banking migration rather than customer churn.

The estimates on separate offline channels of ATM, VRU and call center and number of channels in use are consistent with our above findings. The results point to different responses from customer segments, leading us to conclude that branch network change will have larger effects on heavy branch users for their online banking transactions and on light branch users for their offline channel transactions. This helps the bank understand channel preferences of targeted customer groups and maintain efficiency in the branch network restructuring.

Robustness and Visualizing Post-treatment Trends in Customer Multi-channel Banking Behavior

To ensure that our difference-in-differences estimates are robust, we test our models with another random sample of customers who experienced at most one branch opening or closure in our study time period. Then #BranchOpened, #BranchClosed, #FirstBranch and #LastBranch in the main model become binary variables and are denoted as D_BranchOpen, D_BranchClose, D_FirstBranch and D_LastBranch. This ensures the model to fit the standard difference-in-differences model by eliminating effects from multiple branch openings and closures at a certain location. The estimation results using binary data are consistent with the results using count data with slight inflation in numbers, which provides identical support for our earlier conclusion as well as for our assumption that the first branch opened and the last branch closed have extra effects on customer multi-channel behavior.

We further estimate branch opening and closure effects with two separate models to eliminate the potential correlation between branch opening and closure. The results are also consistent with our earlier findings, affirming the specification of our difference-in-differences model and increasing our confidence about the conclusions that can be drawn related to customer multi-channel preferences. Moreover, with separate models, we are able to explore the post-treatment trends by substituting the D_BranchOpen (D_BranchClose) with 5 indicator variables – PostOpen3 (PostClose3), PostOpen6 (PostClose6), PostOpen9 (PostClose9), PostOpen12 (PostClose12) and PostOpen12+ (PostClose12+), which represent the post-treatment month 1-3, 4-6, 7-9, 10-12 and after 12, respectively. Then the difference-in-differences models are re-specified as

$$y_{ijt} = C_{ij} + \sum[\beta_T PostOpenT_{jt} + \gamma_T PostOpenT_{jt} \times D_FirstBranch_{jt}] + \phi X_{it} + \varepsilon_{ijt}, \text{ where } T = 3, 6, 9, 12 \text{ and } 12+;$$
$$y_{ijt} = C_{ij} + \sum[\beta_T PostCloseT_{jt} + \gamma_T PostCloseT_{jt} \times D_LastBranch_{jt}] + \phi X_{it} + \varepsilon_{ijt}, \text{ where } T = 3, 6, 9, 12 \text{ and } 12+.$$

We plot the post-treatment trends in customer multi-channel usage in Figure 3, with two marked lines representing the average treatment effects of branch opening and closure on the focal channel over time. The qualitative results we have arrived in our main model are also supported in the long-term trend analysis, suggesting that both branch opening and closure will decrease customer offline transactions and enhance their online banking usage. In terms of changing effects over time, however, we observe distinct trends for different channels.

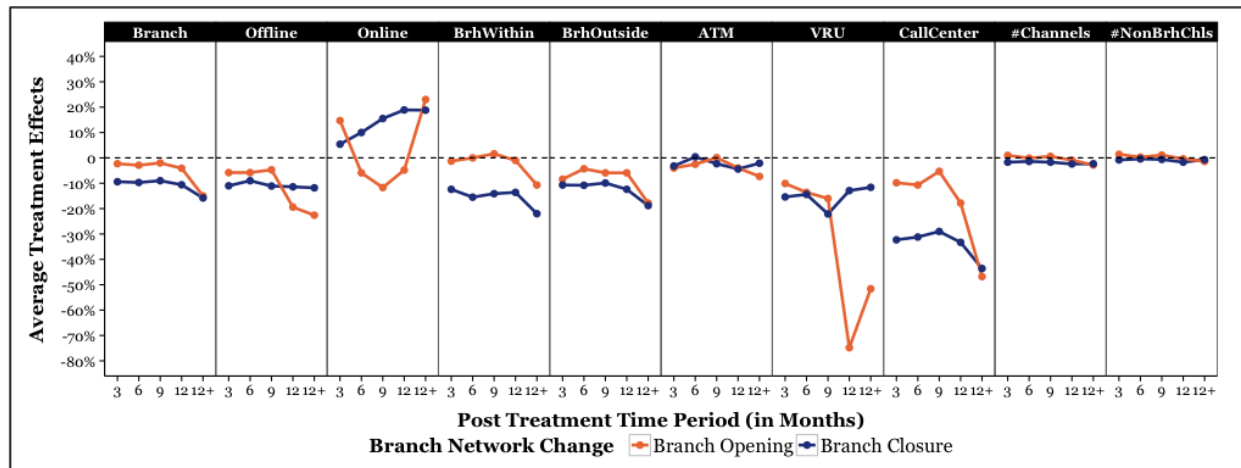


Figure 3. Post-treatment Trends of Customer Multi-channel Usage

For enhancement in transaction volumes through online banking, branch opening tends to cause a short-term boost as opposed to growing effects in a long term after branch closure. In contrast, while branch closure has constant downward pressure on offline transactions over time, we observe significant lagged effects of branch opening on customer transaction consumptions through offline channels. We think one probable cause of the varying trends across different channels is that substitution between channels (i.e. branch opening and offline channels usage, online banking usage and branch closure) takes longer time than synergy (i.e. branch opening and online banking usage, branch closure and offline channels usage) to manifest due to customer switching costs and learning processes. Moreover, we need to look into services offered with each channel and their multi-channel integration to have a thorough understanding. For example, some more complex services such as financial product inquiries are only available through branch, then subsidiary transactions related to this main service will be swiftly reduced after branch closure. Meanwhile, customers are like to gradually move online for those replaceable services to take advantage of the substantially reduced transaction costs.

Cross-selling Performance with Branch Network Change

We complete our research by further investigating the effects of branch network change on cross-selling performance. Our estimation results of cross-sectional logit model are summarized in Table 3.

D_OpenAccounts				
	Post-3 months	Post-6 months	Post-9 months	Post-12 months
D_BranchOpen	0.248*** (0.045)	0.190*** (0.041)	0.134*** (0.039)	0.090** (0.037)
D_FirstBranch	0.227*** (0.046)	0.201*** (0.042)	0.165*** (0.040)	0.145*** (0.038)
Observations	14,200	14,200	14,200	14,200
D_CloseAccounts				
	Post-3 months	Post-6 months	Post-9 months	Post-12 months
D_BranchClose	0.189* (0.102)	0.095 (0.079)	0.004 (0.068)	0.036 (0.063)
D_LastBranch	-0.062 (0.113)	0.076 (0.085)	-0.007 (0.075)	-0.004 (0.069)
Observations	6,783	6,783	6,783	6,783
Controls -Age -Tenure -LowIncome				

Notes. Standard errors are in parentheses.

*Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Table 3. Effects of Branch Network Transformation on Cross-selling Performance

We observe positive and significant coefficients of the branch-opening indicator for customers' banking products adoption behavior. However, the numbers diminish as we change the studied time frame from 3 months to 6, 9 and 12 months ($D_BranchOpen = 0.248, 0.190, 0.134, 0.090$ for 3, 6, 9 and 12 months; $p < 0.001$). This suggests that branch opening has positive impacts on the bank's cross-selling performance, with stronger influence from the first branch entry into a local market. However, customer acquisitions mainly happen shortly after branch opening, and the effects are cut down over time. The results imply that branch opening bring branding effects to a local market in a short term, improving customer awareness and willingness to adopt new banking products. On the other hand, although the coefficients of the branch closure indicator are positive, they are not significant at 1% level. So we cannot conclude that customers will close their banking accounts after branch closure.

Conclusions

The disruptive technology in financial services industry leads us to re-think the distribution of physically presented bank branches in this paper. Specifically, we investigate branch network change, a major strategy that leading banks are actively deploying in current financial services industry to accommodate changing customer preferences, and its impact on customer multi-channel banking behavior.

Our empirical analysis suggests that branch network change including branch opening and closure facilitates customers' migration from offline channels to online banking. However, branch opening leads to rather short-term boost on online banking usage and long-term substitution effect on offline channel usage, while branch closure tends to constantly decrease customer transactions through offline channels and increase customer transactions on online banking in a long run. By looking at the effects among customer segments, we find that heavy branch users are more sensitive with their online banking transactions while light branch users primarily change their offline banking behavior in response to the branch network change. In addition, our results show that branch opening is associated with additional banking products adoption, whereas customers are not likely to close their accounts after the branch closure.

Our work emphasizes the importance of investigating physical channel network change and its impact on customer behavior, especially under the complex multi-channel settings with high-tech disruptions in current financial services industry. Although a considerable number of researches have started from online banking adoption and explored customer channel preferences and banking behavior, surprisingly, there has not been an empirical study that focuses on the effects of bank branch network change. We provide some of the first glances into customer behavior in response to branch network change under the context of financial services. In addition, some papers in retailing industry have investigated the impact of physical store entries on local markets, but few of them offered empirical evidence to quantify the effects of physical store exits. Our work also complements this bunch of researches by adding insights about customer behavior from the perspective of physical store closure.

We also provide useful strategic implications on branch network restructuration in multi-channel service delivery system in practice. First, our results offer new insights about customers' migration pattern from offline channel to online banking after the branch network change. Such insights allow banks to have clearer foresights of customer behavior, thus enhance their confidence in making strategies to restructure the branch network. Second, by looking into different customer segments, locations and time frames, we point to important targeted marketing strategies in branch network restructuration. Banks can utilize the knowledge of relative magnitudes of parameters estimated to optimize the design of branch network distribution. Third, our analysis of cross-selling performance suggests potential benefits in increasing banking product sales with branch openings and release concerns about customer churns with branch closures. We hope that our research will help senior managers in financial services industry to develop a more realistic view of customer behavior in multi-channel financial services and deploy the branch network transformation in a more effective way.

Furthermore, our research has suggestive implications for firms with multi-channel service delivery systems in other industries. The differences in products and services offered by various firms should be considered for external application though. For example, our results are less likely to be informative for retailing industry where main products offered through multi-channels are physical goods, but will be

more applicable for industries where main products offered through multi-channels are virtual goods and services.

The difficulty to generalize our results in all contexts is one of the main limitations of this paper. Our work focuses on financial services industry to achieve higher statistical power in this specific context, so the insights we achieve will be useful especially for financial institutions. However, as we have mentioned above, the findings will be much harder to be applied in other industries, restricting us from building more generalized knowledge of customer multi-channel behavior. Another limitation of generality involves our data from a single bank in US. More generalized insights of customer behavior will require data from more banks with different demographics and customer profiles. Since our data consists of a large sample of customers from a typical commercial bank in US, which is a major financial services market, we are more confident that the distribution of our sample customer profiles are in line with other financial institutions and the conclusions we draw will shed light on the branch network design more broadly. Furthermore, the lack of data from other banks prevents us from controlling for the competing effects in the local market. Our reasonable assumption of individual-location fixed-effects based on a six-year study, during which the financial services industry in US experienced steady growth nationwide, at least partially resolves our concerns about the effects from rival banks on our results. Thus, future research with data from broader sites or other behavioral or survey approaches may provide further insights on customer multi-channel banking behavior in branch network restructuring.

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