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2019

Son, Y., Kwon, E. H., Tayi, G. K., & Oh, W. (2019). Impact of customers' digital banking adoption on hidden defection: A combined analytical–empirical approach. *Journal of Operations Management*, 66(4), 418–440. doi:10.1002/joom.1066

<https://hdl.handle.net/10356/143718>

<https://doi.org/10.1002/joom.1066>

This is the accepted version of the following article: Son, Y., Kwon, E. H., Tayi, G. K., & Oh, W. (2019). Impact of customers' digital banking adoption on hidden defection: A combined analytical–empirical approach. *Journal of Operations Management*, 66(4), 418–440., which has been published in final form at doi:10.1002/joom.1066. This article may be used for non-commercial purposes in accordance with the Wiley Self-Archiving Policy [<https://authorservices.wiley.com/authorresources/Journal-Authors/licensing/self-archiving.html>].

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Impact of Customers' Digital Banking Adoption on Hidden Defection: A Combined Analytical-Empirical Approach

Yoonseock Son

College of Business, Korea Advanced Institute of Science and Technology

Hyeokkoo Eric Kwon¹

Nanyang Business School, Nanyang Technological University, Singapore

Giri Kumar Tayi

School of Business, State University of New York at Albany

Wonseok Oh

College of Business, Korea Advanced Institute of Science and Technology

Abstract

The implementation of digital channels as avenues for economic transactions (e.g., online and mobile banking/FinTech) has shifted the paradigm of customer–bank interactions, providing unprecedented opportunities for both parties. The prevailing belief is that digital banking has several advantages, such as lower costs and higher information transferability for customers. These benefits can also promote competition between banks given customers' predilection for “multi-homing,” or engagement with multiple banks. This study investigated the impact of customers' digital banking adoption on hidden defection, in which customers purchase financial products from competing banks instead of their primary banks. To this end, we developed an analytical model to provide insights into the effects of digital banking adoption while taking customers' multi-homing behaviors into consideration. We then conducted a series of empirical analyses using comprehensive individual-level transaction data to provide evidence of hidden defection. Our findings indicate that customers with higher loyalty exhibit greater hidden defection after digital banking adoption. Customers who engage primarily with personal-service channels (e.g., branches) show stronger hidden defection than do self-service channel (e.g., ATMs) users, and this effect is more prevalent among loyal customers. Our results provide valuable implications for omni-channel services in a market characterized by multi-homing behavior of customers.

Keywords: digital banking adoption, online and mobile banking, FinTech, customer defection, omni-channel strategy, multi-homing, transaction cost economics, information stickiness, panel data, econometric analysis, difference-in-differences model, analytical model

¹ Correspondence: eric.kwon@ntu.edu.sg

1. INTRODUCTION

The rapid digitalization of business worldwide has challenged conventional business models by breaking down industry boundaries while engendering new opportunities. This digital disruption (e.g., online and mobile banking/FinTech) is substantially reshaping the financial service industry (Weill and Woerner 2015). The disruption is forcing banks to refine their costs and profit models by improving their control over operational and administration costs and thereby enhancing profitability (Yiu et al. 2007). This paradigm shift has led to a predicament wherein traditional banks are called on to satisfy the changing demands of clients while having to cope with the effects of the technology infusion propelling the changes (Deloitte 2015).

The advent of digital technology has affected the core of the banking business and has changed the conventional financial services operating system, which had been dominated by offline employee-oriented services. The improved efficiency and cost-effectiveness of technology-enabled service delivery processes (e.g., the reduced need to incur physical costs of branch operations; Boyer et al. 2002) have shifted the managerial focus toward enhancing the efficiency of digital channel operations to reduce operational costs. More importantly, as an increasing number of banks are providing digital banking services, it is imperative that banks understand how customers use the digital services and employ their benefits to foster better customer relationships (Chan and Lu 2004).

The digitalization of service channels has led to substantial changes from the consumers' point of view. Information technology (IT) advances have altered how customers interface with service providers and have thus affected how customers perceive the service experience (Boyer et al. 2002). Prior to the advent of digital banking, consumers engaged primarily with a single bank. However, greater information accessibility and reduced search and transaction costs (Bakos 1997; Brynjolfsson and Smith 2000), as well as the reduced setup costs (Sun 2008) enabled by IT, have triggered customers' multi-homing behaviors and have allowed them to easily access multiple banks simultaneously. A recent report revealed that roughly one in two Americans has an account with more than two banks (Huddleston 2018) and that customers are

increasingly willing to switch primary banks (i.e., the bank to which a customer is most loyal among other banks s/he transacts with),² behaviors that are detrimental to the value of long-term customer relationships (Ernst & Young 2010). This “hidden defection,” in which customers purchase financial products from competing banks instead of from their principal financial institutions, represents a total cost of \$11.4 billion to traditional banks (Bain & Company 2016). This figure is alarming to banks because it points to the potential hidden defection of loyal customers, diverting their loyalty from the focal bank to a rival institution. For instance, banks can lose the customers who tend to become long-term customers, such as those who purchase mortgages (Weill and Woerner 2015). More importantly, hidden defection accounts for 9% to 13% of the annual 10% to 15% losses in gross revenues resulting from customer attrition; this proportion is not detected by banks immediately because these institutions track only the most evident forms of attrition (e.g., client exits) while overlooking less-apparent forms (BCG 2017). As stated by Gerard du Toit, head of Bain’s Banking Practice, “customers are going to go elsewhere for any new needs, and if someone makes it easy to escape their bank for a better place, they’re going to run right out” (Bain & Company 2016).

Changes in the financial services industry have raised concerns among banking executives, stimulating serious debate about whether and how customers’ digital banking usage will affect their loyalty levels. On the one hand, customer loyalty may be enhanced because digital channels allow more efficient and personalized banking service experiences at lower costs (Xue et al. 2007). On the other hand, digital channels can wear away the bond between customers and banks by reducing barriers to entry, thus promoting switching behaviors and diminishing human connection with the banks (The Economist 2015). Similarly, a number of service operations management studies have found that, although technology-based services may reduce transaction costs, customer loyalty may also decline in the long run due to the dissatisfaction of service providers (Heim and Sinha 2001; Thirumalai and Sinha 2005).

Several studies have endeavored to identify the effects of digital banking³ from both the information

² Thus, it may be the bank with which a customer does most of her/his financial business and with which s/he holds most of her/his financial accounts (EY 2010). Accordingly, we utilize various operationalizations of the primary bank in our empirical analyses for generalizability.

³ Our focus in comparing digital to non-digital channels is the difference in transaction costs. We thus consider digital banking as both online and

systems and service operations perspectives (e.g., Campbell and Frei 2010; Xue et al. 2011). For example, Campbell and Frei (2010) examined the effects of digital banking channel adoption on local branches, automated teller machines (ATMs), and phone banking and found that adoption was associated with the substitution of low-cost self-service channels (e.g., ATM, phone banking), the augmentation of costly personal-service channels (e.g., branch visits), and an increase in total transaction volume. We extend this stream of research by unraveling potential downsides of digital banking from the bank's perspective. In reality, digital banking channels may not be wholly favorable to banks but instead may leave them vulnerable to customer churn in a highly competitive environment. This study explores that possibility by illuminating the role played by customers' digital banking adoption in inducing hidden customer defection ("hidden defection" hereafter).

To this end, we adopt the transaction cost economics and information stickiness perspectives to theorize on how customers' digital banking adoption may lead to hidden defection. In line with our theoretical reasoning, we construct an analytical model under the assumption of customers' multi-homing behaviors to formulate propositions on hidden defection following customers' digital banking adoption. We then empirically identify hidden defection using actual customer-bank transaction data to provide a more comprehensive understanding of digital banking adoption.

On the basis of our analytical model, we anticipate an increase in hidden defection as digital channel usage intensifies and increased effects of usage intensity on profits as the number of loyal customers (i.e., those who perceive a focal bank as their primary bank) increases. Motivated by the results of our analytical model, we carry out a difference-in-differences analysis with unique individual-level transaction data on 7,102 customers' comprehensive banking transaction records to identify the expected behaviors regarding hidden defection. In line with the model results, the empirical findings show that the customers' digital banking adoption negatively influences loyal customers' acquisition of financial products from the focal

mobile banking, which provides customers with lower transaction costs vis-à-vis their non-digital counterparts. Non-digital channel services include offline branches, ATM, call centers, and voice response units. Both digital and non-digital channels provide the same services.

bank and that the effects of customers' digital banking adoption on customers' profitability decrease and even become negative as customer loyalty to focal banks increases. We further validate our results by operationalizing customer loyalty using different measurements and by providing qualitative support to our argument through a survey. We also empirically identify that loyal customers who rely more on personal-service channels (e.g., branches) prior to digital banking adoption show a higher degree of hidden defection after digital banking adoption in comparison to those who rely more on self-service channels (e.g., ATMs), indicating potential adverse effects due to the current trend of branch closures.

This study makes several contributions to the literature on digital banking service channels. First, our study is among the first to combine analytical modeling and empirical analyses to illuminate customers' multi-homing behavior in the digitalized financial industry. While pervasive multi-homing behaviors have been widely acknowledged as a critical factor in the competitive dynamics of the banking industry, only a few studies have investigated how multi-homing exerts its effects. Our use of an analytical model for this purpose enabled us to theoretically explain the potential occurrence of hidden defection. Second, although examinations of IT in the operations management literature have primarily focused on its adoption by service providers (i.e., Akturk et al. 2018; Swink et al. 2007), several studies have asserted the need for a more comprehensive understanding of business integration (Oh et al. 2012). Our study provides this understanding by offering insight into digital channel adoption from a customer's perspective. Third, we reveal the importance of considering customer loyalty—a crucial factor affecting hidden defection, as proposed in the analytical model—by investigating the differential effects of digital banking adoption across customers with varying loyalty levels to the focal bank. Fourth, our findings extend those of previous digital banking adoption studies focusing on channel migration. This study is one of the first to examine how the effects of digital financial channel adoption differ according to customers' prior channel usage patterns (i.e., self-service channels, personal-service channels) and to ascertain that these effects are pervasive among loyal patrons who rely more on personal-service channels. Thus, banks can predict and prevent hidden defection by accounting for both customers' loyalty and channel usage patterns prior to their

use of digital financial channels. Finally, whereas previous studies considered total transaction volume as their main outcome of interest, we also examine how customers' digital banking adoption affects the acquisition of financial products and the moderating effect of customer loyalty level, which is closely related to long-term customer relationships (Weill and Woerner 2015). Overall, our findings expand the research by filling an important research gap in the literature's understanding of customer behaviors in the digitalized financial environment.

2. RESEARCH BACKGROUND

The emergence of IT-based self-service channels in the financial industry has given rise to a paradigm shift in how customers interact with financial institutions. Studies have attempted to comprehend the relationship between digital banking usage and customer action, and researchers have explored the effects of customers' digital banking adoption on customer transactions in both offline and digital contexts—efforts that can be traced back to Hitt and Frei (2002). Whereas a large body of literature on digital banking adoption used self-reported surveys (Shaikh and Karjaluoto 2015), Hitt and Frei (2002) enriched this stream of literature by using actual customer data to investigate the intrinsic differences between customer characteristics in terms of channel usage behaviors. Xue et al. (2007) then examined the association between customers' channel choice and firm performance, confirming a link between high customer efficiency and high profitability. Furthermore, Fung (2008) investigated the impact of labor-saving technologies on the efficiency of human resources usage in the banking industry and found that the optimization of digital technologies and human resources usage could improve overall customer efficiency. Expanding the findings of previous studies, Campbell and Frei (2010) and Xue et al. (2011) empirically investigated how customers' digital banking adoption affects channel competition. Recently, Liu et al. (2016) examined the influence of online channels on customer actions across different digital channels and their effects on overdraft and credit card penalty fees. Together, these studies have provided interesting insights into the positive effects of online channel adoption on customers' banking actions.

Our work differs from these studies in that we focus on a critical element concerning the implementation of digital channels in the financial industry—multi-homing behavior—and a consequent phenomenon that may negatively affect traditional banks’ customer base in the long term—hidden defection. Obtaining the transaction data of customers doing business with multiple banks is extremely challenging, as it was for previous studies. Thus, we supplement their efforts by developing an analytical model that accounts for competitive components to theoretically derive fundamental insights into hidden defection, and then empirically validating those theoretical insights via actual transactional data.

Moreover, customers often avail themselves of multiple services to derive maximum utilities despite the inevitable incurrence of overlapping costs, such as subscription fees and management expenses. For example, customers subscribe to several news agencies to comprehend an event from diverse perspectives. Similarly, many banking customers own multiple credit or debit cards to optimize their payment experiences and maximize the benefits offered by card providers. Such behavior is also commonplace in the consumption of digital goods and services; users often engage with multiple social network services (SNSs) to amplify social utility (Cusumano 2011; Kwon et al. 2017). This phenomenon is known as “multi-homing” (Mantena et al. 2012; Rochet and Tirole 2003). In pursuit of a more comprehensive understanding of widespread multi-homing behavior, studies have scrutinized the conditions that are sufficient and necessary for them to occur. Rochet and Tirole (2003) suggested that multi-homing is more prevalent in conditions wherein users incur no fixed usage costs for patronizing multiple services. Zhang and Sarvary (2015) inquired into different equilibria under the assumption of single- and multi-homing behavior. On the basis of a theoretical model, they determined that the greater the number of multi-homing users, the fiercer the providers’ product differentiation challenges.

More important is the suggestion of recent studies that the assumption of single-homing behavior can engender significant bias in research contexts where multi-homing behavior is prevalent given the distinct competitive dynamics under single- and multi-homing assumptions. Goode (2013) argued that the influencing factors for a customer’s propensity to switch to another cloud storage service differ significantly

between multi- and single-homing users. Using a theoretical modeling approach, Ambrus et al. (2016) asserted that a consideration of multi-homing behavior substantially changes the competitive nature of digital advertising markets. Empirical research has also emphasized the need to consider multi-homing behavior. Kwon et al. (2015) insisted that a single-homing assumption expressed in the form of a choice model can critically distort the competitive nature of digital goods (i.e., mobile social applications). In the same vein, we account for pervasive multi-homing behavior in the banking context in favor of the implementation of digital channels by operationalizing customer loyalty toward a focal bank.

3. THEORIES AND HYPOTHESES

3.1 Transaction Cost Economics and Digital Channel

A core management objective of service providers is to reduce transaction costs for themselves and customers (Williamson 1975, 1985). Transaction cost economics (i.e., Coase 1937; Williamson 1985) emphasizes the role of transaction costs associated with each step in an economic exchange. It posits that buyers and sellers engaged in an economic exchange will choose to conduct transactions at the minimum transaction cost. Most operations management studies have examined this issue from the supply side—from intra- and inter-firm perspectives—highlighting digital technology as a means of reducing transaction costs and maneuvering the high-value end of the banking supply chain (i.e., Chan and Lu 2004; Froehle and Roth 2004; Rabinovich et al. 2007; Sanders 2007). The transaction cost economics perspective has also been widely applied to articulate the relationship between transaction costs and digital technology.

Transaction cost economics views an exchange between two parties (e.g., service providers and customers) as a discrete event with a value of its own and reflects on the relationship between each party's ability to make rational decisions according to their own cost structures. Specifically, parties involved in the transaction will incur costs while identifying the appropriate counterpart and obtaining information on the products and services (i.e., search cost). According to transaction cost theory, the economic participants will attempt to make the purchase process more efficient by reducing the associated transaction costs

(Williamson 1975).

Transaction cost economics has been widely used in the operations management literature, especially regarding supply chain management (i.e., Rindfleisch and Heide 1997). The major concern of these studies is that the coordination of interactions between players may be limited due to high transaction costs, reducing market transaction efficiency and ultimately increasing market prices (Sanders 2007). Transaction costs in supply chain management encompass various forms of coordination costs incurred when information is exchanged and integrated into the final decision process (Grover and Malhotra 2003; Johnson et al. 2007). Digital technologies, as a means of alleviating such inefficiency, have been studied in terms of their effects on supply chain activities and are known to decrease transaction costs and other costs associated with transaction risks (i.e., Power and Singh 2007).

Despite the extensive attention paid to the costs of inter- and intra-firm transactions in supply chain and logistics, only a few operations management studies have examined transaction cost economics in relation to customer action, which is equally important but has only recently begun to attract scholarly attention (Akturk et al. 2018; Tsai et al. 2013). Digital technology usage can affect service production economics from the customer's point of view, as it affects not only firms' operational costs but also customers' actions and service demands (Campbell and Frei 2010). Similar to how digital technology reduces transaction costs in service providers' operation processes, engaging customers with the technology is known to reduce customer transaction costs and offer various benefits such as reducing the time and cost of communication, as well as the costs associated with product search and selection processes (Bakos 1991; Malone et al. 1987). Likewise, to integrate digital technologies into their value chain activities, firms operating on digital channels must also understand the changes in demand-side transaction costs that are incurred through changes in customer actions. As customers are at the end of the value chain, we focus on demand-side transaction costs.

Transaction costs are incurred at each step of the purchase sequence, including store access, search, evaluation, selection, and payment (Chircu and Mahajan 2006). Digital technology usage is known to

reduce such underlying costs within the operation structure, altering how service providers and customers interact and ultimately leading to a need for structural changes (Power and Singh 2007). Due to the lower information search costs, customers will form different perceptions of equivalent services depending on the channel with which they are engaging (Boyer and Hult 2006).

3.2 Impact of Digital Channel Adoption on Financial Product Acquisition

We focus on the role of transaction cost economics on digital channels and how subsequent customer actions are affected by digital channel adoption. Previous studies have identified several types of transaction costs in the retail transaction chain (i.e., Chircu and Mahajan 2006). Though various definitions and operationalizations of demand-side transaction costs have been used according to the research context, previous studies have used consistent categories of transaction costs in the digital channel context: time-type, price-type, and psychological-type costs (Chircu and Mahajan 2006; Griffis et al. 2012).

In our study, time-type costs comprise the time-related costs incurred during customers' product search activities. As digital technology usage is likely to have the greatest impact on how customers access information during the search processes, we focus on the time-type costs incurred during customers' product search activities. In consideration of the role digital technology plays in searches for financial products in the banking context, we follow previous literature and focus on four types of costs, namely costs associated with traveling, waiting, searching, and comparing between financial products (i.e., search and acquisition costs). For instance, the searching process in offline branches involves the cost of traveling via a means of transportation (i.e., driving, taking public transportation, walking); once customers reach the offline branch, they will have to wait at the lobby to be assisted by the tellers, which may take a considerable amount of time. More importantly, both travel and waiting costs are exacerbated due to the unprecedented rate of offline branch closures (Deen 2014). Furthermore, customers will have to repeat the process to compare the alternative purchase options offered by other banks. In contrast, customers can navigate the options through the digital channel instantly without facing geographic or temporal barriers, and without the need to incur

significant travel and waiting costs at offline branches. Furthermore, product search costs via the digital channel are markedly lower than those in the offline setting because customers can explore all available products online by simply scrolling down, whereas they will likely be shown only certain options when assisted by tellers in offline branches.

Next, price-type costs are the opportunity cost of money (i.e., monetary benefits such as interest rates) expected to be foregone given a customer's initial investment (i.e., principal amount). Thus, if a customer acquires a savings account, the opportunity cost of money would comprise the foregoing of the present economic value of money, or the opportunity to spend the money, for future benefits (i.e., interest rates). Thus, in terms of price-type costs, customers will aim to make transactions that provide them with the highest expected monetary benefits or highest interest rates. Although digital technology will not directly affect price-type costs, changes in customer search behaviors allowed by the digital channel will enable customers to access alternative financial products offering higher monetary benefits, thus providing them an opportunity to reduce the price-type costs. Lastly, psychological-type costs are the costs incurred due to waiting time, inconvenience, and frustration during interactions with the service provider. For instance, whereas customers have to wait in a queue in offline branches before being assisted by the teller, they can avoid this inconvenience and frustration by performing the same task via digital channels without any waiting costs. All these changes in cost structure facilitated by the introduction and usage of digital technology will reduce customer transaction costs, leading to a positive association with financial product acquisitions. We thus hypothesize as follows:

***Hypothesis 1:** Customers' use of the digital channel has a positive effect on the acquisition of financial products.*

3.3 Moderating Effect of Customer Loyalty on the Relationship between Digital Channel Adoption and Financial Product Acquisition

Although changes in search cost structures in the digital environment may promote more efficient

search behaviors on the demand side of the market, such modifications may also diminish informative power on the supply side. In a non-digital environment, for instance, service providers can exploit the benefits of information asymmetry that stems from the high search costs incurred by customers. However, digital channels allow customers to easily access information not only within a single service provider but also across different service suppliers at low search costs—an affordance that ultimately reduces information asymmetry in the market. Likewise, digital technology is known to engender a market mechanism characterized by efficient allocative structures (Brynjolfsson et al. 1994; Ciborra 1996).

“Information stickiness” pertains to the difficulty and cost of information acquisition and transfer between two parties (von Hippel 1994). The stickiness of information is a function of the expense that is required for an information user to obtain, convey, and use a unit of information; when such cost is low, information stickiness is accordingly weak, but when the cost is high, then information stickiness is strong (von Hippel 1994). Previous literature suggested that knowledge transfer between two parties can be challenging and expensive (i.e., Szulanski 2000; von Hippel 1994, 1998) and may not always be successful, thus leading to inefficient information exchanges (i.e., Riusala and Suutari 2004).

Information stickiness may be reduced through the use of digital technology channels (Amiri 2007), thereby facilitating well-run and direct information acquisition and transfer (i.e., Blumentritt and Johnson 1999). Put differently, the stickiness of information decreases in a digital environment, where the cost of information exchange is lower than that in a non-digital setting. Furthermore, given that stickiness also represents “the degree to which a customer is reluctant to seek the same service elsewhere” (Davis et al. 2015, p. 89), customers may effortlessly shift between vendors (i.e., a client of a certain bank purchases financial products from competing banks) when information stickiness declines. Such switching behavior is expected to be more pronounced in a digital channel, in which customers are less likely to feel “locked in” within a relationship (Bansal et al. 2005).

In the case of banks, the information stickiness perceived by customers will likely decrease

following the customers' adoption of digital banking channels offered by primary and non-primary financial institutions. These changes enable customers to easily search for information on non-primary banks' financial products that come with greater monetary benefits (i.e., low interest rates) and that they would not have been previously aware of.

A notable feature of information stickiness is that its intensity is highly related to the characteristics of the information receiver in a knowledge exchange process (i.e., von Hippel 1994; Szulanski 1996; Ogawa 1998). We therefore expect that perceived information stickiness and its effects on the propensity to switch from primary to non-primary banks will differ according to customer attributes (i.e., the level of loyalty to a primary bank). That is, the information stickiness that customers experience under each bank and the effects exerted by digital channel adoption will vary depending on loyalty levels.

To illustrate, the adoption of digital channels is likely to be followed by customer awareness of the high-value financial product offerings (e.g., loan rates, customized investment programs, and fee structures) of the customers' non-primary banks. The subsiding information stickiness as a result of the customers' digital banking adoption clears the way for loyal customers of primary banks to easily access the valuable products proffered by non-primary banks and to move some of their financial resources to such institutions. Before the emergence of digital banking infrastructures, such sticky information was costly to obtain, thus preventing devoted consumers from partitioning the management of financial assets. Contrastingly, because less loyal customers of a focal bank have already searched for or accessed sticky information—as evidenced by their being a non-primary member of the bank—the effects of customers' digital banking adoption on defection can be kept at a minimum for these consumers.

The relevant literature on customer loyalty has also put forward the argument that, although customer loyalty and behavioral intention are associated to a certain extent, the relationships of consumers with their service providers are not necessarily linear, especially when competitors offer more attractive deals or when customers are aware of them (Anderson et al. 1994). We contend that the transfer of business to non-primary banks (i.e., hidden defection) is more prominent among customers

with considerable loyalty toward their primary financial institutions. Following this line of reasoning, we postulate the following:

***Hypothesis 2:** The relationship between customer digital channel usage and financial product acquisition differs depending on the level of customer loyalty toward a focal vendor; despite the overall positive relationship, defection is likely to occur among customers with high loyalty.*

4. ANALYTICAL MODEL

In this section, we develop an analytical model under the assumption of customers' multi-homing behavior to provide analytical support to the hypotheses. In our analytical model, we also assess the importance of identifying the role of digital channels in inducing hidden defections, as well as the differential impact of digital channel adoption on banks' profits across customers with varying loyalty levels. This novel approach fills gaps left by theories derived under single-homing assumptions, in which the negative effects (i.e., switching behavior) are unlikely to be detected. In our model, we consider the financial market wherein banks with different strategies compete for additional transactions of multi-homing customers. Specifically, we model a case wherein two banks have a different proportion of investments in offline and digital channels, resulting in different operating costs for offline branches and monetary benefits that can be provided to their customers. We also identify the monetary benefits that customers obtain as well as the search and acquisition cost of financial products from their primary and non-primary banks to derive the conditions in which hidden defection occurs.

4.1. Banks

Let us suppose Banks 1 and 2 provide financial services via both digital (i.e., online and mobile) and non-digital (i.e., offline branches) channels and, through distinct omni-channel strategies, the two banks have different offline channel accessibilities N_i , where $0 < N_i < 1$, $i \in \{1, 2\}$. Offline channel accessibility N_i can be considered a relative investment in offline facilities versus digital channels and also

simply the number of offline branches of Bank i . Suppose that Bank 1 (Bank 2) is a more offline-oriented (digital-oriented) bank with a greater (smaller) number of offline branches compared with Bank 2 (Bank 1); thus, $N_1 > N_2$. In addition, we assume that each bank incurs an offline branch operating cost of CN_i , which is proportional to the offline channel accessibility with a constant C , where $0 < C < 1$. As the cost structures of the two banks differ, each of them provides a different baseline contribution P_i , where $0 < P_i < 1$, $i \in \{1, 2\}$, to their customers. For example, a higher (or lower) contribution might indicate a higher (or lower) and lower (or higher) interest rates for savings and loans, respectively. Because of the higher operating cost of Bank 1, it is reasonable to assume that Bank 2 offers a more attractive contribution to their customers than Bank 1; thus, $P_1 < P_2$.

4.2. Customers

To directly identify hidden defection, we focus on a specific segment of customers who use both banks by exploiting digital channels (i.e., multi-homing customers) and consider which bank they will go to for their additional transactions. Suppose that such a market includes two types of customers, A and B, each with mass of γ_A and γ_B , respectively, where $0 < \gamma_A, \gamma_B < 1$. Every customer has transactions with both Banks 1 and 2 (i.e., multi-homing), but type A and type B customers differ in terms of their loyalty toward each bank: Type A and B customers are more loyal to Banks 1 and 2, respectively. In other words, Bank 1 (Bank 2) is the primary bank of type A (type B) customers, and type A (type B) customers are loyal customers of Bank 1 (Bank 2). Therefore, γ_A and γ_B represent the volume of the loyal customers of Banks 1 and 2, respectively.

Similar to the concept of “willingness to pay” in the marketing literature (e.g., Chen et al. 2017; Moorthy 1988), we assume that customers are heterogeneous in terms of their principal amounts (or budgets) for additional transactions with one of the two banks. We model this heterogeneity in principal amounts across type m customers with parameter $x_m \in \text{unif}[0,1]$. Hidden defection occurs if type A (type B) customers deposit their principal amount x_A (x_B) in their non-primary bank [i.e., Bank 2 (Bank 1)]. We

also assume that a customer with principal amount x_m would receive monetary benefit $P_i x_m$ from his/her primary Bank i . Given that banks usually reward their loyal customers with better rates (Andriotis 2015), the monetary benefits the customer could receive from his/her non-primary bank j are discounted by a factor k , where $0 < k < 1$. In other words, a bank provides a higher monetary benefit to their loyal customers than to their less-loyal counterparts. Therefore, the monetary benefit of a customer with principal amount x_m at his/her primary and non-primary banks can be written as follows:

$$\text{Monetary benefit at type } m \text{ customer's primary bank } i = P_i x_m \quad (1)$$

$$\text{Monetary benefit at type } m \text{ customer's non-primary bank } j = k P_j x_m \quad (2)$$

Accordingly, a higher discount factor k implies a greater gap between the monetary benefits provided to loyal and less-loyal customers.

We denote the digital channel usage intensity of type A and B customers as α_m , where $0 < \alpha_m < 1$, $m \in \{A, B\}$. Note that α_m does not indicate the proportion of customers who utilize digital channels only. Since we assume that customers are more likely to multi-home due to the lower search and transaction costs facilitated by digital channels, the likelihood of exhibiting multi-homing behaviors will depend on the digital channel usage intensity but not on whether or not they use the channel. Therefore, $\alpha_m = 0$ and $\alpha_m = 1$ indicate that type m customers rely solely on offline and digital channels for their banking transactions, respectively. In addition, since type A (type B) customers are more loyal to Bank 1 (Bank 2)—the more offline-oriented (digital-oriented) bank—we can further assume that $\alpha_A < \alpha_B$. In other words, type A (type B) customers are more offline-oriented (digital-oriented).

For simplicity, we assume zero product search and acquisition costs (weaker information stickiness) for customers at their primary banks, as they will already have considerable knowledge of the products offered by their primary banks in comparison to other banks. By contrast, we assume a positive cost (stronger information stickiness) to consumers for searching and acquiring products at their non-primary bank and model it as a function of digital channel usage intensity α_m and offline channel accessibility N_i .

This product search and acquisition cost (i.e., $SAcost$) decreases as offline channel accessibility N_i and digital channel usage intensity α_m increase (Bakos 1997). Within search and acquisition costs, we include all the costs incurred during the purchase process (i.e., comparing and choosing the desired product from the provider offering the best option). Given the overwhelming variety of financial products banks offer, customers may consider it burdensome to compare among the alternatives before making a decision (Thirumalai and Sinha 2011). As the search costs and information stickiness perceived by the customers will differ according to their digital channel usage intensity and their familiarity with the bank's services, we model $SAcost$ at their primary and non-primary banks as follows:

$$\text{SAcost of type } m \text{ customers at their primary bank } i = 0 \quad (3)$$

$$\text{SAcost of type } m \text{ customers at their non-primary bank } j = \frac{1 - \alpha_m}{N_j} \quad (4)$$

4.3. Utility Function

Accordingly, the expected utilities for type A and type B customers to initiate an additional transaction of amount x_m with each bank are expressed as

Type A Customers

$$\text{with Bank 1 (primary bank)} \quad U_{A1} = P_1 x_A - 0 \quad (5)$$

$$\text{with Bank 2 (non-primary bank)} \quad U_{A2} = k P_2 x_A - \frac{1 - \alpha_A}{N_2} \quad (6)$$

Type B Customers

$$\text{with Bank 1 (non-primary bank)} \quad U_{B1} = k P_1 x_B - \frac{1 - \alpha_B}{N_1} \quad (7)$$

$$\text{with Bank 2 (primary bank)} \quad U_{B2} = P_2 x_B - 0 \quad (8)$$

The utility function implies that, while banks can attract more customers by directly increasing their contribution P_i , this will reduce their profits. Banks can also increase the number of offline branches N_i

to reduce the product search and acquisition costs of their non-loyal customers (i.e., $\frac{1-\alpha}{N_i}$). Such a strategy will help a bank to take loyal customers away from a competing bank, but it will increase their offline branch operating cost CN_i .

4.4. Different Cases

Consider a non-competitive case wherein every customer could obtain greater benefits from their primary bank compared to their non-primary bank (i.e., $P_1 > kP_2$ and $kP_1 < P_2$). Then, all customers would initiate additional transactions with their primary banks; type A and B customers with $x \in [0,1]$ will choose Banks 1 and 2, respectively.

However, suppose Bank 2 provides greater monetary benefits to both types of customers than does Bank 1 by leveraging its low operating cost (or because customers can search for alternative products with greater monetary benefits from a non-primary bank due to digital channel usage), which is common in today's digitalized financial environment (Murray 2017); thus, $P_1 < kP_2$ and $kP_1 < P_2$. In such a competitive scenario, a certain segment of type A customers (i.e., Bank 1's loyal customers) would initiate transactions with Bank 2 instead of their primary bank (e.g., Bank 1). The mathematical derivation yields the following results:

Lemma 1: Type A customers with $x_A \in [0, x_A^*)$ would initiate additional transactions with Bank 1 whereas those with $x_A \in [x_A^*, 1]$ would start transactions with Bank 2, where $x_A^* = \frac{1-\alpha_A}{N_2(kP_2-P_1)}$.

The proof of lemmas and propositions is provided in Appendix A. This indicates a hidden defection of Bank 1's loyal customers to Bank 2. Therefore, we can define the extent of the hidden defection as a mass of type A customers who initiate transactions with banks 2 (i.e., $\overline{HD} = \gamma_A(1 - x_A^*)$). Solving the first-order derivative of $\overline{HD}$ with respect to α_A yields the following proposition:

Proposition 1: In the competitive environment, hidden defection occurs at an offline-oriented bank, and the extent of it (i.e., $\overline{HD}$) increases as the digital channel usage intensity of offline-oriented customers (i.e.,

α_A) increases.

Proposition 1 implies the positive role of digital channel usage intensity in inducing hidden defection.

4.5. Profitability

In addition to the positive relationship between digital channel usage intensity and the extent of hidden defection, we derive the profits of each bank to identify the differential effects of digital banking adoption across customers with varying loyalty levels. Since we found that bank profits are not a function of digital channel usage intensity α in the non-competitive case, we focus on the competitive case. The mathematical derivation yields the following results:

Lemma 2: *In the competitive environment, the profits of Banks 1 and 2 are*

$$\pi_1 = \frac{(1-P_1)(1-\alpha_A)^2\gamma_A}{2N_2^2(kP_2-P_1)^2} - CN_1, \text{ and}$$

$$\pi_2 = (1 - kP_2)\left(\frac{1}{2} - \frac{(1-\alpha_A)^2}{2N_2^2(kP_2-P_1)^2}\right)\gamma_A + \frac{1}{2}(1 - P_2)\gamma_B - CN_2.$$

Solving the first-order partial derivative of π_1 and π_2 with respect to α leads to the following proposition:

Proposition 2: *In the competitive environment, as the digital channel usage intensity of offline-oriented customers (i.e., α_A) increases, the profits of offline- and digital-oriented banks decrease and increase, respectively.*

Proposition 2 suggests that customers' digital channel usage intensity could be either an opportunity or a threat to banks depending on their competitive situation. Using the second-order mixed partial derivatives of π_1 and π_2 , we obtain the following proposition:

Proposition 3: *In the competitive environment, the effects of digital channel usage intensity of offline-oriented customers (i.e., α_A) on the profits of offline- and digital-oriented banks (i.e., π_1 and π_2) have negative and positive relationships with the volume of offline-oriented customers (i.e., γ_A), respectively.*

Propositions 2 and 3 jointly imply that, for an offline-oriented bank (i.e., Bank 1), customers' digital channel usage intensity reduces its profit (i.e., $\frac{\partial \pi_1}{\partial \alpha_A} < 0$) and that this negative effect deepens when it has more loyal customers (i.e., $\frac{\partial}{\partial \gamma_A} \left(\frac{\partial \pi_1}{\partial \alpha_A} \right) < 0$). By contrast, for a digital-oriented bank (i.e., Bank 2), an increase in the digital channel usage intensity of the competing bank's customers generates profits (i.e., $\frac{\partial \pi_2}{\partial \alpha_A} > 0$) that increase as the competing bank's loyal customers increase (i.e., $\frac{\partial}{\partial \gamma_A} \left(\frac{\partial \pi_2}{\partial \alpha_A} \right) > 0$).

To summarize, the key insights from our analytical model support our transaction cost economics-motivated arguments in developing the hypotheses. In a multi-homing environment, (1) hidden defection in customers' primary banks increases as customers rely more on digital channels, and (2) banks' profits are more vulnerable to the digital channel usage of their loyal customers than to that of their less-loyal counterparts. The first proposition is induced by the decrease in customers' transaction costs with their non-primary bank following digital channel adoption while those with their primary bank remain unchanged in relative terms. Specifically, as customers already have zero search and product acquisition costs with their primary banks, any decrease in these costs facilitated by digital channel adoption will be ineffective. In fact, digital channel adoption may enhance loyal customers' transferability to their non-primary bank, thereby inducing hidden defection. As customers are engaging with their non-primary bank despite its high cost while foregoing the zero costs of engaging with their primary bank, they would be highly motivated to engage more with their non-primary bank after digital channel adoption since the cost-reduction benefits will be enjoyed only with their non-primary bank. This leads to the second proposition.

In addition, overlooking customers' multi-homing banking behavior could have an adverse impact on a bank's profitability. Our model takes into account customers' tendency to transact with multiple banks in the digital financial environment, as well as banks' offline channel accessibility and the differential monetary benefits customers receive from different banks. Thus, our model reflects the competition traditional banks face not only from other traditional banks, which provide higher monetary benefits as a result of branch closures and the consequent decrease in operating cost, but also from new financial

institutions (e.g., digital-only banks, Fintech start-ups) that have emerged in the wake of burgeoning digital disruption.

Our analytical model provides theoretical support for potential hidden defection and drives our empirical analysis examining the hidden defection phenomenon as well as the moderating effect of customer loyalty. To ensure robustness of our results derived from actual transaction data, we use various operational metrics of loyalty (i.e., transaction balance, transaction diversity) and multiple percentile cuts to define “loyal” customers, as there is no precise rule of thumb for defining “loyal” customers. With the variables obtained, we examine the existence and magnitude of hidden defection among loyal customers relative to their less-loyal counterparts.

5. EMPIRICAL ANALYSES

To empirically explore the effects of customers’ digital banking adoption on hidden defection and the moderating role of customer loyalty, we obtain a comprehensive three-year dataset of customer transaction activities from a large commercial bank in Korea. In our analyses, we jointly employ a propensity score matching (PSM) method with difference-in-difference (DID) and difference-in-difference-in-differences (DDD) methods to account for potential self-selection concerns, as customers adopt digital banking of their own volition. Furthermore, we conduct several additional analyses to confirm the validity and consistency of our results.

5.1. Research Context

Our dataset is drawn from one of the largest commercial banks (“focal bank” hereafter) in Korea that is ranked in the top tier in terms of asset size and number of customers. The focal bank serves tens of millions of customers through more than 900 branches and 7,000 ATMs nationwide and provides products (i.e., savings and loans) and services similar to those offered by other commercial banks. Thus, its customer base is highly unlikely to differ from that of other commercial banks. Moreover, the focal bank has endeavored to become a pioneer of financial IT implementation in the nation and has invested heavily in

technology innovations. Consequently, the bank was ranked first in 2015 in total transaction amounts via digital channels. In addition, the focal bank is an ideal setting for examining hidden defection among multi-homing customers since about 90% of its customers responded in our survey that they transact with more than two banks.⁴

5.2. Data Description

The primary data used in this study come from the customer transaction database of the focal bank from September 2013 to August 2016 (three years). We randomly sample 10% of the 24 million customers who did not terminate their accounts during the data period and obtained data on the following categories: (1) account information, (2) transaction type, (3) channel usage, and (4) customer and demographic information. Table 1 lists the variable definitions and summary statistics for our dataset.

Table 1. Variable Definition and Summary Statistics

Category	Variable	Description	Mean	SD
Account Information	Loan Account Balance	Balance on loan account at the end of a month (\$1,000)	6.46	38.55
	Loan Account (#)	Number of activated loan accounts	0.16	0.47
	Savings Account Balance	Balance on savings account at the end of a month (\$1,000)	5.72	78.91
	Savings Account (#)	Number of activated savings accounts	0.40	0.73
	Cash Balance	Cash balance at the end of a month (\$1,000)	1.97	22.64
	Card Account	1 if customers pay card fees, 0 otherwise	0.28	0.39
	Wage	1 if customers use electronic paycheck deposit services, 0 otherwise	0.23	0.30
Transaction Type	ATS Frequency	Number of automatic transfer service	4.87	8.78
	ATS Amount	Amount of automatic transfer service (\$1,000)	1.04	6.07
	Transaction Frequency	Number of transfers made	0.93	4.78
	Transaction Amount	Amount of transfers made (USD)	223.24	1523.72
Channel Usage	ATM	Number of ATM transactions	1.86	3.19
	Phone Banking	Number of phone banking transactions	0.50	2.68
	Teller Transactions	Number of teller transactions	0.24	0.81

⁴ Refer to Section 6 for detailed information on our follow-up survey.

	Branch Visits	Number of branch visits	0.08	0.28
	Profitability	Customer profitability (\$)	0.87	1.9
	Tenure	Length of relationship with the focal bank (years)	11.10	7.71
Customer and Demographic Information	Age	Age of customer (in 2013)	35.80	12.68
	Gender	1 if male, 0 if female	0.43	0.50
	Occupation	9 dummy variables for each occupation segment		
	Residential Area	17 dummy variables for each province		

Notes: The units of time-variant variables (Account Information, Transaction Type, Channel Usage) and time-invariant variables (Customer and Demographic Information) are individual (*i*) - month (*t*) and individual (*i*), respectively.

5.3. Model Specification

5.3.1. Propensity Score Matching

As customer-specific factors may affect customers' decisions regarding digital banking adoption, the results of our analyses may suffer from self-selection bias. For instance, if a certain segment of customers has a tendency to use the focal bank's digital channel, our result would not reflect the true impact of customers' digital banking adoption on hidden defection; the effect would be confounded with individuals' idiosyncratic characteristics. To mitigate such potential issues, we use a PSM method, in which we find a matched pair of control and treatment groups in relation to the proximity of each customer's propensity score (Rosenbaum and Rubin 1983).

To investigate the impact of customers' digital banking adoption on various outcomes, we populate our treatment group with customers who have adopted digital channels during the second year of our data period (i.e., September 2014 to August 2015). Customers who never adopted digital IT channels within our data period are allocated to the control group.⁵ We then use the first year of our data period (i.e., September 2013 to August 2014) as the matching period, mimicking a randomized experimental setup (Rubin 2006). A logistic model is adopted using digital banking adoption, a binary variable, as the dependent variable, and the variables presented in Table 1 are used as the covariates. Furthermore, the baseline matching specification of one-to-one matching without replacement under a caliper size 0.20 times the standard

⁵ Details on the sampling process are provided in Appendix B.

deviation of the propensity scores is used (Xu et al. 2017).⁶ As shown in Table 2, we verify our matching performance by comparing the group mean of the covariates after matching, in which the *t*-test confirms a statistically insignificant difference of all covariates at the 5% level after matching. We also formally conduct a Kolmogorov–Smirnov test and find evidence of strong similarities between the two groups. This procedure yields 3,551 pairs of customers for our use in our main DID and DDD analyses.

Table 2. Covariate Balance before and after Matching

Category	Variable	Control Group	Before Matching		After Matching	
			Treatment Group	<i>t</i> -statistics	Treatment Group	<i>t</i> -statistics
Account Information	Loan Account Balance	5.77	6.62	0.55	5.30	0.53
	Loan Account	0.14	0.14	0.21	0.14	0.08
	Savings Account Balance	1.69	1.84	0.64	1.85	0.22
	Savings Account	0.58	0.50	3.86	0.54	1.32
	Cash Balance	3.32	4.81	2.2	3.75	0.52
	Card Account	0.24	0.30	9.78	0.25	1.46
	Wage	0.28	0.39	2.71	0.31	1.21
Transaction Type	ATS Frequency	4.22	4.47	1.58	4.69	1.79
	ATS Amount	0.97	1.19	0.84	1.02	0.54
	Transaction Frequency	0.81	0.73	0.82	1.05	1.23
	Transaction Amount	0.25	0.22	0.79	0.21	0.69
Channel Usage	ATM	2.02	2.09	1.08	1.97	0.53
	Phone Banking	0.57	0.53	0.78	0.62	0.6
	Teller Transactions	0.26	0.36	3.62	0.23	1.68
	Branch Visits	0.08	0.13	7.23	0.07	1.36
Customer Information/ Demographics	Profitability	0.56	2.91	1.5	1.69	1.21
	Tenure	9.91	11.97	14.91	10.12	1.18
	Age	35.78	47.40	40.43	35.82	0.14
	Gender	0.45	0.48	3.51	0.42	1.32

5.3.2. Difference-in-Differences and Difference-in-Difference-in-Differences Analysis

To examine the post digital banking adoption changes in various outcomes, we conduct a DID analysis using the sample obtained from PSM, in which we compare the relative change of the variables of interest between the treatment and control groups before and after adoption as well as a DDD analysis in which a

⁶ The goodness of fit of the logit model was evaluated using the Hosmer–Lemeshow test. The results are provided in Appendix C.1.

three-way interaction term with customer loyalty is added. In these analyses, we are particularly interested in how customers' acquisition of financial products alters due to the adoption of digital channels depending on the customers' loyalty level.

One issue to address regarding the variables related to financial products (e.g., savings, loans) is that the balance of a savings account at the end of the month is highly likely to remain the same or increase while that of the loan account is likely to remain the same or decrease over time. As our interest is in examining the impact of customers' digital banking adoption on customer product acquisition, the product acquisition variables are converted to binary variables that equal 1 if a customer possesses an active financial product account with a positive balance in a specific month and 0 otherwise.⁷ This choice of our dependent variables is motivated by a recent 2016 report by Bain & Company that highlighted the importance of financial product acquisition in inducing customer loyalty in a multi-homing competitive environment (Bain & Company 2016). We also use customer profitability as a dependent variable to capture how customer value changes after digital banking adoption and how the effect differs according to customers' loyalty level. In our study, customer profitability is operationalized by subtracting the selling and administrative costs incurred during a transaction from the net interest income from each transaction. The selling and administrative costs are allocated to each interacting channel (i.e., mobile, branch, ATM, call center) internally by the focal bank's activity-based costing system. Hence, customer profitability can be either positive or negative depending on a customer's channel usage and product acquisitions.

In previous literature, loyalty is also measured as customers' commitment to increase the depth and breadth of their relationship with the firm (Eisingerich and Bell 2007) in which relationship depth refers to the monetary value of customer behavior (i.e., transaction volume, transaction frequency) and relationship breadth refers to the cross-buying behavior (i.e., the number of different or additional products purchased from a company over time) (Bolton et al. 2004). That is, customers who purchase more and purchase various

⁷ As the balances of savings and loan accounts show a tendency to increase and decrease, respectively, after account opening, using the account balance is highly unlikely to be affected by online banking adoption. We also operationalize acquisitions to equal 1 only for the first month of product acquisition and confirm that the results are consistent. These results are available upon request.

products are likely to be those who contribute higher economic values to a retailer and are recognized as being loyal (Cheng and Chen 2009). Studies on customer relationship management (CRM) have credited transaction amount and cross-buying (i.e., increasing transaction diversity) as a tool for strengthening the customer-firm relationship (Kamakura et al. 1991; Liu 2007). Cross-buying is defined as customers' acquisition of additional services or products from a provider, which increases the connection points with the provider, ultimately leading to higher switching costs for the customers (Kamakura et al. 2003). Successful cross-buying is believed to result in the establishment of trust and familiarity with the service provider (Morgan and Hunt 1994), as well as higher salience (Romaniuk and Sharp 2003), and is an essential indicator of customer-firm relationship status (Verhoef and Donkers 2005). More importantly, cross-buying implies an increase in the customer's share-of-wallet in the relationship with the firm, granting firms an opportunity to learn about their customers' preferences and thus improve their marketing. This is more evident in a competitive environment, as banks believe that a successful blending of financial services into one value proposition, encouraging cross-selling, is an important index of competitive advantage (Jarrar and Neely 2002). In the banking industry, the monetary value of a customer is derived from the average money in all of the customers' deposits during each session (Khajvand and Tarokh 2011), and cross-buying has also been considered as an important measure in determining customer loyalty (Campbell and Frei 2010). Thus, for the operationalization of loyalty level, we use both measures: (1) total balance and (2) transaction diversity.⁸

Loyalty levels can be used as a moderating variable to assess the differential impact of customers' digital banking adoption depending on loyalty. However, there is no standard value of loyalty, and each bank recognizes loyal customers differently on the basis of their internal policy. Hence, we use three different percentile cuts for loyalty levels—50% (Average), 70% (Medium), and 90% (High) for each of the two loyalty measurements⁹—to classify customers into the loyal or less-loyal group and examine how

⁸ We also operationalized loyalty scores using a survey by considering customers' transactions with their primary banks (details of the survey are provided in Section 6).

⁹ We also use 60% and 80% as percentiles to verify the consistency of our results for each percentile.

hidden defection occurs differently in the two groups after digital banking adoption. We test the effect using the following DDD model:

$$\begin{aligned} Outcome_{it} = & \beta_1 Adoption_{it} + \beta_2 Treatment_i + \beta_3 Adoption_{it} * Treatment_i \\ & + \beta_4 Adoption_{it} * Treatment_i * Loyalty_i + \Phi X_i + \alpha_t + \varepsilon_{it}, \end{aligned} \quad (9)$$

where i denotes each customer, and t represents each month. $Outcome_{it}$ is the outcome of interests (i.e., product acquisition, customer profitability), and $Adoption_{it}$ is an adoption dummy variable that takes a value of 0 and 1 for pre-adoption and post-adoption periods, respectively. $Treatment_i$ is a treatment dummy variable that equals 1 for customers in the treatment group (i.e., digital banking adopters) and 0 otherwise. $Loyalty_i$ is a dummy variable that takes a value of 0 if customers' loyalty level is below the percentile cut and 1 otherwise.¹⁰ We also include a vector of customer-specific observables such as age, gender, occupation, residential area, and tenure, as well as a series of time dummy variables to control for observable heterogeneity and longitudinal systematic change across customers. The parameters of interest are the coefficients of the two-way interaction term¹¹ (β_3) and the three-way interaction term (β_4), which are the OLS estimators (Strumpf et al. 2017) that capture the effect of digital banking adoption on the dependent variables, as well as the differential impact for customers with loyalty relative to those who are not loyal in terms of the loyalty score. Hence, significant yet opposite signs of the two parameters indicate a differential impact of customers' digital banking adoption on customers with different loyalty levels, which should be handled with caution.

5.4. Results

We conduct a series of analyses to empirically examine hidden defection and its association with customer loyalty. First, we provide the DID estimates investigating the effect of digital banking adoption on the focal bank to show that our results are consistent with those in the literature (i.e., Xue et al. 2011)—

¹⁰ Customers with a value of 1 (0) for $Loyalty_i$ correspond to Type A (Type B) customers in the analytical model.

¹¹ We refer to the two-way interaction term ($Adoption_{it} * Treatment_i$) as *Interaction* in result tables for simplicity.

in other words, that adoption exerts a positive average effect when customer loyalty is overlooked. Then, we add a three-way interaction term to examine the differential effect of digital banking adoption depending on customer loyalty. Specifically, as the three-way interaction term provides the relative impact on loyal customers relative to that on their less-loyal counterparts, we can estimate the aggregate linear combination impact for the absolute magnitude. As a result, we identify serious hidden defection among loyal customers post-adoption by using the two different loyalty metrics reflecting relationship depth (i.e., total balance) and relationship breadth (i.e., transaction diversity).

Prior to examining the moderating impact of loyalty on hidden defection after digital banking adoption, we estimate our main DDD analysis excluding the three-way interaction term (i.e., DID analysis) to ensure that the average results without the consideration of customer loyalty are consistent with those in the previous research. Table 3 provides a series of DID models, including demographic controls and behavioral controls added in order. In line with previous studies (i.e., Xue et al. 2011), digital banking adoption is found to lead to a higher acquisition rate of financial products on average, indicating support for H1 ($\beta_3, p < 0.01$).

Table 3. Impact of Digital Banking Adoption on Hidden Defection

DV: Product Acquisition	(1)	(2)	(3)
Adoption	-0.0245*** (0.00503)	-0.0498*** (0.00619)	-0.0715*** (0.00684)
Treatment	0.0519*** (0.0109)	0.0415*** (0.0105)	0.0437*** (0.0102)
Interaction	0.111*** (0.00873)	0.108*** (0.00873)	0.0695*** (0.00859)
Demographic Controls	No	Yes	Yes
Behavioral Controls	No	No	Yes
R-squared	0.017	0.094	0.144
No. of Obs.	170,448	170,448	170,448
No. of Users	7,102	7,102	7,102

Notes. Robust standard errors are in parentheses. Time-fixed effects are included. Demographic control variables (Age, Gender, Address, Occupation, Tenure) and behavioral control variables (Transaction Frequency, ATS Frequency, Wage, Branch Visits, ATM, Phone Banking, Teller Transactions, Card Account) are included. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Whereas we note an increase in financial product acquisition after digital banking adoption in our DID analysis, our main interest is whether the same applies to loyal customers. If it does not, the results would

lead to spurious conclusions and misleading implications for traditional banks by overlooking hidden defections and thus being vulnerable to innovations in the financial industry.

We then examine hidden defection among loyal customers using the balance measurement of loyalty for varying percentile cuts, as shown in Table 4. The results show that digital banking adoption induces a negative impact on loyal customers' acquisition of financial products. More importantly, the magnitude of the negative impact increases as the percentile cut increases relative to the less-loyal customers. These results are consistent with our analytical model, where hidden defection in customers' primary bank increases as their digital channel usage increases. The results for the diversity measurement of loyalty are qualitatively consistent and provided in Table C3 in Appendix C.2.

Table 4. Differential Impact of Digital Banking Adoption on Hidden Defection Depending on Customer Loyalty

DV: Product Acquisition	Loyalty Measurement: Total Balance		
	Percentile Cut		
	Average	Medium	High
Adoption	-0.0567*** (0.00661)	-0.0526*** (0.00650)	-0.0643*** (0.00669)
Treatment	0.00856 (0.00879)	0.0123 (0.00854)	0.0392*** (0.00961)
Interaction	0.156*** (0.0118)	0.129*** (0.0101)	0.0949*** (0.00883)
Interaction * Loyalty	-0.142*** (0.0148)	-0.146*** (0.0152)	-0.180*** (0.0201)
R-squared	0.303	0.329	0.206
No. of Obs.	170,448	170,448	170,448
No. of Users	7,102	7,102	7,102

Notes. Robust standard errors are in parentheses. Time-fixed effects are included. Demographic control variables (Age, Gender, Address, Occupation, Tenure) and behavioral control variables (Transaction Frequency, ATS Frequency, Wage, Branch Visits, ATM, Phone Banking, Teller Transactions, Card Account) are included. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The coefficient of the three-way interaction in Table 4 (i.e., β_4) should be interpreted with caution as it indicates a greater negative impact of digital banking adoption for loyal customers than for less-loyal ones. Hence, even if the relative impact is adverse, it may not be the case in absolute terms. To explore the absolute effect of digital banking adoption for loyal and less-loyal customers, we tabulate the aggregate linear combination impact of the two-way and three-way interaction term $\beta_3 + \beta_4$ (i.e., the impact for the

loyal customers) as well as the two-way interaction term β_3 (i.e., the impact for less-loyal customers). The results, as shown in Table 5, provide further support for the existence of hidden defection among loyal customers, as indicated by the negative coefficient of the linear combination (i.e., $\beta_3 + \beta_4$) but the positive coefficient of the two-way interaction term (i.e., β_3). Thus, our empirical results are in line with our analytical model, supporting the existence of hidden defection among loyal customers in the disruptive innovative environment. Therefore, both H2 and Proposition 1 are supported by the empirical results ($p < 0.01$).

Table 5. Impact of Digital Banking Adoption on Hidden Defection for Less-Loyal and Loyal Customers

DV: Product Acquisition				
Customer Segment		Loyalty Measurement: Total Balance		
		Percentile Cut		
		Average	Medium	High
Less-loyal Customers	(β_3)	0.156*** (0.0118)	0.129*** (0.0101)	0.0949*** (0.00883)
Loyal Customers	$(\beta_3 + \beta_4)$	0.0143 (0.0106)	-0.0174 (0.0129)	-0.0853*** (0.0199)
Customer Segment		Loyalty Measurement: Transaction Diversity		
		Percentile Cut		
		Average	Medium	High
Less-loyal Customers	(β_3)	0.159*** (0.0121)	0.161*** (0.00990)	0.104*** (0.00885)
Loyal Customers	$(\beta_3 + \beta_4)$	0.0259** (0.0108)	-0.0442*** (0.0137)	-0.0764*** (0.0176)

Notes. Robust standard errors are in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In addition, motivated by our analytical model, we assess how customer profitability is affected following digital banking adoption. As in the case of our main DDD analysis, the coefficients of interest in this analysis are also the interaction term and the three-way interaction term. As shown in Table 6, the parameter estimates of the interaction term are positive, which implies that the profitability of less loyal digital banking adopters increases post digital banking adoption in comparison to the non-adopters. This finding is in line with the bank's motive to lower cost and thus increase profitability by encouraging customer-bank interaction via the low-cost digital channels. However, we observe negative coefficient estimates for the three-way interaction term, which implies that the cost efficiency of interactions for the

loyal customers goes against the bank's intention. Furthermore, the magnitude of the negative impact on profitability becomes more pronounced as the percentile cut increases; the higher the loyalty, the higher the negative impact of digital banking adoption on loyal customers' profitability. The results for the diversity measurement of loyalty are qualitatively consistent and are provided in Table C4 in Appendix C.2. Therefore, Propositions 2 and 3 are supported by the empirical results.

Table 6. Differential Impact of Digital Banking Adoption on Customer Profitability Depending on Customer Loyalty

DV: Customer Profitability	Loyalty Measurement: Total Balance		
	Percentile Cut		
	Average	Medium	High
Adoption	-0.978 (1.229)	-0.849 (1.226)	-0.779 (1.215)
Treatment	-1.392 (0.937)	-1.540 (0.943)	-1.350 (0.935)
Interaction	2.989*** (0.955)	3.184*** (0.873)	3.195*** (0.822)
Interaction * Loyalty	-0.643 (0.936)	-1.629 (0.998)	-5.156*** (1.516)
R-squared	0.008	0.009	0.011
No. of Obs.	170,448	170,448	170,448
No. of Users	7,102	7,102	7,102

Notes. Robust standard errors are in parentheses. Time-fixed effects are included. Demographic control variables (Age, Gender, Address, Occupation, Tenure) and behavioral control variables (Transaction Frequency, ATS Frequency, Wage, Branch Visits, ATM, Phone Banking, Teller Transactions, Card Account) are included. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.5. Additional Analyses

5.5.1. Prior Channel Usage

We also carry out an additional analysis to develop a multi-faceted understanding of hidden defection. Specifically, we examine customers' prior channel usage [i.e., self-service channels (e.g., ATM, phone banking), personal-service channels (e.g., branch visit, teller transaction)] as this factor could clarify which customers should receive focal attention before and after adoption. We first inquire into the aggregate effects of digital channel adoption with respect to prior channel usage among consumers. For this purpose, we

create the variable *Personal-Service Channel User*, which takes a value of 1 for customers who favor personal-service channels over self-service platforms and 0 otherwise. We then replicate Equation 9 after replacing $Loyalty_i$ with *Personal-Service Channel User_i*. Next, we segment customers into loyal and less loyal patrons for each percentile cut and estimate the same model for each subsample to unravel the differential effects of prior channel usage at different loyalty levels.

Our results for the entire sample indicate that customers who primarily transact over personal-service channels exhibit a stronger intensity of hidden defection than do customers who mainly use self-service channels prior to digital banking adoption (see Table C5 in Appendix C.3). Interestingly, we observe varying effects under different loyalty levels. The presence of less loyal customers increases the rate at which financial products are acquired, regardless of prior channel usage. However, digital banking adoption induces hidden defection among loyal customers, especially when they engage primarily with personal-service channels. Our findings remain robust in terms of the signs and significance level of both loyalty measurements (i.e., total balance and transaction diversity) (see Tables C6 and C7 in Appendix C.3). These results imply that banks should pay special attention to loyal customers.

5.5.2. Robustness Checks

Although we accounted for potential selection bias by complementing PSM with DID, additional observable and unobservable differences between digital banking adopters and non-adopters could bias the results. Hence, we conducted a series of robustness checks in multiple dimensions. First, we account for the homogenous parallel trend assumption of the two groups during the pre-adoption period (see Appendix C.4 for the details of the analyses and results). Second, to validate the generalizability of our main results, we repeat our main analysis using different samples (see Appendix C.5). Third, we carry out a two-stage treatment effects model and look-forward matching to investigate the robustness of our results to the unobservable differences (see Appendices C.6 and C.7). Fourth, we conduct additional analyses to rule out potential alternative explanations of our results (see Appendix C.8).

6. ADDITIONAL EVIDENCE FROM A SURVEY

6.1. Survey Design

To gain a more comprehensive understanding of customers' financial transactions with their primary banks, we conduct a survey. As we have transaction data for only a single bank, we cannot explicitly determine customers' multi-homing behavior or whether customers consider our focal bank their primary bank. Hence, we aim to provide qualitative evidence of such unobservable behaviors via our survey, to compensate for the limitation in our secondary dataset.

The survey data were collected with the cooperation of a major market research firm, Gallup Korea, a leading market research firm in Korea and an affiliate of the global leading research network Gallup International. The firm possesses a large pool of customers, reflecting the whole target population. The firm selects survey respondents under strict conditions in consideration of their previous response qualities, ensuring the credibility of the survey results. The survey data consist of 1,580 customers, and the distribution of their demographic information (i.e., gender, age, residential area, occupations) was controlled to resemble that of the customers of the focal bank. To enhance the reliability and generalizability of our survey results, we ensured that the respondents had different primary banks to prevent the results from being biased by a bank's unique features. For instance, if a certain bank is noted for providing a certain type of products and services with more benefits than others, customers using the specific bank as their primary bank would show transaction activities different from those of customers using other banks as their primary bank.

6.2. Customer Multi-homing Behavior

Our first interest is whether the sample customers transact with multiple banks, showing multi-homing behavior. The descriptive statistics in Table 7 show that about 90% of customers transact with multiple banks and that customers on average transact with 2.9 banks, regardless of the channel. Table 8 presents

the statistics across gender, age group, and occupation, and multi-homing behavior is shown to be prevalent among all subgroups.

Table 7. Survey Data: Number of Banks Customers Transact With

Number of Banks Customers Transact With	Percentage (%)
1	10.6 (n=167)
2	32.6 (n=515)
3	33.2 (n=524)
4	13.6 (n=215)
5	6.3 (n=99)
Above 6	3.8 (n=60)
Average	2.9 (n=1,580)

Table 8. Survey Data: Average Number of Banks Customers Transact with Across Gender, Age Group, and Occupation

Category	Gender		Age Group			
	Male (n=824)	Female (n=756)	20s (n=302)	30s (n=495)	40s (n=459)	50s (n=324)
Average Number of Banks	2.8	3.0	2.7	3.0	3.0	2.9

Category	Occupation				
	Income Earner (n=789)	Individual Business (n=463)	Homemaker (n=219)	Undergraduate/ Graduate Student (n=73)	Others (n=36)
Average Number of Banks	3.0	2.8	3.0	2.7	2.0

Table 9. App Usage Data: Number of Mobile Banking Apps Customers Use

Number of Mobile Banking Apps Customers Use	Percentage (%)
1	29.4 (n=1,652)
2	24.4 (n=1,373)
3	18.7 (n=1,049)
4	12.6 (n=706)
5	7.1 (n=399)
Above 6	7.9 (n=444)
Average	2.67 (n=5,623)

Furthermore, we obtained additional app usage data¹² from the Nielsen KoreanClick to validate the consistency of our survey results. The data consist of the daily app names and app usage times, measured in seconds, of 5,623 representative panel users. As shown in Table 9, we find that users on average use 2.67

¹² Mobile app usage data from the Nielsen group have been used in studies by premier journals in various disciplines (i.e., Danaher and Dagger 2013; Kwon et al. 2016; Ma et al. 2014).

mobile banking apps, which is slightly lower than the figure in our survey results. However, given that this descriptive statistic comes only from mobile banking app usage and that not all customers use mobile banking apps, we expect the statistics to increase when both the offline and online channels are also considered.

6.3. Financial Product Acquisition from Primary Bank

Next, we assess the degree to which customers tend to acquire financial products from their primary banks. For instance, if most respondents answer that they acquire at least one financial product from their primary bank, we could infer that a decrease in financial product acquisition following digital banking adoption indicates an increase in the probability of product acquisition from the competing bank. As shown in Table 10, more than 80% of the respondents answered that they have acquired at least one financial product from their primary bank.

Table 10. Survey Data: Number of Low-Liquidity Products Purchased at Primary Bank

Number of low-liquidity products purchased at primary bank	Percentage (%)
0	18.8% (n=297)
1	28.2% (n=446)
2	31.0% (n=490)
More than 3	22.0% (n=347)

6.4. Alternative Operationalization of Loyalty Using Survey Data

Additionally, as our main loyalty measurements are measured in absolute terms, we aim to operationalize customer loyalty using a more qualitative approach to understand customers' transaction types in their primary banks. In our preliminary interviews, customers reported that they consider a bank with specific transaction types as their primary bank. To obtain a better understanding of such transaction types and examine the consistency of transaction types across customers, we asked the survey respondents about their detailed transaction activities with their primary bank. As presented in Table 11, we observe that (1) receiving wages and (2) the availability of a card account is a major decisive transaction behavior with

a primary bank across all groups. We use the survey results to operationalize the loyalty variables. First, we assign a binary value for each transaction behavior (i.e., financial product acquisition, receiving wage, and availability of card account) and split the sum of the binary values into three different percentile cuts (50%, 70%, and 90%). Alternatively, we impose a stricter condition and limit “loyal” customers to those who engaged in all three transaction behaviors. Then, we allocate the loyalty score to our sample in the transaction data and replicate our main analysis specification. As shown in Table 12, we observe consistency in our results for various operationalizations of the loyalty score based on the results from the survey. We further provide the qualitative insights into the hidden defection based on the survey in Appendix D.

Table 11. Survey Data: Transaction Behaviors with Primary Bank

Number of low-liquidity products purchased with primary bank	Income Transactions			
	Wage	Pension	Sales	No Income Transactions
0 (n=297)	65%	4%	19%	6%
1 (n=446)	77%	8%	21%	4%
2 (n=490)	79%	16%	29%	2%
More than 3 (n=347)	88%	34%	31%	1%

Number of low-liquidity products purchased with primary bank	Payment Transactions			
	Card Account	Utility Bills	Other Living Expenses	No Payment Transactions
0 (n=297)	89%	55%	45%	5%
1 (n=446)	91%	57%	42%	4%
2 (n=490)	95%	70%	51%	1%
More than 3 (n=347)	96%	83%	46%	0%

Table 12. Differential Impact of Digital Banking Adoption on Hidden Defection Depending on Customer Loyalty

DV: Product Acquisition	Loyalty Measurement from Survey			
	Percentile Cut			
	(1) Average	(2) Medium	(3) High	(4) Binary
Adoption	-0.0290*** (0.00516)	-0.0339*** (0.00514)	-0.0349*** (0.00515)	-0.0328*** (0.00516)
Treatment	0.0208** (0.00865)	0.0258*** (0.00791)	0.0446*** (0.00963)	0.0309*** (0.00948)
Interaction	0.198*** (0.0125)	0.170*** (0.00940)	0.102*** (0.00884)	0.179*** (0.0147)

Interaction * Loyalty	-0.170*** (0.0149)	-0.224*** (0.0158)	-0.145*** (0.0177)	-0.122*** (0.0157)
R-squared	0.220	0.292	0.359	0.208
No. of Obs.	170,448	170,448	170,448	170,448
No. of Users	7,102	7,102	7,102	7,102

Notes. Robust standard errors are in parentheses. Time-fixed effects are included. Demographic control variables (Age, Gender, Address, Occupation, Tenure) and behavioral control variables (Transaction Frequency, ATS Frequency, Wage, Branch Visits, ATM, Phone Banking, Teller Transactions, Card Account) are included. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

7. DISCUSSION

The influx of digital technology (e.g., online and mobile banking/FinTech) into the financial industry has spurred an innovative disruption that has drawn attention to a worrisome phenomenon for bank managers—hidden defection. Motivated by an environment that enables multi-homing, customers are increasingly willing to secure more efficient bank transactions given easy access to information about products from various banks. In this study, we used both analytical and empirical approaches to examine the influence of customers' digital banking adoption on the hidden defection and the role of customer loyalty. We also explored the differential effects of customers' prior service usage patterns, which has been overlooked by previous research on digital banking adoption (e.g., Campbell and Frei 2010; Hitt and Frei 2002; Xue et al. 2007; Xue et al. 2011). Table 13 summarizes our key findings and their implications.

The results of the analytical model and empirical analysis collectively confirmed the existence of hidden defection among loyal customers who treat our focal bank as their primary bank. Specifically, the average effect of digital banking adoption is favorable for financial product acquisition reflecting stickiness in the customer–bank relationship, but this is also associated with the tendency of loyal customers to acquire fewer financial products. This hidden defection is more pronounced among loyal customers who availed themselves mainly of personal services prior to digital banking adoption. Digital banking adoption increases the profitability of less-loyal customers but negatively affects it among loyal customers. In addition, loyal customers who rely primarily on personal-service channels (e.g., offline branches) prior to digital channel usage show greater hidden defection than do those who employed mainly self-service channels prior to digital channel usage. These results collectively suggest that, although banks are rapidly shifting toward digital channels while shutting down offline branches, a seamless experience across digital and offline

platforms, known as “omni-channel servicing,” should still be provided, especially to loyal customers.

Table 13. Key Findings and Implications

Analytical Model	Empirical Analysis	Implications
<i>Disregard of competition driven by customers’ multi-homing behavior (H1)</i>		
In a non-competitive case, customers acquire financial products from their primary banks.	Without a consideration of customer loyalty, customers’ digital banking adoption leads to a higher acquisition of financial products.	Overlooking fierce competition driven by customers’ multi-homing behaviors results in a misguided view that prompts banks to ignore the potential pitfall of hidden defection.
<i>Consideration for competition driven by customers’ multi-homing behavior (H2)</i>		
The consideration of competition between banks revealed that hidden defection increases as customers’ usage of digital channels increases. (P1)	The examination of customer loyalty found evidence of hidden defection among loyal customers following digital channel adoption both relative to less-loyal customers and in absolute terms.	Though digital channels may enhance customer convenience by reducing search and product adoption costs, they can induce hidden defection through increased information accessibility and reduced switching costs.
The intensity of customers’ digital channel usage adversely affects the economic dimension (i.e., customer profitability) and is more pronounced among loyal customers. (P2 and P3)	Digital channel usage increases customer profitability on average but diminishes the profitability of loyal customers. This occurs because, although digital channels act as substitutes for self-service and personal-service channels for less-loyal customers, loyal customers tend to increase their usage of personal-service channels.	In line with banks’ aim of lowering customer interaction costs and consequently increasing their profitability, customer profitability tends to increase after digital channel adoption. However, because demand for offline personal-service channels increases after digital channel adoption among loyal customers, banks should strategically allocate their budgets to both offline and digital channels in consideration for their loyal customers. An ill-conceived closure of branches may backfire and increase hidden defection.
Additional Empirical Analyses		

Key Findings: Loyal customers who engaged principally with personal-service channels prior to digital channel adoption show greater hidden defection than do those who mainly employed self-service channels prior to digital channel adoption. Prior service usage type has no significant effect on hidden defection among less-loyal customers.

Implications: Banks should be cautious in dealing with customers who adopt digital channels. Specifically, their prior interactions with banks should be considered in customer relationship plans, as these may predict hidden defection. Banks should provide customized customer services to personal-service users instead of merely leaving them to engage via digital service avenues.

Our study presents important theoretical and managerial implications for the growing literature on customers' digital banking adoption. First, variations in customer loyalty levels should be examined so that the effects of customers' digital banking adoption can be identified in a way that is not affected by flaws in averages. For instance, overlooking customer loyalty may erroneously highlight the positive side of digital technology adoption, whereas accounting for customer loyalty may render a different outcome. Comprehending customers' digital banking adoption solely on the basis of aggregate-level analyses can therefore be misleading for banks.

Second, banks should acknowledge the double-edged nature of financial IT implementation rather than see it as a cure-all for their customer relationship problems. For example, instituting digital channels is expected to reduce customers' search and product adoption costs, but such a strategy may instead increase transferability and thereby encourage loyal customers to shop around for competing banks. The results revealed that loyal customers show a low probability of product acquisition from their focal banks after financial technology adoption. This possibility aligns with a recently emerging phenomenon called "hidden defection." The managerial gravity of this issue should not be disregarded, as reduced product acquisition probabilities are more pronounced for low-liquidity assets (e.g., savings and loan accounts), which largely determine long-term switching costs and customer–bank relationships. Managers are thus advised to exercise vigilance against the deceptively positive average effect of customers' digital banking adoption and strive to attract new customers while minimizing the risk that their loyal clientele will succumb to hidden defection.

Third, amid growing regulations, heightened competitive pressure from new players, and rapidly

changing customer expectations, profit optimization has received relatively scant attention for the survival of financial service organizations; it is essential for these firms to stratify and target customers who have the potential to evolve into profitable patrons (Oracle 2018). Despite this sense of emergency, many banks may be misleadingly deceived by the belief that their loyal customers will always remain profitable and they should therefore focus on enhancing the remunerative potential of less loyal clients in the digital environment. This status quo strategy, however, can place firms at risk—an implication that offers renewed insights into the dynamics of both profit maximization and customer loyalty. Whereas the profitability of less loyal customers may increase following digital channel adoption, that of loyal customers decreases. The emergence of digital banking infrastructures can motivate loyal consumers to look for more lucrative options at other banks and relocate their financial resources to such institutions with ease. Given that the loss of loyal consumers may considerably outweigh the acquisition of less loyal clients from other banks, companies should formulate strategic campaigns designed exclusively for the protection and retention of faithful consumers. Additionally, current operations management and marketing programs, including product bundling, relationship pricing, and real-time cross-selling/up-selling, should be refined in a way that facilitates not only the earning but also the strengthening of customer loyalty. Financial institutions can likewise learn lessons from telecommunications or cable companies that have dramatically revamped their reward schemes and special offer programs to retain their loyal consumers.

Fourth, the recent trend of offline branch closure without careful consideration of omni-channel banking strategies should be re-examined. Banks currently operate numerous channels, thereby creating more complex but less intimate customer-bank relationships (Capgemini 2013) and diminishing customer satisfaction (Protiviti 2016). With banks shutting down branches at the fastest pace in decades (Ensign et al. 2018), endless controversies have arisen regarding whether such closure is advisable or not (i.e., Shevlin 2019; Demos 2016). Our results cast light on both sides of the discussion in terms of customer loyalty. We found that among loyal customers, those who primarily transact with banks for personal services (i.e., branch visit, teller transaction) as opposed to self-directed services (i.e., ATM transaction, phone banking)

prior to digital channel adoption show the greatest magnitude of hidden defection following digital channel adoption. Conversely, previous channel usage does not influence or even positively affect the probability of product acquisition for less loyal customers and loyal clients who primarily engage in self-service channels. Correspondingly, branch closure may have no adverse effect on some customers, but it may backfire for a certain segment of loyal patrons. For instance, the shutting down of banks may inevitably drive loyal customers who rely heavily on personal-service channels (e.g., branch visit) to adopt digital banking, eventually leading to potential hidden defection. Hence, extra caution should be exercised in managing this population of customers when bank branches are closed. Specifically, offline branches should nurture loyal customers by providing them with tailored services that are rarely available through digital channels. The infamous statement of Bill Gates that “banking is necessary, banks are not” accurately reflects the online-to-offline transition necessary for efficiency, but physical banks remain essential for sustaining fidelity among loyal consumers in multi-homing environments. Given the importance of customer experiences for bank branches (Accenture 2016) and customer-initiated interactions for customer loyalty (Protiviti 2016), offline branches should not be shut down on purely cost-reduction grounds but should be managed under a long-term plan that features omni-channel banking strategies.

Though our study provides fruitful insights into the effects of digital banking on customer behavior, it has several limitations. One drawback concerns its scope. The study did not cover the time-variant density of physical channels (e.g., branches, ATMs) in residential areas. The availability of such data would allow a more concrete understanding of hidden defection and help bank managers formulate strategic action plans that ensure that branch closures occur efficiently. Another limitation is that the dataset consists of monthly information on customer transaction behaviors. Future studies could use data on a finer level of granularity to illuminate the effects of digital banking on hidden defection. Furthermore, we lacked data on the exact date of each customer’s digital banking adoption. Hence, we assumed that customers who did not use digital banking during the first year of our data period had not adopted digital banking in the past, as a customer is unlikely to completely stop using digital banking for a year. Lastly, we used a dataset drawn from a single

bank and thus had to make assumptions of multi-homing behaviors. Although we endeavored to validate our assumption from multiple perspectives, future studies could collect data from multiple banks to better infer customer loyalty and customers' multi-homing behavior to investigate hidden defection more thoroughly. Notwithstanding these limitations, our findings remain a valuable reference for bank managers. Understanding customers' states of mind and their levels of fealty in the digitalized financial environment is critical, particularly for loyal patrons. That a paradigm shift in the financial sector is occurring does not necessarily mean that all trends must be followed or that personal-service channels should be indiscriminately shut down, as doing so may harm customer relationship initiatives in the long run.

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