

The Decline of Branch Banking and the Transformation of Bank Accessibility

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ABSTRACT

We investigate whether an increase in banks’ online banking accessibility would compensate for the reduction in their physical banking accessibility. We find that while some banks did enhance their online banking accessibility to offset the negative impact of their branch-closing activities, it is not true for other banks. Our results also suggest that branch-closing activities have a negative impact on the bank’s ability to maintain and increase their total deposits, but the negative impact is lesser for banks that enhanced their online banking accessibility. Finally, we find that the profitability of the banks increased together with their branch-closing activities; the increase is more significant for banks that strengthened their online accessibility and less significant for banks that have declined in their online accessibility.

Keywords: Physical accessibility; Online banking; Online accessibility; Branch closing.

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1. INTRODUCTION

When was your last visit to your local bank branch? The period of Internet and Mobile Banking has made banking simpler, easier, and extremely convenient. Cashless transactions with Credit Cards and Debit cards have accelerated with mobile apps and Internet Banking. Never before could bank customers check their account balance and make transactions while laying down on their bed at home. You can book hotels and order food online, and you make the payment online. In other words, you shop online, and you pay online. Almost every single transaction can be executed without going to your bank to exchange cash. Fewer customers use bank tellers for routine transactions.

A 2016 survey of consumers in North America by Accenture Consulting showed that the Internet is the main channel for banking compared to physical branches or ATMs, with 60% of North American consumers using it weekly. Within U.S., 90% of adults use the Internet according to a recent survey conducted by Pew Research Center. A report of the Federal Reserve Board in 2016 showed that 71% of the U.S. consumers who have a bank account reported that they used online banking. There has been an increase in the number of consumers

who have not visited their banks or branches in at least six months according to report on Bankrate.com, and it is very likely that they have switched to online banking.

Before the onset of Internet banking and mobile banking, there had been many benefits associated with having a high number of branch locations. From the banking system perspective, Carson and Mitchener (2005) show that branching increases competition and forces weak banks to exit the banking system. Their empirical results indicate that the effects of branching on competition were quantitatively more important than geographical diversification for bank stability. From the banks' perspective, having a high number of branch locations improves their profitability. Berger, Leusner, and Mingo (1997) find that for banks with many branches, the number of branches appears to be on average about twice the cost-minimizing number. However, this may be optimal from a profitability standpoint because the "over-branching" branches attract extra customers and, as a result, the banks receive extra revenues from providing extra customer convenience that offset the extra cost of over branching, which may not be very expensive (only about 3.3% of total branching costs). Therefore, they conclude that actual cost savings from reducing the number of branches would be less and that banks would lose revenues greater than any cost savings from closing branches. From the bank customers' perspective, they benefit from a high number of branch locations that improve the customer convenience. In a study about the impact of bank branching on the accessibility of banking services to the customer, Evanoff (1988) found that branching restrictions had significantly decreased the level of service accessibility in both metropolitan and rural areas, and the relaxation of branch restrictions would increase the number of bank offices and enable banks to better serve their customers and to improve service accessibility (in the time, distance, and cost required to obtain banking services).

However, after the onset of Internet and mobile banking, the number of bank branch being closed has been increasing dramatically in the last few years. In their article in The Wall Street Journal, Ensign, Rexrode, and Jones (2018) reported that banks were closing branches at the "fastest pace in decades" and the number of branches in the U.S. declined by more than 1,700 in the 12 months from July 2016 to June 2017. In addition, according to a report posted on Orion Investment Real Estate website in 2018, U.S. banks closed a net 2,069 branches in 2017, an increase over 18% compared to the number closed in 2016. Prior to that, Morgan, Pinkovsky, and Yang (2016) report that U.S. banks closed 4,821 branches from 2009 to 2014, reducing the total number of branches by about 5 percent. Even though the driving forces of the trend are not fully disclosed by all the banks, they could be demand or profit driven. In other words, the demand for physical branch services has declined due to the increase in online banking. At the same time, as banks are leaving less profitable areas, they may be closing branches that have become unprofitable. We expect that this trend would even speed up more in the next few years as a number of bank holding companies have reported plans to increase spending on technology to increase bank customers' reliance on online and mobile banking to conduct more of their banking activity. For example, Wells Fargo & Company closed a net of 194 branches in 2017 and 250 more branches in 2018, and it plans to close 500 or more in 2019 and 2020 (Orion Investment Real Estate, 2018).

"Based on our current assumptions regarding consumer channel behavior and our own technology advances as well as other factors, we can see our total branch network declining to approximately 5,000 by the end of 2020," said John Shrewsberry, CFO of Wells Fargo (Orion Investment Real Estate, 2018). (*Well Fargo had more than 6,000 U.S. branches in 2018*).

"While branches are still important and not going to disappear anytime soon, they don't see the traffic they did in the past, and that's a trend that's going to continue", said Greg McBride, CFA, chief financial analyst for CreditConnector.com (Ensign et al., 2018).

In addition, according to the EY Global Banking Outlook 2018, 85% of banks surveyed plan to make digital transformation programs a priority in 2018 and 59% of banks surveyed expect that their technology investment budgets will go up by more than 10% in 2018.

While it is reasonable to assume that the branch closing activity will have a negative impact on the physical accessibility of banking services, there has been limited study on whether banks have improved their online banking accessibility by optimizing the web experience for their customers to mitigate such impact. In addition, the effect of these branch closing activities on the banks' deposits accounts as well as on the banks' profitability has not received full attention in the literature. This study aims to fill in these gaps. First, we predict that along with closing branches, banks would improve the online accessibility of their banking services to mitigate the negative impact of the branch-closing activities on the physical accessibility of their banking services. We test the hypothesis by evaluating the changes in banks' online accessibility levels together with their strategic branch-closing activities from the beginning of 2017 to the end of 2018 to examine whether the banks have improved their online banking accessibility to make up for the reduction in their physical banking accessibility. Second, we hypothesize that there is a substitution effect between the banks' physical banking accessibility and their online banking accessibility in term of attracting and maintaining capital flows from depositors. Specifically, if banks shut down their branches and at the same time enhance the accessibility of their online banking, then the banks are less likely to experience a substantial negative impact on the growth of their total deposits (the sum of transaction accounts and non-transaction accounts) because of their branch-closing activities. However, if banks shut down their branches but do not improve the accessibility of their online banking during the same period to compensate for the reduction in their physical banking accessibility, the banks are more likely to experience a noticeable and significant decline in the growth of their total deposits. To test this hypothesis, we measured the banks' total deposits growth during their branch-closing period and examined the relationship between the banks' total deposits growth with their online banking accessibility during the period. Third, branches closures have helped the banks save on occupancy and employee costs, bringing down overall expense but the banks could maintain their normal revenue levels with fewer locations in a digital world where bank customers often rely on mobile apps and online banking (Ensign et al., 2018). In addition, the branches being selected are most likely unprofitable ones. Therefore, we predict that the profitability of the banks is likely to be strengthened with their strategic branch-closing activities, and the degree of such increase in profitability is positively related to the improvement in the banks' online banking accessibility. Specifically, if banks cut down branches but at the same time improve their online banking accessibility, then the banks' profitability is likely to grow significantly. However, if the banks cut down branches but do not strengthen their online banking accessibility, then the banks' profitability is still likely to increase, but less significantly.

We constructed a sample of the largest banks in the U.S., including only banks with at least 500 branches. We believed that with such requirements, our sample would only include large national banks and the geographical coverage of their branches would be extensive, making our results economically significant because these banks account for a very high proportion of total banks' assets, total deposits, number of branches, and number of customers in the U.S. We then only investigated banks that closed at least 1% of their total branches during the branch closing trend because we believed that the scale of closing less than 1% of total branches is negligible to have any significant impact on the banks' total deposits growth. Also, such scale is not large enough that the banks must improve their online banking accessibility to substitute for the loss in their physical accessibility. Our final sample was comprised of the 18 largest national banks in term of number of total branches as well as in

term of the number of branches being closed. We measured and used the compliance of the banks' websites to the standards mentioned in Web Content Accessibility Guidelines (WCAG) developed by World Wide Web Consortium (W3C) as a proxy for the banks' online accessibility levels. While these WCAG guidelines focus specifically on accessibility for people with disabilities, the W3C is an international consortium which was founded to recommend high quality standards for the Web, and as such its design principles are intended to enable the most accessible experience on web-based platforms for all users. This will be further expanded in Section 3.

We found that on average, the banks in our sample had reduced the number of their branches by 7% from the 1st quarter of 2017 to the 4th quarter of 2018. During the same period, the number of WCAG accessibility violations in the banks' websites had also dropped by 4%, suggesting that the banks on an aggregate level might have improved their online banking accessibility to compensate for the loss of physical branches, which gives support to our first hypothesis. However, the result is not consistent at the individual bank level. While we found out that some banks have improved the accessibility of their online banking after closing their branches, we did not find such improvement in other banks.

We also found strong evidence for a substitution effect between the physical accessibility and the online accessibility of the banks' banking services on their total deposits, which supports our second hypothesis. Specifically, we found that when banks reduced their physical accessibility but improved their online accessibility during the same period, the banks continued to experience a positive deposit growth rate that is similar to the average growth rate in the banking industry. However, for banks that reduced their physical accessibility but did not enhance the accessibility level of their online banking, we found evidence that these banks still experienced a positive growth in their total deposits, but the rate was significantly lower than the average growth rate in the banking industry. Most importantly, we found that banks that reduced both the physical accessibility and the online accessibility of their banking services experienced a depletion in the growth of their total deposits. Their total deposits growth rates during the period are either negative or insignificantly difference from zero, and the rates are much lower than the average growth rate in the banking industry during the same period. The results suggest that the reduction in the banks' physical accessibility of their banking services has a negative impact on the bank's ability to maintain and increase their total deposits, but the degree or magnitude of such negative impact is reversely associated with the improvement in the banks' online banking accessibility.

Last, we found evidence that the profitability of the banks has increased when they were strategically closing their branches, and the magnitude of the increase in profitability is positively related to the improvement in the banks' online banking accessibility, which gives support to our final hypothesis. Specifically, we found that the profitability of the banks increased significantly when the banks enhanced their online banking accessibility together with their strategic branch-closing activities. Our results also indicate that if the banks that did not improve their online banking accessibility while closing their branches; they still experienced a rise in their profitability yet at a smaller degree.

The remainder of this paper is organized as follow. In the next section, we present our hypotheses. Section 3 provides a background on WCAG standards compliance as a measurement of banks' online accessibility. In section 4, we present the sample selection procedure and data description. Section 5 shows empirical results and the conclusion is discussed in section 6.

2. HYPOTHESES

Hypothesis 1: When banks are cutting down their branches, it is likely that the banks will improve the accessibility of their online banking to compensate for the negative impact of the branch closing on their physical banking accessibility.

Hypothesis 2a: When banks are cutting down their branches, the banks are likely to experience a negative impact on the growth of their total deposits due to the reduction in their physical banking accessibility.

Hypothesis 2b: However, the degree of such impact mentioned in *Hypothesis 2a* is greater for banks that do not improve the accessibility of their online banking together with their branch-closing activities, and weaker for banks that enhance the accessibility of their online banking together with their branch-closing activities.

Hypothesis 3a: When banks are cutting down their branches, their profitability is likely to increase because the branches closures would reduce the banks' overall expense but the banks' revenues are likely to be stable even with fewer locations in a digital world where bank customers often reply on mobile apps and online banking for their banking services and because the branches being closed are in general the unprofitable ones.

Hypothesis 3b: The degree of the profitability increase mentioned in *Hypothesis 3a* is lesser for banks that do not improve the accessibility of their online banking and greater for banks that enhance the accessibility of their online banking together with their branch-closing activities.

3. BACKGROUND ON ONLINE BANKING ACCESSIBILITY MEASUREMENT

As noted earlier, the concept of online accessibility as pertinent to the W3C and WCAG principles is focused on accessibility for people with disabilities. In 2018, Centers for Disease Control and Prevention (CDC) reported that approximately 25% of U.S. adults live with a disability, and this likelihood increases for adults who are age 65 and older. This does not mean that they do not or do not wish to use the same web-based services that are used by most of the general population. In fact, in a study on the accessibility of banking and finance systems for blind users, Wentz, Pham, and Tressler (2017) showed that there is a preference towards using the web versus going to physical bank locations for banking services for the same reasons that are often noted by the general population: convenience, privacy, and independence. Equity through access to banking services should be a goal of any bank, but if a financial motivator is needed, Donovan (2016) reported that people with disabilities and their friends and family have an estimated \$4 trillion USD of discretionary spending power (in the U.S. alone). Cage (2015) did a survey in the U.K. and reported that approximately 75% of consumers with a disability would walk away from a business because of inaccessibility. Additionally, in the U.S., Title III of the Americans with Disabilities Act (ADA) denotes banks under the category of providing public accommodations, and this has been a dominant motivator for legal settlements and frequent litigation. There is a growing list of banks and financial institutions that have reached legal settlement agreements specifically related to the accessibility of their websites and mobile applications such as Sovereign Bank Settlement Agreement (2002), HSBC Card Services Settlement Agreement (2009), 12 Banks statewide in New York State Settlement Agreement (2013), among others.

To comply with the ADA, organizations typically look to the primary accessibility guidelines for webpages and applications that are maintained by the World Wide Web Consortium (W3C), which is an international consortium that produces standards for web

content. The guidelines relevant to websites are known as the Web Content Accessibility Guidelines, or WCAG. The current version of WCAG is WCAG 2.1, and it outlays 13 guidelines that fall under the principles of web content being perceivable, operable, understandable and robust. Within those standards are a subset of testable “Success Criteria” which determine level of accessibility for those broader guidelines. There are three levels for criteria: A, AA, and AAA, with AAA being the highest. Most policies strive for a minimum of AA. For example, there is a principle that requires things to be “Operable” on a website, but within that principle, there are guidelines such as “Keyboard Accessible” and “Enough Time.” Within a guideline such as “Keyboard Accessible” there would be success criterion for “Keyboard” (2.1.1) that states that all the content functionality must work from a keyboard (i.e., not just through a touch screen or mouse input).

Over time, many products that have been highly used and valued by the general population were originally developed as assistive technology, including the typewriter, the audiobook, and even many aspects of text-to-speech features that we regularly rely on (Lazar, Goldstein, and Taylor, 2015). It is equally common for organizations that make their websites more accessible to see ancillary benefits from that expenditure. Therefore, while banks need to address accessibility for their customers with disabilities, there is growing realization that improving the accessibility level of their websites can benefit other customers as well, especially given the trend today that fewer customers are using tellers and more customers are using online banking for their routine transactions as well as other banking services. Examples of broader benefits can include an improved efficiency of the interface, financial benefits from improved search engine rankings (Parks and Sedov, 2016), a facilitation of future innovation (Brownlee, 2018), or simply the fact that an accessible website often results in a better user experience for all customers. If a website has a higher number of accessibility violations, it hinders general access to the services provided.

To understand how a more accessible website can benefit all users, an easy example is that of the novice users to a website (first time visitor, first time online banking user). Another example would be trying to use a bank website or app in a condition with contrast extremes (outdoors, poor indoor lighting, using a mobile interface) or during situations of higher cognitive load. In both situations, the general practices related to high accessibility would improve the usage for that situation.

Figure 1 Example of an accessibility violation that could impact all users: Minimum contrast (WCAG Success Criterion 1.4.3)



Accessibility also impacts the speed and intuition by which an interface can be used. Such improvements to interface speed, clarity of directions and functionality, and multi-context performance can lead to greater user satisfaction. In a market space that is concerned about customer acquisition and retention such as banking industry, this would seem to be something of high priority. For customers to adopt online banking, banks should design their websites to be friendly, clear, easy to navigate, and with detailed instructions (Ngugi et al. 2020).

For each bank in our sample, we tested and measured the compliance of the bank’s website homepage to the WCAG guidelines, following the method used in Wentz, Pham, and Feaser et al. (2019). We use the number of WCAG violations as a proxy for the bank’s online inaccessibility level. The more violations to the WCAG standards found in the bank’s website, the lower level of compliance to the WCAG standards which implies that the bank has a lower level of online accessibility. On the other hand, the fewer violations to the WCAG standards

found in the bank's website, the higher level of compliance to the WCAG standards which implies that the bank has a higher level of online accessibility.

4. SAMPLE SELECTION

We collected the banks' number of branches information from U.S. bank locations. At the time of this study, there were more than 5,000 registered banks and financial institutions in the U.S. However, there is only a small number of banks that have a high number of branches. For example, only 94 banks that have more than 100 branches and only 48 banks that have more than 200 branches across the U.S. Given our resources and time constraints, we decided to adopt a cut-off sampling procedure in which we test our hypotheses on a handful number of top banks in the U.S. in terms of number of branches. Specifically, we only included in the sample banks with more than 500 branches so the banks in our sample would be large banks and the geographical distribution of their branches would be extensive, meaning our results are both statistically and economically significant. We further excluded banks that closed less than 1% of their total branches during the period from the 1st quarter of 2017 to the 4th quarter of 2018. We believed that for banks that closed less than 1% of their total number of branches, the scale would not be large enough for the banks to have developed their online banking accessibility to make up for their physical accessibility reduction. Also, such scale is negligible to have any significant impact on the growth of the banks' total deposits. The above requirement leaves us with a final sample of 18 largest banks in the U.S. that had reduced a considerable number of branches in both the relative percentages and the absolute values. The banks in our sample and their number of branches information are presented in Table 1 below.

Table 1: Banks and Their Number of Branches

Bank Name	Q1 2017	Q4 2018	Closing	Closing %
Wells Fargo Bank	6,172	5,746	426	6.90
JPMorgan Chase Bank	5,412	5,174	238	4.40
Bank of America	4,708	4,408	300	6.37
U.S. Bank	3,216	3,122	94	2.92
PNC Bank	2,670	2,494	176	6.59
Branch Banking and Trust Company	2,207	1,977	230	10.42
Regions Bank	1,549	1,469	80	5.16
SunTrust Bank	1,397	1,253	144	10.31
KeyBank	1,355	1,195	160	11.81
Huntington National Bank	1,315	1,174	141	10.72
TD Bank	1,300	1,269	31	2.38
Fifth Third Bank	1,210	1,176	34	2.81
Citizens Bank	848	802	46	5.42
Manufacturers and Traders Trust Company	858	833	25	2.91
Citibank	756	715	41	5.42
Capital One	705	551	154	21.84
Santander Bank, N.A.	674	632	42	6.23
Compass Bank	671	646	25	3.73
Mean	2,057	1,924	133	7.02
Median	1,335	1,224	118	5.83

5. EMPIRICAL RESULTS

Table 1 shows that number of branches has been decreasing across all banks in our sample and the branch-closing trend among big banks has been significant in the last few years. On average, the banks in our sample had closed 133 of their branches during the period, which accounts for 7.02% of their total branches. Our sample is skewed to the right because of a few giant banks that have closed many branches, so we also report the median to avoid bias. The median of branches being closed in our sample is 118 branches, which accounts for about 5.83% of total branches of a median bank in our sample. Regarding the number of branches being closed, Wells Fargo Bank had closed the most during the period with 426 branches being closed. Bank of America is the next one with 300 branches. Nine banks in our sample (50%) closed more than 100 of their branches. However, Compass Bank and Manufacturers and Traders Trust Company closed just 25 branches in total during the period. Regarding the percentage of branches being closed, Capital One is on the top of the list with 21.84% of its branches being closed during the period. KeyBank, Huntington National Bank, Branch Banking and Trust Company, and SunTrust Bank closed more than 10% of their branches. Meanwhile, TD Bank and Fifth Third Bank closed only 2.38% and 2.81% of their branches, respectively.

Table 2: Banks and their number of WCAG accessibility violations

Bank Name	Q1 2017	Q4 2018	Difference	Difference in %
Wells Fargo Bank	1	1	0	0
JPMorgan Chase Bank	5	3	-2	-40
Bank of America	3	2	-1	-33
U.S. Bank	4	2	-2	-50
PNC Bank	7	9	+2	+29
Branch Banking and Trust Company	4	4	0	0
Regions Bank	3	3	0	0
SunTrust Bank	6	6	0	0
KeyBank	5	2	-3	-60
Huntington National Bank	2	2	0	0
TD Bank	3	2	-1	-33
Fifth Third Bank	5	7	+2	+40
Citizens Bank	4	4	0	0
Manufacturers and Traders Trust Company	5	6	+1	20
Citibank	4	3	-1	-25
Capital One	5	5	0	0
Santander Bank, N.A.	4	5	+1	+25
Compass Bank	5	6	+1	+20
Average	4.17	4	-0.17	-4

Table 2 reports the number of WCAG accessibility violations that we found when we first examined the banks' websites in the 1st quarter of 2017 and when we re-examined their websites in the 4th quarter of 2018. We documented a total of 75 accessibility violations among 18 banks in our sample in the 1st quarter of 2017. When we measured the WCAG violations again in the 4th quarter of 2018, the number has decreased to 72 violations, a reduction of 3 violations that is equivalent to 4% of total violations. As shown in table, the banks in our sample on average had reduced their WCAG violation by 0.17 violation from Quarter 1 of 2017 to Quarter 4 of 2018.

The aggregate numbers in Table 1 and Table 2 seem to support our hypotheses 1. While the banks had closed on average 7% of their branches from the first quarter of 2017 to the last quarter of 2018, which caused a reduction in the physical accessibility of their banking services, they had also enhanced the online accessibility of their banking services by reducing 4% of their WCAG violations. The initial results show that the banks had increased their online accessibility to compensate for the reduction in their physical accessibility. However, the results are not consistent but mixed at individual bank level. While some banks have clearly improved their online accessibility to compensate for the reduction in their physical accessibility as a result of their branch-closing activities, we did not observe the same improvement in other banks. Specifically, six out of 18 banks in our sample had increased their online accessibility, mitigating the negative impact on their physical accessibility as a result of their branches reduction activities. However, seven banks in our sample had not improved the accessibility of their online banking in tandem with their physical accessibility contraction. Surprisingly, the remaining five banks in our sample had experienced a decline in both of their physical banking and online banking accessibility. The findings suggest that not all the banks had developed a strategic plan to make up for the reduction of their physical banking accessibility. In other words, while closing branches has been a trend and possibly a strategic plan of many banks in the last few years, the banks' digital transformation programs as well as their increasing technology investment budgets to make up for their physical branches being closed have neither received full attention nor seemed to be effective. The results suggest that many banks need to pay more attention to reducing their WCAG violations if they want to offset the reduction of their physical banking accessibility by improving the accessibility of their online banking.

Table 3a: Changes in banks' total deposits

Bank Name	Q1 2017	Q4 2018	Change %
Wells Fargo Bank	1,245,096,000	1,261,795,000	1.34
JPMorgan Chase Bank	1,265,873,000	1,281,202,000	3.63
Bank of America	1,273,468,000	1,345,197,000	5.63
U.S. Bank	315,464,029	327,824,504	3.92
PNC Bank	259,364,074	261,570,258	0.85
Branch Banking and Trust Company	167,597,112	168,539,000	0.53
Regions Bank	100,217,551	96,461,043	-3.75
SunTrust Bank	164,028,439	163,527,658	-0.31
KeyBank	106,578,801	110,832,095	3.98
Huntington National Bank	79,393,505	82,636,356	4.08
TD Bank	233,344,129	250,701,149	7.44
Fifth Third Bank	106,880,802	108,189,880	1.22
Citizens Bank	87,914,988	90,202,701	2.60
Manufacturers and Traders Trust Company	98,521,648	90,810,074	-7.83
Citibank	475,593,000	503,685,000	5.91
Capital One	224,027,996	233,086,565	4.04
Santander Bank, N.A.	59,640,206	55,545,446	-6.87
Compass Bank	67,894,627	70,513,924	3.86
Mean	351,716,550	361,239,981	1.68
Median	165,812,776	166,033,329	3.12

In Table 3a, we reported the impact of the banks' branch-closing activities on their total deposits. Banks' total deposits are retrieved from the Bank Regulatory database at Wharton

Research Data Service (WRDS). The banks' level of total deposits in Quarter 1 - 2017 and Quarter 4 - 2018 are reported in the first two columns of Table 3a. The difference between the two levels of total deposits over the period is reported in the last column. TD Bank experienced the highest increase in total deposits at 7.44% over the period. Second and third places belong to Citibank and Bank of America: their total deposits have increased by 5.91% and 5.63%, respectively. While some banks have experienced a rise in their total deposits, others have experienced the opposite. For example, the total deposits at Manufacturers and Traders Trust Company has dropped by 7.83%, the highest cutback in our sample. Santander Bank is the second, having a reduction of 6.87% in their total deposits. On average, the banks in our sample experienced a slight growth of 1.68% in their total deposits over the period. The rate was significantly lower than both the FDIC-insured banks annual deposit growth rate of 5.4% over a 5-year period ended in 2018 (Harris III, Thiem, and Woodhead, 2018) and the U.S. banks' total deposit growth rate of 5.79% from quarter 1 of 2017 to quarter 4 of 2018, according to Yahoo Finance. The result implies that the banks have experienced a negative impact on the growth of their total deposits when they closed their branches and therefore reduced the physical accessibility of their banking services, which gives support to our Hypothesis 2a.

In order to investigate the Hypothesis 2b, we categorized the 18 banks in our sample into three groups of banks based on the change in their online banking accessibility from the 1st quarter of 2017 to the 4th quarter of 2018: better, same (no change), and worse. Group 1 consists of six banks that have improved the online accessibility of their banking services by reducing the number of WCAG violations in their websites during the period. Group 2 consists of seven banks that have maintained the same online accessibility level of their banking services during the period. Group 3 consists of five banks that have experienced a decline in their online banking accessibility. The three groups of banks and the average change in their total deposits are reported in Table 3b.

Table 3b: Changes in banks' total deposits grouped by changes in the banks' online accessibility from Q1-2017 to Q4-2018

Group 1 (better)	Group 2 (no change)	Group 3 (worse)
JPMorgan Chase Bank	Wells Fargo Bank	PNC Bank
Bank of America	Branch Banking and Trust Company	Manufacturers and Traders Trust Company
U.S. Bank	Regions Bank	Fifth Third Bank
KeyBank	SunTrust Bank	Santander Bank, N.A.
TD Bank	Huntington National Bank	Compass Bank
Citibank	Citizens Bank	
	Capital One	
Average Change in	Average Change in	Average Change in
5.09%	1.22%	-1.75%
Relative to the banking	Relative to the banking	Relative to the banking
-0.70%	-4.57%	-7.54%

Table 3b shows that the total deposits of the banks in group 1 had increased by 5.09% from 2017-Quarter 1 to 2018-Quarter 4, a rate that is marginal lower than the 5.79% average growth rate of total deposits in the banking industry during the same period. Meanwhile, the banks in group 2 had only experienced a small increase in their total deposits at the rate of 1.22%, which is not only lower than the average growth rate of total deposits in the banking industry, but also significantly lower than the rate of the banks of group 1. In other word, the growth rate of total deposits of the bank in group 2 is 4.57% less than the U.S. banks' average

growth rate. The most interesting result is from the banks in group 3; they have experienced a decline of 1.75% in their total deposits during the period. It means their total deposit has dropped 7.54% relatively to other U.S. banks. The results give strong support to our Hypothesis 2b that during the period when banks closed their branches and therefore reduced their physical banking accessibility, the negative impact on the bank's total deposits growth is stronger for banks that did not improve their online banking accessibility and weaker for banks that enhanced their online banking accessibility.

Table 4a. T-Test for the difference in total deposits growth between groups 1 and 2

Two-Sample Assuming Equal Variances			Two-Sample Assuming Unequal Variances		
	Group 1	Group 2		Group 1	Group 2
Mean	5.085	1.218571429	Mean	5.085	1.218571429
Variance	2.24379	7.594780952	Variance	2.24379	7.594780952
Observations	6	7	Observations	6	7
df	11		df	9	
t Stat	3.058668491		t Stat	3.20104819	
P(T<=t) one-tail	0.005438897		P(T<=t) one-tail	0.00540655	
t Critical one-tail	1.795884819		t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.010877794		P(T<=t) two-tail	0.010813099	
t Critical two-tail	2.20098516		t Critical two-tail	2.262157163	

Table 4b. T-Test for the difference between groups 1 and 3

Two-Sample Assuming Equal Variances			Two-Sample Assuming Unequal Variances		
	Group 1	Group 3		Group 1	Group 3
Mean	5.085	-1.754	Mean	5.085	-1.754
Variance	2.24379	27.55843	Variance	2.24379	27.55843
Observations	6	5	Observations	6	5
df	9		df	5	
t Stat	3.074500796		t Stat	2.819001783	
P(T<=t) one-tail	0.006628612		P(T<=t) one-tail	0.018576125	
t Critical one-tail	1.833112933		t Critical one-tail	2.015048373	
P(T<=t) two-tail	0.013257224		P(T<=t) two-tail	0.037152251	
t Critical two-tail	2.262157163		t Critical two-tail	2.570581836	

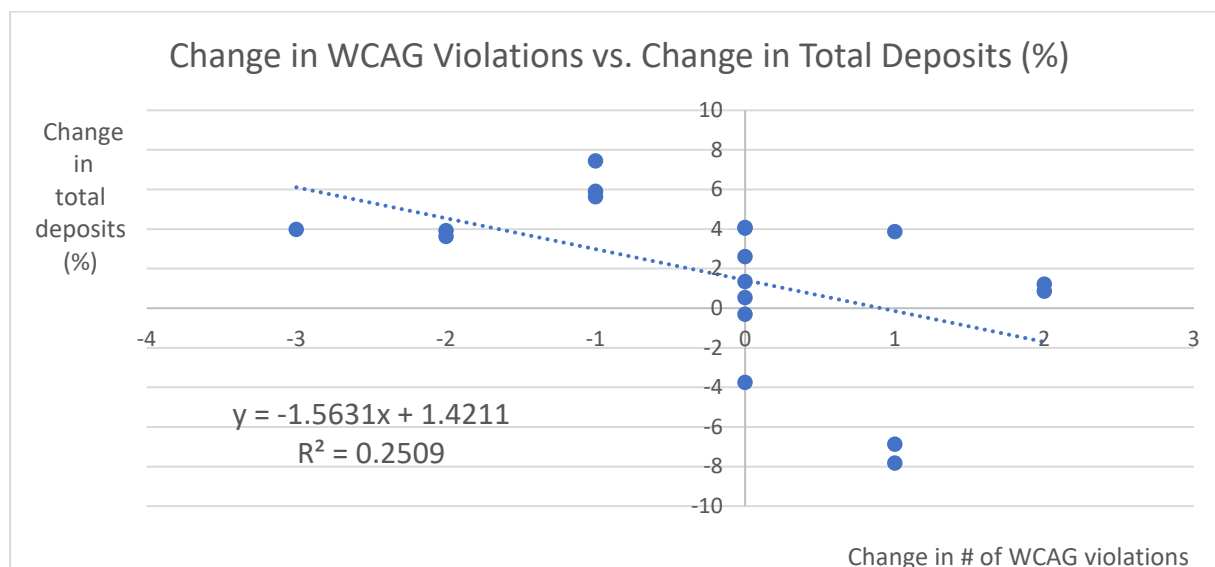
Table 4c. T-Test for the difference between groups 2 and 3

Two-Sample Assuming Equal Variances			Two-Sample Assuming Unequal Variances		
	Group 2	Group 3		Group 2	Group 3
Mean	1.218571429	-1.754	Mean	1.218571429	-1.754
Variance	7.594780952	27.55843	Variance	7.594780952	27.55843
Observations	7	5	Observations	7	5
df	10		df	6	
t Stat	1.286141106		t Stat	1.157365209	
P(T<=t) one-tail	0.113686983		P(T<=t) one-tail	0.145555864	
t Critical one-tail	1.812461123		t Critical one-tail	1.943180281	
P(T<=t) two-tail	0.227373966		P(T<=t) two-tail	0.291111728	
t Critical two-tail	2.228138852		t Critical two-tail	2.446911851	

We double checked the robustness of our Hypothesis 2b by reporting the t-test statistics for the difference in total deposits growth rates among the three groups of banks mentioned above. We report the results of both the t-test assuming the variances of the two samples are equal and the t-test assuming the variances of the two sample are unequal. The results in Table 4a shows that the mean value of total deposit growth rates of the banks in group 1 is significantly higher than the rates of the banks in group 2 at a 1% level of confidence, so we can reject the null hypothesis that the two means are the same. In other words, the results show that the total deposit growth rates of the banks that enhanced their online banking accessibility (group 1) are significantly higher than the rates of the banks that did not enhance their online banking accessibility (group 2). The gap between the two rates is even larger when we compare group 1 and group 3. The results in Table 4b shows that the mean value of deposit growth rates of the banks in group 1 are significantly higher than the rates of the banks in group 3 at 1% level of confidence, so we can reject the null hypothesis that the two rates are the same. In other words, when banks closed their branches and therefore reduced their physical banking accessibility, the ones that enhanced their online banking accessibility (group 1) was able to maintain and attract deposits better than those that lessened their online banking accessibility (group 3). Last, the results in Table 4c shows that there is difference between the mean value of deposit growth rate of banks that maintain their online banking accessibility while reducing their physical banking accessibility (group 2) and banks that have declined in both physical and online banking accessibility (group 3). However, the difference is not statistically significant.

In summary, the t-tests results in Tables 4a, 4b, and 4c reinforce our Hypothesis 2b that the banks would experience different degrees of the negative impact on the growth of their total deposits, depending on the changes in their online banking accessibility.

Figure 2



In another effort to double-check the robustness of our Hypothesis 2b, we ran a linear regression of the change in the banks' total deposits on the change in the banks' number of WCAG violations to test the effect of the banks' online banking accessibility on their total deposit growth. Slope and intercept of the regression are illustrated in Figure 2. The regression line has a negative slope, showing that on average, total deposits decline with an increase in WCAG violations. In other words, if a bank's website has more WCAG violations and therefore lower their online banking accessibility, it is likely that the bank would experience a

decline in its total deposits growth rate. Likewise, if a bank's website has fewer WCAG violations and therefore higher its online banking accessibility, it is likely that the bank would experience an increase in its total deposits growth rate.

Figure 3. Regression output: Change in WCAG Violations vs. Change in Total Deposits (%)

SUMMARY OUTPUT								
<i>Regression Statistics</i>								
Multiple R	0.50							
R Square	0.25							
Adjusted R	0.20							
Standard	3.73							
Observations	18							
	<i>Coefficients</i>	<i>Standard</i>	<i>t Stat</i>	<i>P-</i>	<i>Lower 95%</i>	<i>Upper</i>	<i>Lower</i>	<i>Upper</i>
Intercept	1.42	0.89	1.60	0.13	-0.46	3.30	-0.46	3.30
Change in #	-1.56	0.68	-2.31	0.03	-2.99	-0.13	-2.99	-0.13

The statistics of the regression is presented in Figure 3. The coefficient on WCAG violations is -1.56 which can be interpreted that having one more WCAG violation in a bank's websites would result in a decline of 1.56% in the bank's total deposits or having one less WCAG violation in a bank's website would result in an increase of 1.56% in the bank's total deposits. Both t-value and p-value of the test indicate that the coefficient is statistically significant at 5% level of confidence, giving support for our Hypothesis 2b that there is a positive relationship between the banks' online accessibility improvement and their total deposits growth.

Table 5a: Changes in banks' return on earning assets (ROEA)

Bank Name	ROEA (%)	ROEA (%)	Change (%)
Wells Fargo Bank	3.31	4.05	0.74
JPMorgan Chase Bank	2.32	3.24	0.92
Bank of America	3.07	3.78	0.71
U.S. Bank	3.35	4.18	0.83
PNC Bank	3.14	3.72	0.58
Branch Banking and Trust Company	3.48	4.12	0.64
Regions Bank	3.48	4.13	0.65
SunTrust Bank	3.33	3.89	0.56
KeyBank	3.47	4.17	0.70
The Huntington National Bank	3.67	4.36	0.69
TD Bank	2.62	3.42	0.80
Fifth Third Bank	3.59	4.14	0.55
Citizens Bank	3.52	4.20	0.68
Manufacturers and Traders Trust Company	3.64	4.33	0.69
Citibank	4.08	4.75	0.67
Capital One	4.50	5.17	0.67
Santander Bank, N.A.	3.37	3.87	0.50
Compass Bank	3.70	4.04	0.34
Mean	3.42	4.08	0.66
Median	3.48	4.13	0.68

In Table 5a, we documented the impact of the banks' branch-closing activities on their profitability. We obtain banks' financial data from the Office of the Comptroller of the Currency - Department of Treasury. We use the banks' return on earning assets (ROEA) as a proxy to measure their profitability. The banks' ROEAs in Quarter 1 - 2017 and in Quarter 4 - 2018 are reported in the first two columns of Table 5a. The difference between the two levels of profitability over the examined period is reported in the last column. All the banks in our sample have experienced an increase in their ROEAs during the period. On average, the profitability of the banks in our sample has increased by 0.66% in tandem with closing their branches. JP Morgan Chase is the bank whose profitability increased the most at 0.74%. Coincidentally, JP Morgan Chase has publicly highlighted its intentional efforts towards increased online accessibility (Hamidullah-Bahl, 2015). Second place belongs to U.S. Bank; its ROEA has increased by 0.83%. Santander and Compass banks are the two banks that experienced the lowest increase in profitability; their ROEAs only increased by 0.50% and 0.34%, respectively. The result implies that the banks have experienced a positive growth in their profitability when they shut down their branches as a strategic move to improve their performance, which gives support to our Hypothesis 3a.

In order to investigate the Hypothesis 3b, we again categorized the 18 banks in our sample into 3 groups of banks based on the change in their online banking accessibility from the 1st quarter of 2017 to the 4th quarter of 2018: better, same (no change), and worse, following the same the procedure described above in Table 3b. The three groups of banks and their average change in ROEA are reported in Table 5b.

Table 5b: Changes in banks' ROEA grouped by changes in the banks' online accessibility from Q1-2017 to Q4-2018

Group 1 (better)	Group 2 (no change)	Group 3 (worse)
JPMorgan Chase Bank	Wells Fargo Bank	PNC Bank
Bank of America	Branch Banking and Trust Company	Manufacturers and Traders Trust Company
U.S. Bank	Regions Bank	Fifth Third Bank
KeyBank	SunTrust Bank	Santander Bank, N.A.
TD Bank	Huntington National Bank	Compass Bank
Citibank	Citizens Bank	
	Capital One	
Average Change in ROEA	Average Change in ROEA	Average Change in ROEA
0.77%	0.66%	0.53%

Table 5b shows that the banks in group 1 had increased their profitability by 0.77% over the period. Meanwhile, the banks in group 2 had experienced a smaller increase of 0.66% in their profitability over the same period, but this figure is still higher than the profitability increase of the banks in group 3. The results gives strong support to our Hypothesis 3b that while the banks would experience an increase in their profitability following their branch-closing activities, the degree of such positive effect is weaker for banks that do not improve the accessibility of their online banking and greater for banks that enhance the accessibility of their online banking together with their branch-closing activities.

Table 6a. T-Test for the difference in ROEA between groups 1 and 2

Two-Sample Assuming Equal Variances			Two-Sample Assuming Unequal Variances		
	Group 1	Group 2		Group 1	Group 2
Mean	0.77166667	0.66142857	Mean	0.77166667	0.66142857
Variance	0.00909667	0.00304762	Variance	0.00909667	0.00304762
Observations	6	7	Observations	6	7
df	11		df	8	
t Stat	2.60241196		t Stat	2.49545109	
P(T<=t) one-tail	0.01229401		P(T<=t) one-tail	0.01860241	
t Critical one-tail	1.79588482		t Critical one-tail	1.85954804	
P(T<=t) two-tail	0.02458801		P(T<=t) two-tail	0.03720483	
t Critical two-tail	2.20098516		t Critical two-tail	2.30600414	

Table 6b. T-Test for the difference in ROEA between groups 2 and 3

Two-Sample Assuming Equal Variances			Two-Sample Assuming Unequal Variances		
	Group 2	Group 3		Group 2	Group 3
Mean	0.66142857	0.532	Mean	0.66142857	0.532
Variance	0.00304762	0.01637	Variance	0.00304762	0.01637
Observations	7	5	Observations	7	5
df	10		df	5	
t Stat	2.41512942		t Stat	2.12510228	
P(T<=t) one-tail	0.01818157		P(T<=t) one-tail	0.04347087	
t Critical one-tail	1.81246112		t Critical one-tail	2.01504837	
P(T<=t) two-tail	0.03636314		P(T<=t) two-tail	0.08694175	
t Critical two-tail	2.22813885		t Critical two-tail	2.57058184	

Table 6c. T-Test for the difference in ROEA between groups 1 and 3

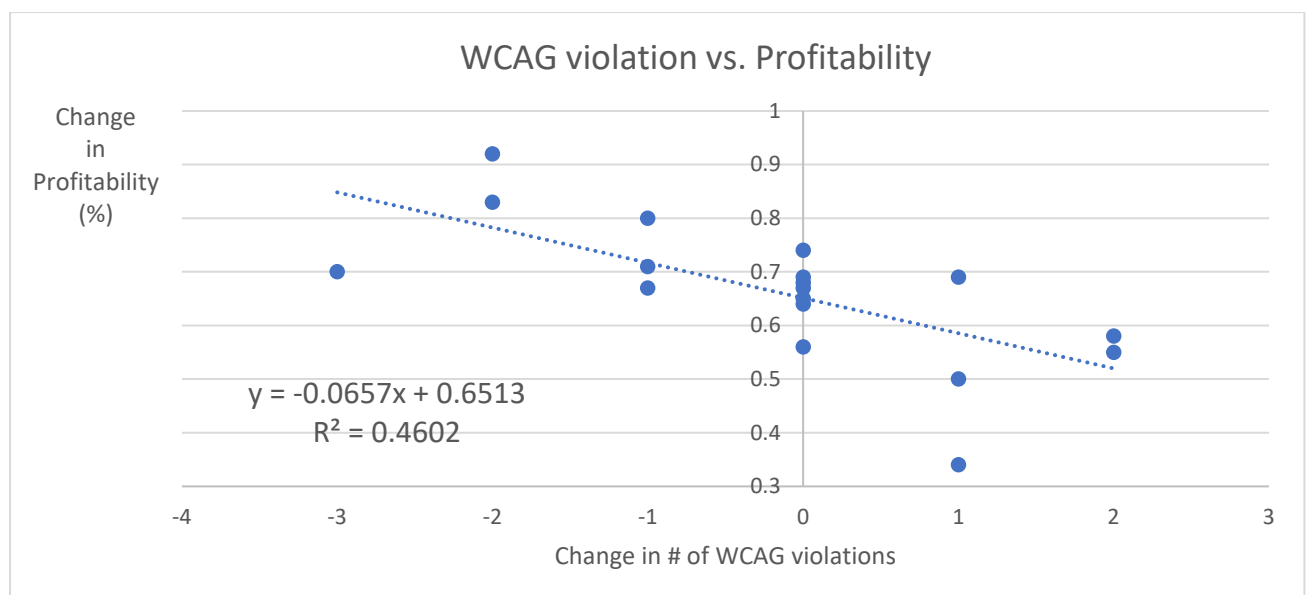
Two-Sample Assuming Equal Variances			Two-Sample Assuming Unequal Variances		
	Group 1	Group 3		Group 1	Group 3
Mean	0.77166667	0.532	Mean	0.77166667	0.532
Variance	0.00909667	0.01637	Variance	0.00909667	0.01637
Observations	6	5	Observations	6	5
df	9		df	7	
t Stat	3.56453947		t Stat	3.46285927	
P(T<=t) one-tail	0.00303797		P(T<=t) one-tail	0.00525342	
t Critical one-tail	1.83311293		t Critical one-tail	1.89457861	
P(T<=t) two-tail	0.00607594		P(T<=t) two-tail	0.01050684	
t Critical two-tail	2.26215716		t Critical two-tail	2.36462425	

In an effort to check the robustness of our Hypothesis 3b, we report the t-test statistics for the difference in profitability growth among the three groups of banks, assuming the variances of the two samples are equal and also assuming the variances of the two sample are unequal. The results in Table 6a shows that the mean value of profitability growth of the banks in group 1 is significantly higher than the mean value of the banks in group 2 at a 5% level of confidence, so we can reject the null hypothesis that the two means are the same. In other words, the results show that when banks closed branches and reduced their physical banking accessibility, the profitability growth of the banks that enhanced their online banking accessibility is significantly higher than that of the banks that did not enhance their online

banking accessibility. Similarly, the results in Table 6b shows that the mean value of profitability growth of the banks in group 2 is significantly higher than the mean value of the banks in group 3 at 5% level of confidence, so we can reject the null hypothesis that the two profitability growths are the same. Particularly, the results show that when banks closed branches and therefore reduced their physical banking accessibility, the ones that maintained their online banking accessibility experienced a higher profitability growth than those that declined in their online banking accessibility. Given the results in Tables 6a and 6b, it is not surprising that the results in Table 6c shows that there is a strong difference between the mean value of profitability growth of banks that enhanced their online banking accessibility and that of banks that declined in their online banking accessibility. The difference is statistically significant at 1% level of confidence.

In short, the t-tests results in Tables 6a, 6b, and 6c strengthen our Hypothesis 3b that while the banks are likely to increase their profitability with their strategic branch-closing activities, the magnitude of the increase is positively related to the improvement in their online banking accessibility.

Figure 4. Change in WCAG Violations vs. the change in Profitability (%).



In another effort to double-check the robustness of our Hypothesis 3b, we ran a linear regression of the change in the banks' profitability on the change in the banks' number of WCAG violations to test the effect of the banks' online banking accessibility improvement on their profitability. Slope and intercept of the regression are illustrated in Figure 4. The regression line has a negative slope, meaning that on average, profitability of the banks would suffer when banks having more WCAG violations in their websites (lower level of their online accessibility). It also means the profitability of the banks would be better when banks having fewer WCAG violations in their websites which implies the banks' online accessibility has been improved.

Figure 5. Regression output: Change in WCAG Violations vs. Change in Profitability (%)

SUMMARY OUTPUT								
<i>Regression Statistics</i>								
Multiple R	0.68							
R Square	0.46							
Adjusted R	0.43							
Standard	0.10							
Observations	18							
	<i>Coefficients</i>	<i>Standard</i>	<i>t Stat</i>	<i>P-</i>	<i>Lower 95%</i>	<i>Upper</i>	<i>Lower</i>	<i>Upper</i>
Intercept	0.65	0.02	27.91	0.00	0.60	0.70	0.60	0.70
Change in #	-0.07	0.02	-3.69	0.00	-0.10	-0.03	-0.10	-0.03

The statistics of the regression is presented in Figure 5. The coefficient on WCAG violations is -0.07 which can be interpreted that having one more WCAG violation on a bank's website would result in a decline of 0.07% in the bank's return on earning assets, or having one less WCAG violation on a bank's website would result in an increase of 0.07% in the bank's return on earning assets. Both t-value and p-value of the test indicate that the coefficient is statistically significant at 1% level of confidence, giving support for our Hypothesis 3b that there is a positive relationship between the banks' online accessibility and their profitability.

6. CONCLUSION

Banks have been closing branches at the fastest pace in the last decade because there has been an increase in the number of consumers who no longer visit their physical bank branches for their routine transactions, and more customers have switched either partially or completely to online banking. Closing unprofitable branches is expected to continue and be a strategic plan of many banks in the near future.

The branch-closing activities have reduced the physical accessibility of banking services. In addition, online banking transactions have gradually replaced the traditional banking transactions in physical branches. Therefore, we investigated whether an increase in banks' online banking accessibility would compensate for the decline in their physical banking accessibility. We found that while some banks did enhance their online banking accessibility to offset the negative impact of their branch-closing activities, it is not true for other banks.

Our results also suggest that branch-closing activities have a negative impact on the bank's ability to maintain and increase their total deposits, but the negative impact is lesser for banks that enhanced their online banking accessibility.

Finally, we found that the profitability of the banks in general increased together with their branch-closing activities. Interestingly, the increase is more significant for banks that strengthened their online banking accessibility and less significant for banks that have declined in their online banking accessibility.

In conclusion, banking customers moving to online banking is an inevitable trend and branch-closing has become a strategic plan of many banks. Our findings suggest that when the banks are cutting down their branches, they should invest in improving the online accessibility of their banking services to offset the reduction in their physical banking accessibility, especially when their online banking accessibility is likely to have an impact on both of their total deposits and profitability.

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