The Effects of COVID-19 on the Mobile Payment Banking System

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Abstract

This study includes an examination of the effect of the Coronavirus (COVID-19) pandemic on electronic payment apps. Ever since the pandemic caused a global shutdown, the banking industry was forced to adjust their usual operations and adopt new technological advancements that would allow for contactless payment. Consumers, worried about contracting the virus through the physical exchange of currency, resorted to utilizing payment apps. This contributed to the increase in electronic payment usage. This research addresses the effect of COVID-19 on three different electronic payment apps, Venmo, PayPal, and Zelle. A comparative longitudinal analysis shows the increase in total transactions from each app through secondary data. This study includes a regression analysis of the relationship between total payment volume (TPV) and time, as well as a forecast of future app usage.

Keywords: mobile banking, COVID-19, mobile payment apps, technology, finance

The Effect of COVID-19 on the Mobile Payment Banking System

Following the Coronavirus (COVID-19) pandemic, many industries were affected by the stalled economy caused by the extended period of lockdown. Many companies shut down their operations indefinitely, causing a great loss in profits (Fairlie & Fossen, 2021). Many companies and industries are still recovering from the detrimental effects of COVID-19. A particular industry that has experienced growth through the course of the pandemic is the banking industry, specifically online banking (Mustafa, 2021). Since physical contact was limited, banks were forced to adjust their methods of facilitating payments to accommodate to the social distance practices (Mustafa, 2021). Though some banks had already integrated technology into their operations before COVID-19, the pandemic rapidly increased the digitization of the banking industry (Popa & Luca, 2022). Banks streamlined the transfer of money between bank accounts and created mobile banking apps. In-person bank tellers were replaced with automated machines that would assist individuals with transferring funds (Popa & Luca, 2022). Instead of exchanging physical cash currency, individuals utilized virtual payment platforms such as Venmo or PayPal.

The purpose of this study is to examine the effect of COVID-19 on the usage of electronic payment apps. This includes a literature review that begins with a history of mobile banking, a definition of mobile payment apps, and an overview of the COVID-19 pandemic. Additionally, it includes discussions of the effects of COVID-19 on the banking industry by observing brick-and-mortar bank shutdowns, the transmission of COVID-19 through cash, and the adoption of mobile banking. It also contains a comparative trend analysis to determine the growth of three mobile payment apps, PayPal, Venmo, and Zelle, using historical secondary data resulting in several findings and a forecast the observed trends. Finally, the study highlights limitations and implications for future research.

COVID-19 and the Banking Industry: A Literature Review

Mobile Banking

Until the 1960s, banking was mainly an analogue industry. Banks were brick-and-mortar buildings that required bank tellers to process deposits, withdrawals, and perform virtually every function of a bank. The first introduction of technology into banking was in 1967 when Barclays Bank installed the first automatic teller machine (ATM) in the United Kingdom (Kalaitzakis, 2020). This was the first time that a customer could perform financial transactions over an electronic device, thus eliminating the need for the customer to visit a bank branch. The introduction of the ATM into the banking industry created the connection between finance and technology, and it sparked the shift from analogue banking to digital banking (Kalaitzakis, 2020). The term "digital banking" refers to using technology channels to conduct banking business (Kaur et al., 2021). This shift continued through the introduction of the World Wide Web in the 1990s, as well as the transition from the telegraph to fax and emails. Wells Fargo and ING were the first banks to experiment with internet banking, which allowed customers to access their bank information, such as balances and loans, through their computers in their homes (Kalaitzakis, 2020). Between 2000 and 2010, many leading banks provided digital banking services which inspired other banks to do the same (Singh et al., 2023). The invention of the cell phone introduced another facet of banking, mobile banking.

Mobile banking is a subset of internet banking; it utilizes portable devices, like the smartphone, to perform the functions of banking (Kalaitzakis, 2020). Not only could customers access their banking from their computers at home, but they could access it from virtually anywhere through their mobile devices. Banks developed their own apps for customers to download on their smartphone that allowed them to access their accounts and complete

transactions on the move (Singh et al., 2023). As more technology was introduced into the banking industry, more brick-and-mortar branch banks began to close due to the elimination of the need for physical banks. US. Banks closed over 4,800 branches from 2009 to 2014 which reduced the total number of branches by five percent (Pham et al., 2022). With the decrease of physical banks came the increase of mobile banking. A 2016 report showed that 71 percent of consumers who have a bank account reported that they used online banking (Pham et al., 2022). As of 2019, mobile banking made up 22 percent of global spending (Eneizan et al., 2022).

Non-financial companies entered the mobile banking sector by creating apps to facilitate peer-to-peer payments (P2P) between customers. This development allowed for individuals to pay and receive payment from other individuals who may not have the same bank as them. Companies like Venmo and PayPal were created to facilitate payments between individuals through a mobile app. Customers can link their bank accounts or credit/debit cards to the apps to make and receive payments easily.

Mobile Payment Apps

Mobile payment apps are defined as software applications that allow customers to send and receive money or pay for goods and services using their smartphones (The Pew Charitable Trusts, 2019). The invention of mobile payment apps has revolutionized the way some consumers spend their money. Instead of writing checks or paying with cash, consumers can open the app on their phones and make payments electronically. There are various types of mobile payment apps such as P2P apps, mobile wallet apps, wearables, and bank-specific mobile apps. P2P apps allow consumers to link their debit/credit cards to the app in order to send and receive payments from their friends. Users authenticate their card or bank routing information and can pay their friends with a click of a button. In 2021, more U.S. bank users performed P2P

transactions through a direct money transfer service (mobile payment app) than through a wire bank transfer (Statista, 2021). This has not always been the case; as mobile payment apps gain more traction, more consumers are using mobile payment apps rather than bank transfers or wire transfers. Mobile wallet apps are electronic "wallets" that allow the user to store multiple cards on their mobile devices to make purchases online. Using near-field communication (NFC), a user can also make payments in person by hovering their mobile phone over the payment screen. This transfers the user's card data to the person collecting the payment without having to swipe or tap their card. Wearables are similar to mobile wallets; they use NFC to complete transactions, but they are available on smartwatches like the Apple iWatch. Finally, bank-specific mobile apps allow bank users to view their account balances, process checks, and view transaction history. The most popular function on a primary bank's mobile app is the mobile check deposit (Statista, 2021). The key difference between bank apps and mobile payment apps is that bank apps are associated with a specific bank, whereas mobile payment apps can be used by any bank user and can facilitate payments between consumers with different bank accounts.

Consumers use mobile payment apps for a variety of reasons. Most consumers believe that it makes paying for things easier, makes sending people money to people safer, and allows them to split expenses with others more easily (Anderson, 2022). Many consumers switch to mobile payment apps because of the inconvenience of cash, social influence, and the ability to view transaction history (Jung et al., 2020). Though mobile payment apps are widely appealing, some consumers choose not to use them due to lack of trust, lack of perceived necessity, and lack of knowledge (Anderson, 2022; Jung et al., 2020). Many consumers are concerned with the safety of their personal information and choose not to download the app and input their bank information (Anderson, 2022). Thirty-four percent of consumers who do not use mobile banking

apps say that they are not confident that the app would keep their data safe from hackers (Anderson, 2022).

PayPal

PayPal, started in 1998, is the most well-known mobile payment app in the United States (Statista, 2021). As the oldest of the apps analyzed, PayPal is the most well-known. Of consumers in the U.S., 38% use it and like it (Statista, 2024). PayPal offers a variety of features such as P2P transactions to other PayPal users, bill payments, and even facilitates cryptocurrency purchasing (PayPal, 2024). Many consumers utilize their PayPal account to quickly purchase things online instead of entering their debit/credit card information; this is a feature that is unique to PayPal. One of PayPal's many advantages is that it offers features to aid small businesses in facilitating transactions (PayPal, 2024). Though it is popular among small business owners, a disadvantage of using PayPal is its high processing fees.

Venmo

Venmo began in 2009 and has been owned by PayPal since 2013; it is the next most popular app. In the U.S, 16% of consumers use Venmo and are satisfied with it (Statista, 2024). Venmo can also be seen as a form of social media; users can add "friends" and view, like, and comment on their friends' transactions. Venmo is most popular among Gen Z due to the social media aspect (Statista, 2024). One way that Venmo stands out is that it is user-friendly, and individuals can confirm that they are paying the correct person by entering the last four digits of the person's phone number. This creates an added layer of protection and assures that their money is going toward the intended person. A disadvantage arises due to the fees associated with instant transfer to an individual's bank account. However, customers can choose to do a wire transfer which takes 1-3 days with no charge.

Zelle

Zelle, created in 2017, is the newest of the three mobile apps. This is reflected through its market penetration, as only 14 percent of U.S. consumers use Zelle and like it (Statista, 2024). Zelle only facilitates P2P payments, and there is no social media aspect or anything other than transferring funds. Many banks such as Capital One partner with Zelle to allow their customers to make or receive payments to other bank users. This is advantageous, as the bank users' information is already entered into the mobile payment app's system. On the other hand, Zelle is not widely known and does not have the bells and whistles that Venmo or PayPal have.

COVID-19

The Coronavirus (COVID-19) pandemic began in December of 2019 in Wuhan, China (CDC, 2024). It began spreading to other parts of the world and reached the U.S. in January of 2020. On March 11th, 2020, the World Health Organization (WHO) declared it to be a public health emergency (Shabir et al., 2023). Businesses across the globe began shutting down due to the uncertainty of the severity of the virus as well as its high transmissibility rate. Countries closed their borders, cancelled flights, and would not allow anyone in or out. This virus is fatal, and whoever caught COVID could become seriously ill and/or die (Alfaro & Jeong, 2020). In order to "flatten the curve," governments worldwide imposed strict lockdowns, traced contact between infected patients, and increased digitization to save lives while ensuring that essential functions continued (Raghavan et al., 2021). The workplace absences and company shutdowns disrupted the supply chain, thus creating a supply shock in the economy (Alfaro & Jeong, 2020). The global gross domestic product (GDP) growth rate, which was projected to be 2.3 percent for 2020, ended up falling by 3 percent (Alfaro & Jeong, 2020). The economy experienced the deepest dive in GDP since the Great Depression.

As the pandemic continued, society began to adapt to the changes that came along. Organizations had to reconfigure their resources, systems, and workforce in order to continue operating (Raghavan et al., 2021). The unemployment rate peaked at 13 percent during the second quarter of 2020 (U.S Bureau of Labor Statistics, 2022). Due to the economic impact of the virus, governments encouraged banks to be flexible to meet the needs of their customers. This was shown in the form of loan forgiveness, loan modifications, and the Paycheck Protection Program (PPP). The PPP issued loans to small businesses across the U.S. to cover the paychecks of their employees who were not allowed to work (FDIC, 2021). The U.S. government enacted many programs to boost the economy as COVID cases continued to climb. The number of confirmed COVID cases drastically increased day-by-day in 2021 and 2022 (Elflein, 2023). Finally, in 2023, the number of confirmed cases began to level off as more individuals received vaccinations and the virus continued to mutate and thus became as normal as the common cold.

For the purpose of this research, the COVID-19 pandemic began in January of 2020 (Q1 2020) and ended in May of 2023 (Q2 2023), when the federal government declared an end to the public health emergency for the pandemic (CDC, 2024).

The Effect of COVID-19 on the Banking Industry

The COVID-19 pandemic had a notable impact on the banking industry. In previous economic crises like the Great Depression and the Great Recession, banks have been at the center of the problem (Marcu, 2021). This time, banks were seen as part of the solution, as it was a health crisis, not a financial crisis (Marcu, 2021). The pandemic has forced the economy to continuously adapt to the mandates, lockdowns, and demands that were constantly changing. The following section elaborates on the existing research that surrounds brick-and-mortar bank

shutdowns, the transmission of COVID through cash, the adoption of mobile banking, and the growth of mobile payment apps.

Brick-and-Mortar Bank Shutdowns

The pandemic accelerated the closures of many brick-and-mortar banks across the globe. Though the closure of physical banks was a trend long before the pandemic, the imposed lockdowns and uncertainty of the pandemic increased the rate of bank closures drastically. The financial crisis in 2008 and the following recession, the Great Recession, is what initially sparked this trend, as banks moved away from expanding their branch network and redirected their efforts toward automation (Edlebi et al., 2022). The COVID pandemic instilled much uncertainty in the economy, as well as prevented customers from visiting physical branches. The Federal Reserve System states that bank branches have closed at record high rates during the COVID-19 crisis (Kreiss, 2021). The total number of banks that closed in 2020 is more than the number of banks closed any other year from 2011 to 2019 (Kreiss, 2021). About 3,700 banks closed in 2020 compared to 3,000 in the year with the next highest bank closures (Kreiss, 2021). Bank closures during the pandemic were concentrated in metropolitan areas, as 87 percent of bank closures during COVID occurred in a metropolitan area (Kreiss, 2021). From 2019 to 2020, there was a 2.7-point increase in the rate of decline of brick-and-mortar banks in metropolitan areas (Kreiss, 2021).

Historically, the vast majority of banks were small, local banks, but the pandemic shifted the banking landscape. In 1994, small banks made up 84 percent of all banks in the U.S; in 2021, there are far fewer banks, and small banks make up 52 percent where large banks make up 48 percent (Edlebi et al., 2022). Since 2017, there have been 7,425 bank branches that have closed, which is 9% of the total banks in 2017 (Edlebi et al., 2022).

Though banks have been closing their physical branches, this does not necessarily mean that banks are losing profit or going out of business. Pham et al. (2022) conducted a study that addressed whether a decrease in a bank's physical presence has a negative impact on their ability to maintain their total deposits. The researchers also investigated if a bank's online accessibility would compensate for the reduction in physical accessibility (Pham et al., 2022). Through polling a sample of the largest banks in the U.S., the researchers collected data regarding the number of bank closures and an analysis of their websites through the Web Content Accessibility Guidelines (WCAG). Their findings showed that branch-closing activities have a negative impact on banks' ability to maintain and increase deposits, but the negative impact is less for banks that have an established online banking presence (Pham et al., 2022). Also, financial profitability increased with branch-closing activities, and the banks that strengthened their online accessibility experienced more profitability (Pham et al., 2022). From the sample, the banks closed an average of 133 of their branches during the period, which is 7.02 percent of their total branches during the pandemic (Pham et al., 2022). Though banks increased the amount of branch closures, if their online accessibility was established, they did not lose profit, as many individuals resorted to conducting their banking from their computers and phones.

Transmission of COVID through Cash and Credit Cards

Due to the transmissibility of the virus, many people were very aware of the surfaces they came in contact with. Research indicates that the coronavirus can survive up to three hours in the air, 24 hours on cardboard, and even longer on other hard surfaces (Auer et al., 2020). People began to fear that they would contract the virus through the physical exchange of cash or through paying with their debit or credit cards. As a result, consumers shifted away from using cash.

Researchers from the National Library of Medicine investigated the impact that the virus had on the utilization of cash. There was a large decline in cash usage at the point-of-sale (POS); POS transactions paid in cash declined from 31 percent at the beginning of 2020 to 13 percent in April of 2020 (Jonker et al., 2022). The usage of cashless payment instruments increased while the use of cash decreased, because of the fear of getting infected by the virus using cash (Jonker et al., 2022). Similarly, Huterska et al. (2021) asserted that the fear of contagion plays a prominent role in an individual's decision to abandon cash in transactions. Consequentially, many businesses chose to not accept cash due to the desire to avoid physical contact (Auer et al., 2020; Huterska et al., 2021). During the pandemic, the rate at which consumers move away from cash has increased drastically (Auer et al, 2020; Huterska et al., 2021). The emotionally motivated factor, fear of using cash, played an important role in mobilizing consumers to start using cashless payments or choose them more often than before (Huterska et al., 2021).

Adoption of Mobile Banking

The social distancing mandates, lockdowns, and government restrictions forced individuals to remain within the comfort of their own homes to avoid contracting the virus. Because of this, consumers turned to utilizing mobile or online banking to cash checks, transfer funds, pay bills, and make payments. Many individuals already utilized mobile banking, while others were forced to adopt it for the first time. Nonetheless, the use of cashless payment methods increased despite the lack of additional financial incentives (Huterska et al., 2021). This section discusses the frequency and growth of mobile banking as well as the factors that contribute to mobile banking adoption.

Frequency and Growth of Mobile Banking. The COVID-19 pandemic accelerated the global growth of digital banking among both existing and new users. Tut (2023) asserted that the

use of mobile banking increased by 54% during the pandemic, claiming that the pandemic has accelerated the adoption of financial technology (FinTech). Similarly, Vilhena and Navas (2023) performed a multivariate analysis through polling 351 individuals, and they determined the trends and customer usage of mobile banking during the pandemic. Based on their data, the researchers concluded that the COVID-19 pandemic accelerated the growth of digital banking. They also found that the majority of the respondents (86.5%) agreed that the pandemic accelerated the urgency of digital transformation (Vilhena & Navas, 2023). They concluded that a very high percentage (99.6%) of respondents indicated their intention to continue using mobile banking services (Vilhena & Navas, 2023). This assertion agrees with the projection that the global payment market is expected to witness a compound annual growth rate (CAGR) of over 25 percent from 2020 to 2028 (Al-Qudah et al., 2022).

Gupta and Parti (2021) provided an overview of the pandemic, as well as the effect of COVID-19 on different digital payment sectors. The researchers utilized primary and secondary data, such as reports provided by banks, to determine the impacts of digital payments on economic growth; these impacts include business, sectoral, and payment categories. COVID-19 adversely affected major sectors of the economy, especially the manufacturing, retail, and hospitality industries (Gupta & Parti, 2021). Travel bans, shop closures, and decrease in consumer discretionary income further negatively affected payments (Gupta & Parti, 2021). However, there are certain areas that experienced acceleration in digital payments. These areas included grocery stores, pharmacies, and utility payments (Gupta & Parti, 2021). The researchers concluded that the concerns over the transmission of the virus through exchange of physical currency increased the use of online transactions. They claim that digital payments are no longer used simply for convenience, but they are a necessity for essential transactions such as bill

payments, groceries, and pharmacies (Gupta & Parti, 2021). The number of online transactions surged by 23% between June 2020 and July 2020, while mobile banking specifically saw an increase in 12.41 percent in fiscal year 2020 (Gupta & Parti, 2021; Pokhrel, 2022).

Factors that Contribute to Acceptance. Many studies indicate various factors that contribute to the acceptance of mobile banking during the era of COVID-19. Eneizan et al. (2022) addressed the effect of COVID-19 on the acceptance of mobile banking. The researchers polled 290 people using an electronic questionnaire to analyze the effect of individuals' attitudes toward the acceptance of mobile banking during the pandemic. They found that the main factors that contributed to the adoption of mobile banking were uncertainty, perceived usefulness, and perceived risk of COVID-19 (Eneizan et al., 2022). The researcher asserted that the lockdown and social distancing orders that had been established to prevent the pandemic from spreading had directly resulted in an increase in online activities (Eneizan et al., 2022). Through this study, the researchers proved that due to the uncertainty of the pandemic, many individuals chose to utilize mobile banking platforms to facilitate their financial transactions (Eneizan et al., 2022). Similarly, Upadhyay et al. (2022) conducted a study on the important factors that affected behavioral intention toward mobile payment services during COVID-19. They found that perceived severity of the pandemic had a positive impact on consumers' attitude to adopt mobile banking (Upadhyay et al., 2022).

Along those lines, Pokhrel (2022) indicated that perceived fear during the COVID-19 pandemic is an antecedent for behavior intention of mobile banking adoption. Before the pandemic, people considered mobile payments to be a convenience, but COVID-19 changed this status-quo (Upadhyay et al., 2022). Due to the uncertainty, severity, and fear of the pandemic, individuals were prompted to adopt mobile banking. Firstly, these transactions were instrumental

in adhering to the social distancing norms imposed upon society (Pokhrel, 2022; Upadhyay et al., 2022). Due to the six-feet-apart rule imposed by most businesses and organizations, consumers resorted to contactless P2P payments instead of exchanging cash. Secondly, many delivery services started accepting digital payments, and customers were left with no choice but to adopt digital payment services (Upadhyay et al., 2022). The COVID-19 crisis has given mobile payments more attention because it kept economies functioning and helped people reduce contact with the virus (Al-Qudah et al., 2022). Many consumers switched to mobile payment services to prevent themselves from contracting the virus through the physical exchange of currency (Al-Qudah et al., 2022; Pokhrel, 2022). Adopting this preventative behavior showcases an individual's perception of the severity of the pandemic and their feeling about the COVID-19 contraction (Upadhyay et al., 2022).

Kumar et al. (2023) agreed with the aforementioned conclusion that perceived risk is a factor that contributes to mobile payment adoption. This study incorporated another factor, trust. The researchers polled 253 users ages 18-30 through a questionnaire, and the data was analyzed through structural equation modeling. The results show that perceived trust (PT) positively affects the actual use of banking services (Kumar et al., 2023). Fifty-eight percent of Americans who never use payment services stated that they don't use payment services due to a lack of trust (Anderson, 2022). Since mobile devices are personal in nature, trust is an important factor that influences individuals' behaviors and willingness to accept mobile payment devices (Jung et al., 2020). Due to the uncertainty amidst the COVID-19 pandemic, some consumers were unwilling to adopt mobile payment apps because of lack of trust. Those who do trust did not have a problem utilizing mobile payment apps to facilitate their payments during the pandemic.

Comparative Trend Analysis of Mobile Payment App Growth

The extreme situation of COVID-19 had a strong impact on consumer behavior. After reviewing the existing literature surrounding mobile payment systems amidst the COVID-19 pandemic, a gap has been identified. There are few analyses comparing different mobile payment apps with one another on a longitudinal basis. Though it has been established that mobile payment transactions grew overall due to the pandemic, little research has shown how much growth specific apps have experienced, or if there is a causal relationship between the pandemic and growth. The observations seen through literature analysis raise the following research question: What is the extent of the growth in mobile payment apps before and after the pandemic, and did the pandemic have a significant effect on mobile payment apps? The researcher will be examining the growth of Venmo, PayPal, and Zelle, three apps within the mobile payment banking system, during the COVID-19 pandemic. The researcher will be performing a regression analysis to determine if there is a significant relationship between time and the total payment volume (TPV) facilitated by each app. Finally, the researcher will forecast the linear regression into the future to predict continued app growth. The hypotheses and corresponding null hypotheses are as follows:

$H1_0$: There is no significant relationship between time and Venmo's TPV from 2018 to 2023.

$H1_A$: There is a significant relationship between time and Venmo's TPV from 2018 to 2023.

$H2_0$: There is no significant relationship between time and Zelle's TPV from 2018 to 2023.

$H2_A$: There is a significant relationship between time and Zelle's TPV from 2018 to 2023.

$H3_0$: There is no significant relationship between time and PayPal's TPV from 2018 to 2023.

$H3_A$: There is a significant relationship between time and PayPal's TPV from 2018 to 2023.

The researcher chose to analyze these three companies, because they are not specific banks, rather they are apps created to facilitate P2P payments. Instead of analyzing each major bank's mobile app, the researcher focuses on these independent companies that facilitate mobile payments. The data provided by banks does not differentiate mobile transactions from the total transactions, so analyzing transaction volume of mobile payment apps that strictly process mobile payments is a better indicator of the growth of digital payments.

Methodology

The purpose of this study is to analyze the effect of COVID-19 on the usage of electronic payment apps. The researcher utilized secondary data gathered from a public database, Statista, to perform the analysis. The secondary data that was analyzed is the total payment volume (TPV) per quarter for each of the three mobile payment apps, Venmo, PayPal, and Zelle. Quarterly TPV refers to the dollar amount of transactions facilitated by the app per quarter. This data is sufficient for analyzing growth because it quantifies the transactions each app is facilitating into dollar amounts that can be compared between quarters.

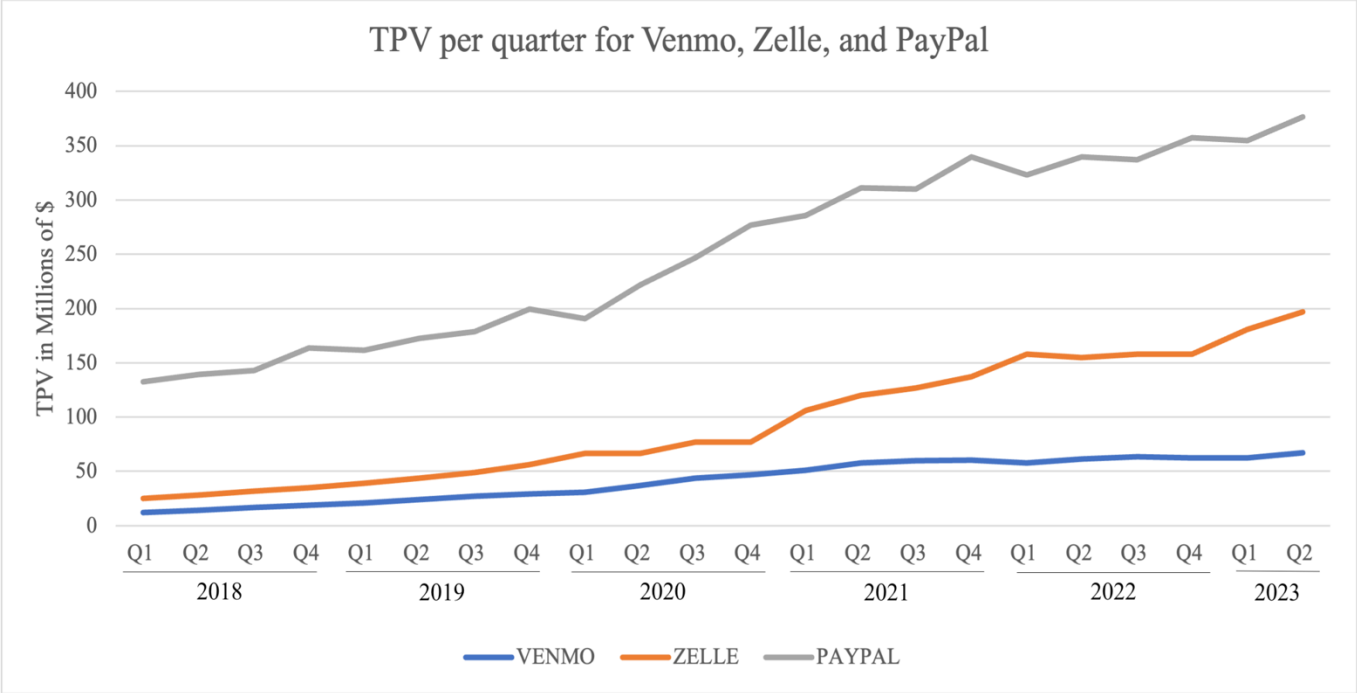
The quarterly TPV for each app was analyzed through times-series analysis in order to determine the growth rate each app experienced between 2018 and 2023. This five-year period shows the growth rate before and during the pandemic, which allows for differentiation between normal growth and pandemic-related growth. The researcher also performed a regression analysis to determine whether time has a significant relationship with TPV for each app.

Results

The researcher compiled the TPV per quarter beginning in Q1 of 2018 and ending in Q2 of 2023 from the three mobile payment apps (Figure 1). The raw data is listed in the appendix. As seen below, PayPal is the largest app in terms of TPV, followed by Venmo and Zelle.

Figure 1

TPV per quarter for Venmo, Zelle, and PayPal from Q1 2018 to Q2 2023



Percent change from the previous year is a valuable metric in determining the growth experienced by the specific apps. The following percentages illustrate the change in TPV from the previous year-end from before the pandemic to during the pandemic.

Table 1

Percent change of TPV year-over-year for Venmo, Zelle, and PayPal

Year	Venmo	Zelle	PayPal
2018	58.33%	40.00%	23.64%
2019	52.63%	60.00%	21.85%
2020	62.07%	37.05%	38.95%
2021	28.94%	78.50%	22.54%
2022	3.14%	15.33%	5.26%

Regression Analysis

The researcher addressed the three hypotheses through linear regression analysis. The assumptions for linear regression are met and are as follows: the dependent variables are normally distributed, there is a linear relationship between the independent variable and dependent variable, and there is no homoscedasticity.

The critical t value for the corresponding degrees of freedom (21) and confidence level (95%) is 2.080. This critical value applies to all three analyses.

Venmo's regression analysis produced a t Statistic of 20.673 and a P-value of 5.73E-15. The t Statistic from this model is greater than the critical value of 2.080, which indicates there is a significant relationship between time and Venmo's TPV. The R square value is 0.9553.

Zelle's regression analysis produced a t Statistic of 22.816 and a P-value of 8.61E-16. The t Statistic from this model is greater than the critical value of 2.080, which indicates there is a significant relationship between time and Zelle's TPV. The R square value is 0.9630.

PayPal's regression analysis produced a t Statistic of 24.545 and a P-value of 2.09E-16. The t Statistic from this model is greater than the critical value of 2.080, which indicates there is a significant relationship between time and PayPal's TPV. The R square value is 0.9679.

Dummy Variable

To further analyze this data, a dummy variable was introduced to the regression model. This variable accounts for a specific event, the pandemic in this case, and determines if it influences the dependent variable, TPV. For periods Q1 2018 through Q4 2019, a dummy variable of 0 was used to signify the period without the pandemic. Periods Q1 2020 through Q2 2023 had a dummy variable of 1, which indicates the period with the pandemic.

Venmo's regression analysis with the dummy variable produced a t Statistic of 2.662 and a P-value of 0.015. The t Statistic is greater than the critical value of 2.080, which signifies that the pandemic had a significant effect on TPV for Venmo.

Zelle's regression analysis with the dummy variable produced a t Statistic of -1.502 and a P-value of 0.149. The t Statistic is less than the critical value of 2.080, which signifies that the pandemic did not have a significant effect on TPV for Zelle.

PayPal's regression analysis with the dummy variable produced a t Statistic of 1.094 and a P-value of 0.288. The t Statistic is less than the critical value of 2.080, which signifies that the pandemic did not have a significant effect on TPV for PayPal.

Discussion

The researcher used this data to draw various conclusions about the extent of the growth for each of the three mobile payment apps. As seen in Table 1**,** the percent change varied between different companies and different years. Venmo experienced a significant level of growth before the pandemic in 2018 and 2019, 58.33 percent and 52.63 percent respectively. In 2020, Venmo experienced a jump in growth related to its TPV of 62.07 percent. It then leveled off in 2021 and 2022 with growth rates of 28.94 percent and 3.14 percent respectively. It is clear that the large growth in TPV during 2020 was related to the effects of the pandemic on the economy. Where global spending decreased during the pandemic, mobile payment app transactions actually increased, showing that though there was a decrease in overall payments, as consumers were turning to mobile payment apps to facilitate their transactions.

Zelle's TPV growth trends are seemingly peculiar. As the newest of the apps, Zelle experienced pre-COVID TPV growth of 40 percent in 2018 and 60 percent in 2019. Contrary to assumptions, Zelle experienced a decrease in growth rate during the beginning of the pandemic;

a 37.05 percent growth rate in 2020. The following year, the growth rate more than doubled; Zelle's TPV growth was 78.5 percent in 2021. Like Venmo, the 2022 TPV percent growth dropped down to 15.33 percent. While Zelle's TPV growth dropped during the first year of the pandemic, it grew drastically in the second year.

Finally, PayPal saw consistent growth in the pre-COVID years, 23.64 percent in 2018 and 21.85 percent in 2019. During the first year of the pandemic, the TPV growth rate increased to 38.95 percent. In 2021, the growth rate dropped to 22.54 percent. In 2022, the growth rate further dropped to 5.26 percent.

Overall, all three mobile payment companies experienced larger growth during the pandemic, though the specific year and amount varies between the different apps. Also, all three apps showed the growth rate leveling out around Q2 of 2022. This could be attributed to the pandemic leveling out in terms of the number of confirmed cases, or due to consumers adjusting to the "new normal," or the adapted way of living. Visually, Figure 1 aids in displaying the upturn in the growth rate trend at the beginning of the pandemic and the leveling out of the trend around the middle of 2022.

Turning to the regression model, the researcher made the following conclusions about the hypotheses presented:

$H1_A$: There is a significant relationship between time and Venmo's TPV from 2018 to 2023.

$H1_0$: There is no significant relationship between time and Venmo's TPV from 2018 to 2023.

The researcher rejected the null hypothesis. Since $20.673 > 2.08$, there is a significant relationship between time and Venmo's TPV. Additionally, the pandemic had a significant effect on TPV, since $2.662 > 2.080$

$H2_A$: There is a significant relationship between time and Zelle's TPV from 2018 to 2023.

$H2_0$: There is no significant relationship between time and Zelle's TPV from 2018 to 2023.

The researcher rejected the null hypothesis. Since 22.816 > 2.08, there is a significant relationship between time and Zelle's TPV. The pandemic did not have a significant effect on TPV, since -1.502 < 2.080

$H3_A$: There is a significant relationship between time and PayPal's TPV from 2018 to 2023.

$H3_0$: There is no significant relationship between time and PayPal's TPV from 2018 to 2023.

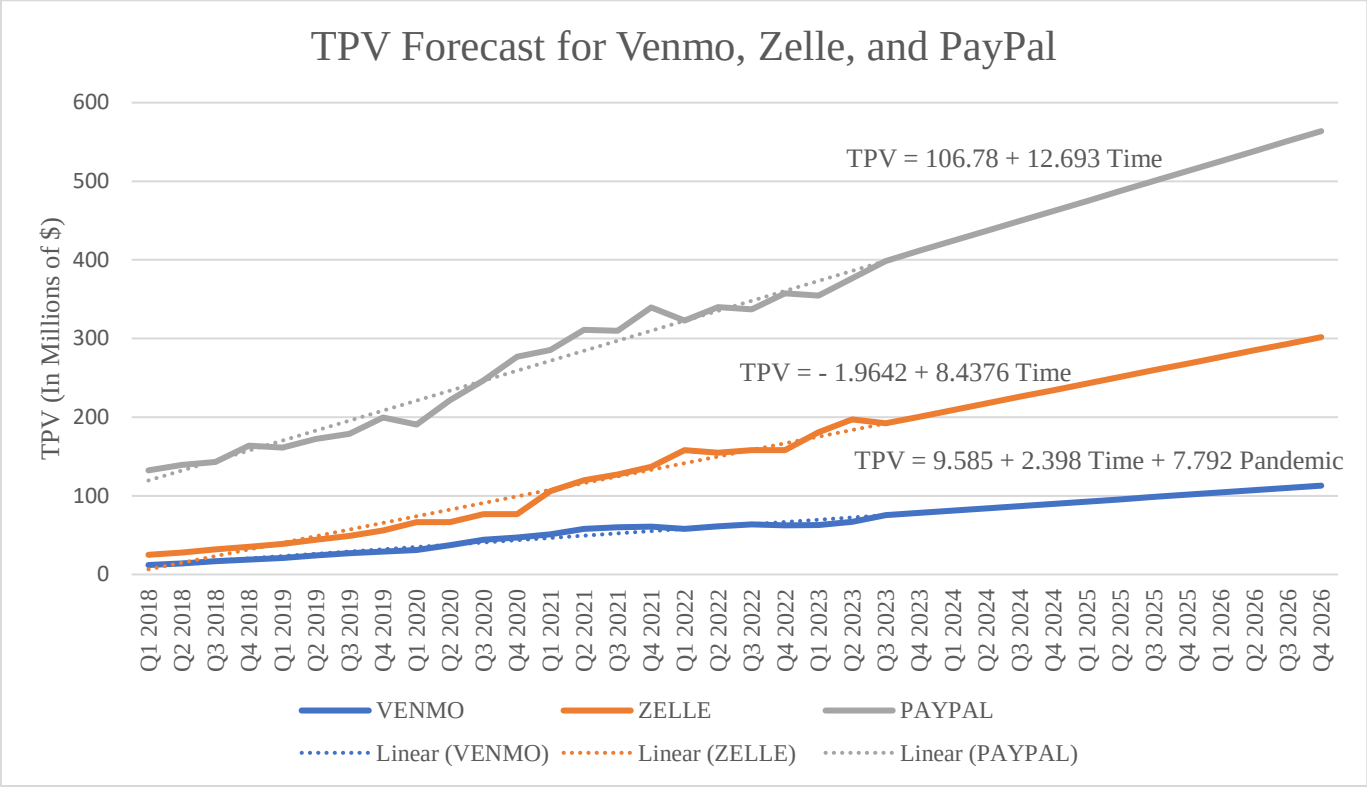
The researcher rejected the null hypothesis. Since 24.545 > 2.08, there is a significant relationship between time and PayPal's TPV. The pandemic did not have a significant effect on TPV, since 1.094 < 2.080.

Forecasting

The TPV from the pre-COVID and during COVID time periods were used to create the three linear equations that are used to project future TPV until the end of 2026. According to the projections, by Q4 of 2025 Venmo, Zelle, and PayPal are expected to have TPVs of $101 million, $268 million, and $513 million, respectively. Additionally, by Q4 of 2026 Venmo, Zelle, and PayPal are projected to have TPVs of $113 million, $301 million, and $564 million, respectively. Figure 2 shows the projection following the trendline created by the current TPV data for the three apps. The slopes used to forecast are listed above their respective lines. The linear regression forecasting technique is widely used, and because the TPV is linear in respect to time, linear forecasting is an acceptable technique.

Figure 2

TPV forecast for PayPal, Venmo, and Zelle until 2026 using the linear forecasting method.



Limitations

This study has limitations. The data set includes pre-COVID and during COVID numbers, but it does not include any data points from after the official end of the pandemic. In order to make an accurate forecast, the study would need to include post-COVID TPV data to ensure that the projected growth rate is not overstated due to the large growth experienced during the pandemic. This study is simple regarding the equation and basic assumptions used; also, sample size is somewhat limited. Due to the small amount of relevant data available, this study focused on the total payment value experienced by three mobile payment apps on a timeline, instead of analyzing the effect that a variable has on TPV. If more data were available regarding

mobile payment apps, the researcher could have performed correlation analysis on different variables associated with the pandemic in relation to the performance of the three apps. This research also does not discover the cause of the growth, but merely speculates about what could have potentially caused the growth. Additionally, no research has been conducted on why certain apps grew more than others. The forecasting method that the researcher chose may not have been the method that most accurately predicts future trends. Other more complex forecasting techniques could be used to project future TPV.

Future Research

This study contributes to the existing observation that mobile banking and contactless transactions grew at a larger rate during the pandemic than before the pandemic. The findings of this study point researchers to discover the causation of why certain mobile payment apps grew more than others. Researchers could also study the implementation of AI, blockchain, and other emerging technologies and their impacts on the banking industry. More robust data analysis can be performed to determine the effect of different variables on TPV in mobile payment apps. Some potential variables include the number of confirmed COVID-19 cases, the number of bank closures, and many others. Other researchers could forecast future TPV trends using a method other than linear regression forecasting to determine other possible future outcomes. Additionally, researchers could determine why the pandemic had a statistically significant effect on Venmo, but not the other mobile payment apps.

Conclusion

The use of mobile payment apps is increasing rapidly in today's post-COVID world. Evidence from previous studies indicates that the COVID-19 pandemic contributed to the increased adoption of contactless payments, mainly due to the perceived risk of COVID-19 and

the fear of contracting the virus through physical payments. The review of literature highlighted the trends observed in the banking industry such as brick-and-mortar bank shutdowns, a decrease in the use of cash, and the adoption of mobile payment apps within the time of the COVID-19 pandemic. The researcher performed a longitudinal analysis of the TPV of three mobile payment apps, Venmo, PayPal, and Zelle. Through analyzing TPV growth rates, the researcher concluded that there was a significant increase in the number of transactions facilitated by each mobile payment app during the time of the pandemic. Though all increased at different rates, all three apps experienced above-average growth during 2020 and 2021. The regression analysis indicated that time had a significant relationship with the TPV from all three apps, but the pandemic only affected Venmo. Using linear regression forecasting, the researcher projected future TPV trends until Q4 of 2026. Based on the projections, TPV for all three mobile payment apps is expected to continue to grow following the COVID-19 pandemic.

Mobile payments were seen as the solution during the pandemic to balance social distancing, where human interaction was limited, and the continuation of regular life, like processing payment transactions. Now that more consumers are switching to contactless payments, businesses should consider either adopting contactless payments within their operations or adapting to be able to receive payments from consumers using mobile payment apps. Mobile payment app manufacturers can observe the trends in technology adoption that the researcher reviewed to better create and market their apps. The future is digital, and as shown through this study, mobile payment apps are continuing to become a more popular method of making and receiving payments.

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Appendix

Table A1

Quarterly total payment volume per quarter for Venmo, Zelle, and PayPal in millions of dollars

Quarter	Venmo	Zelle	PayPal
Q1 2018	12	25	132.36
Q2 2018	14	28	139.40
Q3 2018	17	32	143
Q4 2018	19	35	163.65
Q1 2019	21	39	161.49
Q2 2019	24	44	172.36
Q3 2019	27	49	178.67
Q4 2019	29	56	199.40
Q1 2020	31	67	190.57
Q2 2020	37	67	221.73
Q3 2020	44	77	246.69
Q4 2020	47	77	277.07
Q1 2021	51	106	285.45
Q2 2021	58	120	310.99
Q3 2021	60	127	309.99
Q4 2021	60.60	137	339.53
Q1 2022	57.80	158	322.98
Q2 2022	61.40	155	339.79
Q3 2022	63.60	158	336.97
Q4 2022	62.50	158	357.38
Q1 2023	62.70	181	354.51
Q2 2023	67	197	376.54

Sources: (PayPal & Statista, 2023), (Statista & U.S. SEC, 2023), and (Zelle, 2023).