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ORIGINAL ARTICLE

The effect of cashless payments on the internet and mobile banking

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Abstract

Some of the problems of cash transactions were the inconvenience of handling cash and the limited availability of banking services to facilitate cash withdrawals. The purpose of this paper is to examine the impact of cashless payments on the usage of the internet and mobile banking services in twofolds. First, the Wald test was applied to determine the short-run causal effect of the diffusion from cash to cashless payment on the internet and mobile banking. Second, the autoregressive distributed lag (ARDL) bounds test was employed to determine the long-run effect of cashless payments on the internet and mobile banking. The novelty of this study is threefold. First, this study employed the total value of cashless payments transacted per month data that were previously unavailable for time series analysis. Second, unlike studies on the intention to adopt cashless payments, internet and mobile banking, this study used data of actual transactions paid by a consumer. Third, this study established that the internet and mobile banking were delivery channels for cashless payments.

Keywords Cashless · Mobile banking · Internet banking · ARDL

Introduction

Payment for daily consumption can be made by physical cash or cashless payment tools. Some frequently used cashless payment tools were credit transfer payments, cheques, direct debits (Tee and Ong 2016), credit cards (Shy 2020), charge cards and e-wallets (Teng and Khong 2021; Alam et al. 2021). Consumers used cashless payments due to their convenience (Jebarajakirthy and Shankar 2021), efficiency (Kaur et al. 2020) and cost-effectiveness (Mukhopadhyay 2016). Figure 1 showed that in 2019, there was an increase in the average daily value of cashless transactions reported by the Bank of International Settlement and the Central Bank of Malaysia when compared to 2015. Among the Asian countries[1] listed in Fig. 1, the average daily transfer payments from Japan (USD73,692 million) and South Korea (USD50,673 million) were the highest in 2019, to be followed by Malaysia (USD25,190). As for the usage of cards and electronic money (e-money), Malaysia had the highest daily average transaction of USD5575 million in 2019, as compared to South Korea (USD2148 million) and Japan (USD2065 million). See Fig. 1 for the graphical illustration of the rise in the usage of cashless payments.

Some of the problems of cash transactions were the inconvenience of handling cash that required consumers to queue in the bank to withdraw money (Jebarajakirthy and Shankar 2021) and the limited availability of banking services (Zhou et al. 2021) to facilitate cash-related shopping. Most commercial banks[2] in Malaysia operate from 9.30 a.m. to 4.00 p.m., while some operate from 9.30 a.m. to 3 p.m. The inconvenience to withdraw money and the limited banking hours have prompted the Central Bank of Malaysia[3] to promote the usage of cashless payments in Malaysia. The bank aimed to increase the usage of 44 cashless payments

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[1] Except for China, the Asian countries were listed based on the availability of data published by the Bank of International Settlement statistics. Data on Malaysia were extracted from the Central Bank of Malaysia.

[2] Due to movement control of the covid-19 pandemic, all banks operated after 9 a.m. to 1 p.m. Currently, some banks have extended their banking hours to 3 p.m. or 4.00 p.m., depending on the severity of covid-19 cases where the banks are located.

[3] The Central Bank of Malaysia's financial strategies as reported in its Financial Sector Blueprint, 2011–2020.

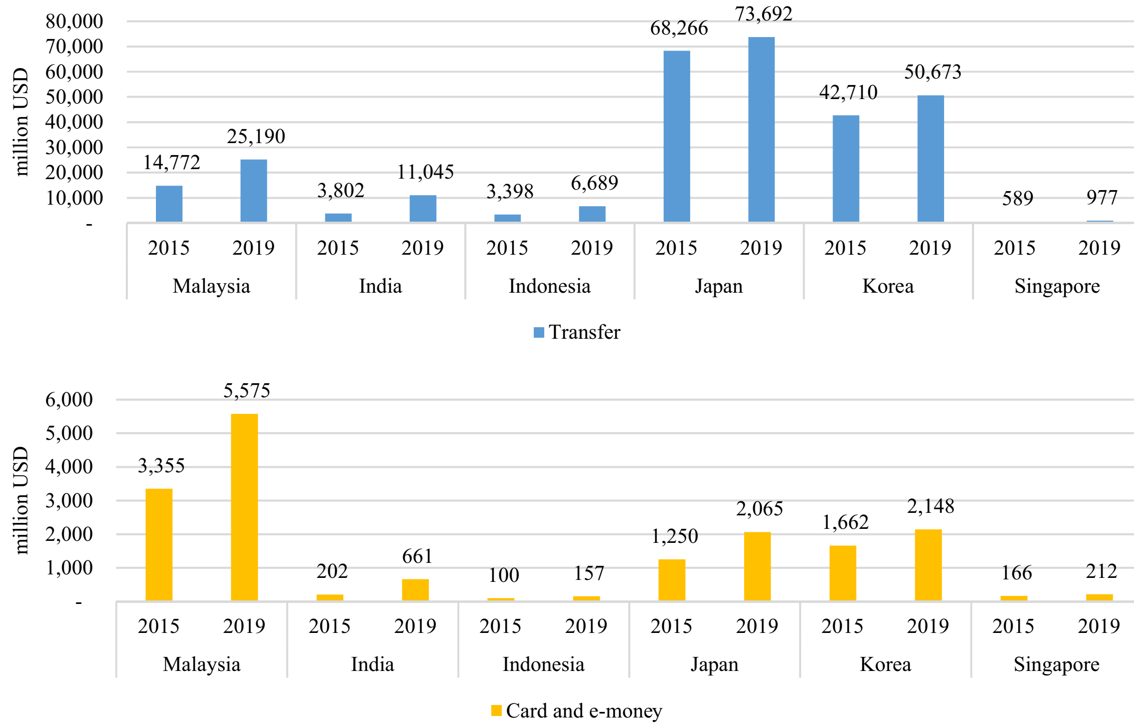
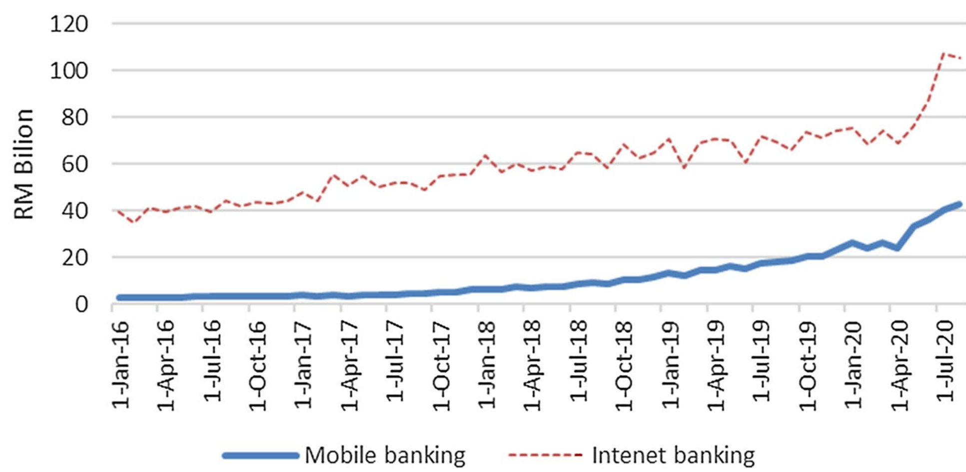


Fig. 1 Transfer, card and e-money payment for selected Asian countries. Source: Bank of International Settlement statistics and payment statistics from the Central Bank of Malaysia

Fig. 2 Internet and mobile banking. Source: Central Bank of Malaysia



per person per year to 200 transactions per person per year (Bank Negara Malaysia 2011).

The elimination of cash as a medium of transaction will hamper economic activities, reduce a country's comparative advantage in production and cause inefficiency in the allocation of resources (Cohen et al. 2020). However, substituting cash with alternative cashless payment tools will not eliminate the function of money as a medium of transaction (Krivosheya 2020). Cashless payments complement the usage of physical money through internet banking or mobile banking applications. Cashless payments made through internet and mobile banking application cost less than cash-based transactions (Ananda et al. 2020). Development in internet banking or mobile banking applications promotes financial intermediation and economic growth (Mhadhbi et al. 2020).

Cashless consumption could be paid through the internet or mobile banking. Figure 2 illustrated the monthly data for a total value in Ringgit Malaysia (RM) of internet banking and mobile banking transactions per month in Malaysia from 1 January 2016 till 1 August 2020. Throughout this period, the figure showed an increasing trend in the usage of internet banking and mobile banking. The data in Fig. 2 also showed a spike in the usage of both internet and mobile banking since 1 April 2020. The spike in the usage of both internet and mobile banking coincided with the movement control order (MCO)[4] implemented in Malaysia.

The usage of internet banking and mobile banking application in Malaysia has increased since April 2020. However, it is uncertain if the increase was caused by the Central Bank of Malaysia's effort in promoting the usage of cashless payments in internet banking and mobile banking in Malaysia. A recent study in Malaysia found that consumers' perception of their technical skill, knowledge and perceived usefulness of cashless payment was the main determinant of cashless payment adoption (Rahman et al. 2020). Since cashless payments are transacted through the internet and mobile banking, this paper will determine the impact of diffusion from cash to cashless payments in twofolds. First, the Wald test was applied to determine the short-run causal effect of cashless payments on the internet and mobile banking. Second, the autoregressive distributed lag (ARDL) bounds test was employed to determine the long-run effect of cashless payments on the internet and mobile banking. These two econometrics analyses were suitable to identify the determinants of internet and mobile banking in Malaysia.

The novelty of this study is threefold. First, this study employed the total value of cashless payments transacted per month data that were previously unavailable for time series analysis. We employed the cashless payment time series to estimate the ARDL model and determined its effect on the internet and mobile banking. Second, unlike studies on the intention to adopt cashless payments, internet and mobile banking, this study used data of actual transactions paid by a consumer from the period 1 January 2016 to 1 August 2020. It differs from previous studies that examine the intention to adopt cashless payments, internet and mobile banking that examined consumers' perception and intention to use mobile banking at a particular point in time when the data were collected. Third, this study established that the internet and mobile banking were delivery channels of consumer banking services. Both the internet and mobile banking are the channel for cashless payments to be made online. They were not cashless tools like what Semerikova (2019) and Oyelami et al. (2020) proclaimed.

The next section of this study reviews literature on cashless payment, internet and mobile banking, to be followed by a discussion on the estimation technique used, empirical findings, discussion and recommendations. The paper ends with some concluding remarks.

Cashless payment, internet banking and mobile banking

Cashless payments do not substitute but complement the usage of physical money. Due to their differences in usage and functionality, each cashless payment tool affects the adoption of internet and mobile banking differently. Some of the commonly used cashless payment tools are credit transfer, electronic wallet, direct debit, credit card and charge card. Credit transfer allows consumers to transfer funds from their savings account to another account through internet banking or mobile banking applications. Consumers can also transfer credit from their savings account to their electronic wallet (Oyelami et al. 2020) to pay for their shopping.

An electronic wallet (e-wallet) is pre-loaded with money either with a cash deposit or credit transfer from the owner's savings account (Mawejje and Lakuma 2019; Alam et al. 2021). It is also known as digital money (Klyton et al. 2021) or mobile money (Mawejje and Lakuma 2019). E-wallets can be used to pay for normal offline shopping, as well as online shopping. Money loaded in the e-wallet (Klyton et al. 2021) enables consumers to make payments by scanning the quick response (QR) code for their purchases made. E-wallets were also linked to the customers' credit cards and personal details to provide convenience for point of sales shopping (Kaur et al. 2020). A leading e-wallet in Malaysia is the Touch and Go (TNG[5]) wallet (Alam et al. 2021). The TNG wallet uses near-field communication technology that allows consumers to scan QR codes to pay for purchases. The TNG wallet is also linked to a TNG debit card that is used to pay for parking fees, public transportation (buses and trains) and highway tolls.

An automated teller machine (ATM[6]) card is a debit card. Consumers can debit directly from their savings account to pay for their purchases. Payment can be directly debited by tapping on the ATM card, commonly known as "PayWave". PayWave also used the near-field radio frequency technology that allowed contactless payment (Trütsch 2020) for normal offline shopping.

A credit card[7] is another popular cashless payment tool. Credit cards are issued as a credit facility to the cardholder,

[4] The movement control order implemented in Malaysia was either an extended, conditional or recovery MCO of several phases of 2 weeks each. The first phase of MCO began on the 18th March of 2020 and lasted for more than a month. The second phase of MCO was implemented from 13th Jan 2021 to 18th Feb 2021, and extended in several states, namely Selangor, Penang, Johor and the Federal Territory of Kuala Lumpur.

[5] Touch and Go (TNG) is an e-wallet established in collaboration with Ant Financial, an Alibaba Group from China.

[6] ATM cards allow depositors to withdraw from their savings account at the automated teller machines. ATM cards also function like debit cards.

[7] Commercial banks in Malaysia used two payment networks to issue their credit cards, namely Mastercard and Visa.

thus there is a credit limit for each card issued (Murthi et al. 2019). In Malaysia, credit card payments are made either through PayWave or keying in a secret pin. At a specific date every month, the cardholder can either settle in full or partial outstanding balance of the card. For any outstanding balance not paid, the cardholder will be charged a finance interest fee of about 15% to 20% per annum of the amount owed. The interest fee to finance credit card outstanding balance varies across banks. Another cashless payment tool is the charge card. The functions of charge cards[8] are very similar to credit cards. The only difference between the two is that charge cards do not have any credit limit. That means any outstanding balance charged to the card has to be paid in full by the due date every month.

Both the internet and mobile banking payment channels require a network connection to perform banking transactions. Mobile banking allows banking transactions to be done using banking applications installed on mobile phones. Internet banking could be performed through mobile phones as well as other devices like tablets, laptops and personal computers. Almost all banking transactions could be done using either the internet or mobile banking, except transactions involving physical cash.

The internet and mobile banking allowed cashless transactions to be conducted without the need to queue in the bank, almost 24/7 (Zhou et al. 2021), except for the daily downtime for system updates. The increased usage of the internet and mobile banking was induced by the advancement of online businesses (Ho et al. 2020). All the previous studies examined the usage of the internet and mobile banking based on consumers' intention to use the delivery channels. Consumers' level of education, income (Zagalaz Jiménez and Aguiar Díaz 2019), financial literacy (Andreou and Anyfantaki 2021) and the internet banking interface design (Sharma et al. 2020) were identified intentions to adopt internet banking. Perceived usefulness, design of the mobile banking application interface, customer experience (Chaouali et al. 2019), digital divide (Klyton et al. 2021), digital literacy and awareness of the benefits of use (Elhajjar and Ouaida 2019) were intentions to adopt mobile banking. All these studies did not examine the impact of cashless payment tools on the internet and mobile banking. Cashless payment was found to encourage internet and mobile banking (Kachathan & Chalchotchuang 2020; Aduba 2021). Urhie et al. (2021) found mobile banking to promote cashless payments. In Singapore, the usage of cashless payments was high, but Singaporeans still prefer cash and card payments (Mumtaza et al. 2020). There is no conclusive evidence that diffusion from cash to cashless payment would increase the usage of internet and mobile banking services. Tiong (2020) even thinks that Malaysia is a cash-based and not cashless community.

[8] American Express (Amex) and Diners Club are two popular payment issuers of charge cards in Malaysia but they are falling out of their popularity in recent years.

Diffusion of innovation

The concept of diffusion was defined as "the process by which an innovation was communicated through certain channels over time among the members of a social system" (Rogers 1983). *Diffusion of innovations* (DOI) happened when an advancement or process of doing things became accustomed to society due to the gains brought by the innovative approach. Even though DOI does not happen very quickly (Roger 1983), the speed of diffusion usually varies due to trialability, relative benefits of new over existing approach, self-efficacy (Waheed et al. 2015) and familiarity with the new approach (Dash et al. 2014).

Financial innovations increase the usage of cashless payments (Krivosheya 2020). Based on the DOI theory, Kaur et al. (2020) discovered that promoting the features and advantages of e-wallets, as well as ensuring the compatibility of the e-wallets to users' lifestyles were important elements to increase the adoption of e-wallets. In Taiwan, users' perception of relative benefits, intricacy, compatibility, uncertainty and usage frequency was found to significantly affect the adoption of its internet-linked ATM card services (Wang et al. 2012).

Jamshidi and Hussin (2016) applied the DOI theory and Theory of Reasoned Action (TRA) to gauge the usage of Islamic credit cards in Malaysia. They argued that compatibility, society's influence and satisfaction were the main factors that influence the usage of Islamic credit cards. Ironically, by applying similar theoretical background, Jamshidi and Kazemi (2019) contested Jamshidi and Hussin's (2016) earlier findings and claimed that benefit and attitude will also affect the adoption of Islamic credit cards.

The DOI Theory forms the fundamental expansion of many studies related to intentions and adoptions of new technological-based. This study was motivated by Del Gaudio et al. (2020) that discovered the diffusion of financial technologies from conventional to digital payment services would enhance the performance of financial institutions. Unlike previous studies that examined the intention to use innovative payment tools, this paper examined the actual impact of the diffusion of cashless payment tools on the usage of internet and mobile banking services in the short and long run.

The diffusion of cash to cashless payment encouraged internet and mobile banking (Kachathan and Chalchotchuang

2020; Aduba 2021). Online debit and credit cards payments require transaction authorization code (TAC) from the bank. Offline debit and credit cards payments require secret pin setting and paywave[9] limit setting online. Thus, debit and credit cards payment will not be possible if the customer does not activate its internet or mobile banking services to link to its cards accordingly.

Based on the findings of previous literature and the theoretical background of DOI, the hypothesis statements of this study were specified as follows:

H1: There is a short-run causal effect of cashless payments (credit card, charge card, e-wallet, credit transfer, and direct debit) on the internet and mobile banking.
H2: There is a long-run effect of the usage of cashless payments (credit card, charge card, e-wallet, credit transfer, and direct debit) on the internet and mobile banking.

Both hypotheses were examined using the econometrics time series analysis of the ARDL estimation specified in the Methodology section.

Methodology

This study employed the econometrics analysis of time series estimation. In time series estimation, it is crucial to regress stationary time series data. Estimation of non-stationary time series will produce invalid and meaningless regression output. The level of stationarity of the time series would later determine the appropriate econometric estimation model to be employed.

The stationarity of the time series data was tested using the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) and the augmented Dickey–Fuller (ADF) unit root tests. All variables had to be stationary to avoid spurious regression. Cashless payment tools studied were credit cards, charge cards, e-money, credit transfer and direct debit. These tools were regressed against the internet banking channel in Eq. (1) and mobile banking channel in Eq. (2) below.

$$\mathrm{LIB} = \mathrm{f}(\mathrm{CRE}, \mathrm{CCLEM}, \mathrm{CT}, \mathrm{DD}) \tag{1}$$

$$\mathrm{LMB} = \mathrm{f}(\mathrm{CRE}, \mathrm{CCLEM}, \mathrm{CT}, \mathrm{DD}) \tag{2}$$

All data were obtained from the Central Bank of Malaysia payment system database, measured as the total value in RM billion transacted per month from 1 January 2016 to 1 August 2020. In Eqs. (1) and (2), IB is internet banking, LMB denotes the log of mobile banking, CRE is credit card, CC is charge card, LEM is the log of e-money, CT is credit transfer and DD is Direct Debit. The data used in this study refer to individual consumers' total value of transactions per month. It should be noted that no other description of the types of consumers could be identified from the macroeconomic time series applied.

Since some of the variables used were stationary at levels, while others were stationary in the first difference, the autoregressive distributed lag (ARDL) model was applied. None of the variables were $I(2)$ and the cointegration relationship between variables was examined through the ARDL model (Danish et al. 2018; Atmaca and Karadaş 2020). The long-run and short-run relationships of the variables were analysed following the ARDL Bounds Test (Pesaran et al. 2001). The *ARDL-Unrestricted Error Correction Model (ECM)* was estimated for IB and LMB as stipulated in Eqs. (3) and (4), respectively.

$$\begin{aligned}\Delta\mathrm{LIB}_t = &\beta_0 + \beta_1\mathrm{LIB}_{t-1} + \beta_2\mathrm{CRE}_{t-1} + \beta_3\mathrm{CC}_{t-1} + \beta_4\mathrm{LEM}_{t-1} + \beta_5\mathrm{CT}_{t-1} + \beta_6\mathrm{DD}_{t-1} + \sum_{i=1}^{\rho}\beta_{7i}\Delta\mathrm{LIB}_{t-i} \\ &+ \sum_{i=1}^{q}\beta_{8i}\Delta\mathrm{CRE}_{t-i} + \sum_{i=1}^{r}\beta_{9i}\Delta\mathrm{CC}_{t-i} + \sum_{i=1}^{s}\beta_{10i}\Delta\mathrm{LEM}_{t-i} + \sum_{i=1}^{v}\beta_{11i}\Delta\mathrm{CT}_{t-i} + \sum_{i=1}^{w}\beta_{12i}\Delta\mathrm{DD}_{t-i} + \mu_t\end{aligned} \tag{3}$$

$$\begin{aligned}\Delta\mathrm{LMB}_t = &\alpha_0 + \alpha_1\mathrm{LMB}_{t-1} + \alpha_2\mathrm{CRE}_{t-1} + \alpha_3\mathrm{CC}_{t-1} + \alpha_4\mathrm{LEM}_{t-1} + \alpha_5\mathrm{CT}_{t-1} + \alpha_6\mathrm{DD}_{t-1} \\ &+ \sum_{i=1}^{\rho}\alpha_{7i}\Delta\mathrm{LMB}_{t-i} + \sum_{i=1}^{q}\alpha_{8i}\Delta\mathrm{CRE}_{t-i} + \sum_{i=1}^{r}\alpha_{9i}\Delta\mathrm{CC}_{t-i} + \sum_{i=1}^{s}\alpha_{10i}\Delta\mathrm{LEM}_{t-i} \\ &+ \sum_{i=1}^{v}\alpha_{11i}\Delta\mathrm{CT}_{t-i} + \sum_{i=1}^{w}\alpha_{12i}\Delta\mathrm{DD}_{t-i} + \varepsilon_t\end{aligned} \tag{4}$$

The ARDL-unrestricted ECM combined the short-run corrections with long-run equilibrium information. The *F*-statistic estimated from the ordinary least square

[9] PayWave is payment made using debit or credit card without any secret pin to authorize the payment.

Table 1 Unit root tests

Variables	At Constant (t_μ)	Levels Trend (t_τ)	First Constant (t_μ)	Difference Trend (t_τ)
KPSS unit root test				
CRE	0.4741 (4)**	0.1298 (3)*	0.0327 (3)	0.0334 (3)
CC	0.4023 (5)*	0.2016 (5)**	0.1254 (3)	0.0533 (3)
EM	0.9197 (5)***	0.2596 (5)***	0.4555 (2)*	0.0976 (5)
LEM	0.8634 (6)***	0.2499 (5)***	0.3447 (3)	0.0884 (8)
CT	0.9620 (5)***	0.2035 (4)**	0.0490 (3)	0.0308 (3)
DD	0.9047 (6)***	0.2488 (4)***	0.2016 (3)	0.0348 (3)
MB	0.9229 (5)***	0.2556 (5)***	0.4629 (14)*	0.4629 (14)*
LMB	0.9029 (6)***	0.2256 (5)***	0.4418 (2)*	0.04086 (2)
LIB	1.0357 (5)***	0.0950 (2)	0.1213 (0)	0.0464 (0)
ADF unit root test				
CRE	– 3.4719 (0)**	– 3.8283 (0)**	– 8.8068 (0)***	– 8.7285 (0)***
CC	– 1.8933 (1)	– 1.3564 (1)	– 15.0274 (0)***	– 15.2563 (0)***
EM	3.4370 (4)	0.4116 (4)	– 5.2589 (4)***	– 6.9176 (3)***
LEM	0.9077 (0)	– 1.6463 (0)	– 9.3288 (0)***	– 9.6804 (0)***
CT	– 1.9108 (1)	– 6.2243 (0)***	– 13.1386 (0)***	– 13.0171 (0)***
DD	2.4592 (5)	– 1.4309 (5)	– 5.0161 (4)***	– 5.9780 (4)***
MB	5.6912 (4)	3.8962 (4)	– 3.0081 (1)**	– 4.3759 (1)***
LMB	2.1433 (1)	– 1.2733 (1)	– 12.3380 (0)***	– 13.1071 (0)***
LIB	1.0788 (1)	– 0.9923 (1)	– 10.9749 (0)***	– 11.1512 (0)***

***, ** and * Denote rejection of the null hypothesis at the 1%, 5% and 10% levels, respectively

estimation of Eqs. (3) and (4) assessed the presence of a cointegration relationship. The vector ECM reduced form was specified as follows:

$$\Delta \mathrm{LIB}_t = \partial + \sum_{i=1}^{p} \beta_{7i}\Delta \mathrm{LIB}_{t-i} + \sum_{i=1}^{q} \beta_{8i}\mathrm{CRE}_{t-i} + \sum_{i=1}^{r} \beta_{9i}\Delta \mathrm{CC}_{t-i} + \sum_{i=1}^{s} \beta_{10i}\Delta \mathrm{LEM}_{t-i} + \sum_{i=1}^{v} \beta_{11i}\Delta \mathrm{CT}_{t-i} + \sum_{i=1}^{w} \beta_{12i}\Delta \mathrm{DD}_{t-i} + \sigma \mathrm{ECT}_{t-i} + \theta_t \quad (5)$$

$$\Delta \mathrm{LMB}_t = C + \sum_{i=1}^{p} \alpha_{7i}\Delta \mathrm{LMB}_{t-i} + \sum_{i=1}^{q} \alpha_{8i}\mathrm{CRE}_{t-i} + \sum_{i=1}^{r} \alpha_{9i}\Delta \mathrm{CC}_{t-i} + \sum_{i=1}^{s} \alpha_{10i}\Delta \mathrm{LEM}_{t-i} + \sum_{i=1}^{v} \alpha_{11i}\Delta \mathrm{CT}_{t-i} + \sum_{i=1}^{w} \alpha_{12i}\Delta \mathrm{DD}_{t-i} + \gamma \mathrm{ECT}_{t-i} + \vartheta_t, \quad (6)$$

where $i = 1, 2 \ldots n$.

The coefficient of the lag of the error correction term determined the speed of the adjustment process to return to long-run equilibrium after a shock occurred. The chi-squared statistics of the Wald test could determine the significance of the independent variables affecting the dependent variable. The Wald test had been applied in several recent papers to establish the short-run relationship between macroeconomic variable on the stability of banks (Dua and Kapur 2018), banking technologies and bank efficiencies (Chaffai and Coccorese 2019), as well as mobile money and banks' performance (Iheanachor and Ozegbe 2020). The Wald test was conducted to determine the significance of the short-run dynamics of the reduced estimation model.

Findings

The KPSS unit root test rejected the null hypothesis of stationarity for all series at a 1% level of significance, except for CRE, CC and IB. CRE and CC rejected the null hypothesis of stationarity at the 10% level. As for IB, the null hypothesis of stationarity was rejected at a 1% level of significance for constant only. The ADF unit root test was conducted to further confirm the stationarity of the series. CRE was found to be $I(0)$ at 5% level and CT with trend was $I(0)$ at 1% level of significance. All other series were $I(1)$ at a 1% level of significance. See Table 1 for details.

Table 2 Long-run forms and bounds test

Model		*F*-statistic
LMB		11.0474***
LIB		5.7334***
Significance level (%)	Lower bound, *I*(0)	Upper bound, *I*(1)
10	2.08	3.00
5	2.39	3.38
2.5	2.70	3.73
1	3.06	4.15

*** Denotes rejection of the null hypothesis at the 1% level of significance

Table 3 Short-run coefficient Wald test and ECT

	Mobile banking	Internet banking
Chi-square		
ΔCRE	3.0413	9.8871**
ΔCC	9.1971**	5.7904
ΔLEM	1.6172	6.1539
ΔCT	9.5207**	8.3957*
ΔDD	11.0047**	6.9597
t-Statistics		
ECT(− 1)	− 0.6811*	− 0.0285

** and * Denote rejection of the null hypothesis at the 5% and 10% levels

ARDL bounds test

Based on the unit root test in Table 1, some of the variables were *I*(0) and others *I*(1). The *F*-statistics of the ARDL bounds test was used to determine the long-run cointegrating relationship of the variables for internet and mobile banking services. The results of the *F*-statistics of the bounds test could reject the null hypothesis of no cointegration for both internet and mobile banking at a 1% level of significance. There was long-run cointegration from the cashless payment tools for both internet and mobile banking. See Table 2 for details.

Based on both the Akaike information criterion and Schwarz Bayesian criterion, the optimum lag length for IB and LMB was lag three and lag four, respectively. The results of Wald tests for Eq. (5) showed that charge card (CC), credit transfer (CT) and direct debit (DD) affected mobile banking in the short run at 5% level of significance. The lag of the error correction term that measured the speed of adjustment, in the long run, was found to be statistically significant for mobile banking at a 10% level. As for internet banking, credit card (CRE) and credit transfer (CT) affected internet banking significantly in the short run at 5% and 10% levels, respectively.

The lag of the error correction term measured the speed of adjustment of internet banking (IB) and mobile banking (LMB) in the long run. At the 10% level, it was found

Table 4 Long-run coefficients estimates for internet banking

Long-run coefficients analysis			*t*-Statistic	Prob.
Variable	Coefficient	Std. error		
CRE	− 2.5719	3.2633	− 0.7881	0.4358
CC	− 59.2072	39.8107	− 1.4872	0.1457
LEM	− 141.6121	92.6732	− 1.5281	0.1352
CT	0.0986	0.6081	0.1621	0.8721
DD	13.3278	7.0937	1.8788*	0.0684
C	39.0073	26.2369	1.4867	0.1458
Diagnostic		*F*-statistics		Probability
Breusch–Godfrey LM test		0.5039		0.6086
Breusch–Pagan–Godfrey test		1.6003		0.1227
Jarque–Bera normality test		1.6115		0.4468

* Denotes rejection of the null hypothesis at the 10% level of significance

Table 5 The long-run coefficients estimates for mobile banking

Long-run coefficients analysis			*t*-Statistic	Probability
Variable	Coefficient	Std. error		
CRE	– 0.0366	0.0390	– 0.9390	0.3528
CC	0.3791	0.2721	1.3934	0.1705
LEM	0.6994	0.5301	1.3193	0.1939
CT	0.0020	0.0072	0.2787	0.7818
DD	0.0681	0.0348	1.9567*	0.0567
C	0.3642	0.2727	1.3353	0.1886

Diagnostic	*F*-statistics	Probability
Breusch–Godfrey LM test	0.1437	0.8666
Breusch–Pagan–Godfrey test	0.7651	0.6485
Jarque–Bera normality test	0.7038	0.7034

* Denotes rejection of the null hypothesis at the 10% level of significance

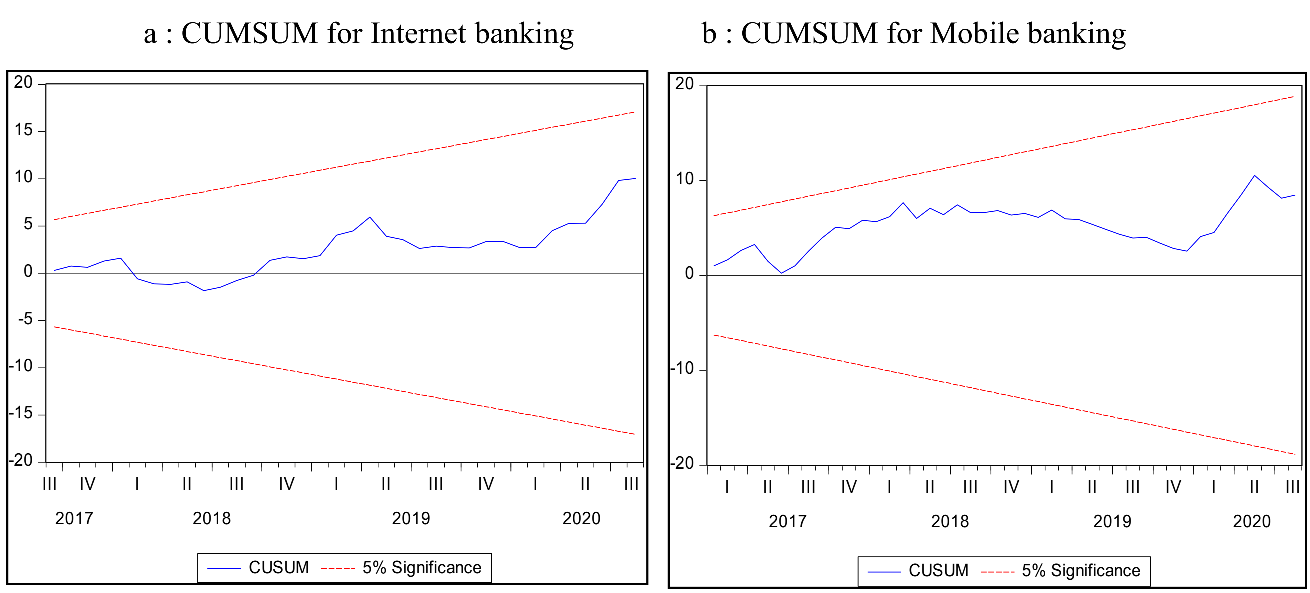


Fig. 3 **a** CUMSUM for internet banking. **b** CUMSUM for mobile banking

that only mobile banking services (LMB) will significantly adjust to equilibrium when there was a deviation from one period to another. See Table 3 for details.

There was only one positive long-run effect running from direct debit (DD) to internet banking at a 10% level. The residual passed all the no serial correlation, homoscedastic and normally distributed tests. Both Cusum and Cusum squares tests have shown that coefficients were stable at a 5% level. See Table 4 for details.

Similar to internet banking, only direct debit (DD) affected mobile banking at a 10% level. The residual tests indicated no serial correlation, homoscedastic and normally distributed. See Table 5 for details.

The cumulative sum (CUSUM) plots the cumulative sums of variation from the mean. Figure 3 of Cusum and Fig. 4 of Cusum squares tests showed that coefficients were stable at a 5% level for both internet and mobile banking.

Discussion and implication

This study hypothesized that cashless payments (credit card, charge card, e-wallet, credit transfer and direct debit) affected the internet and mobile banking in the short run. Based on the H1 statement, only charge card (CC), credit transfer (CT) and direct debit (DD) affected mobile banking significantly in

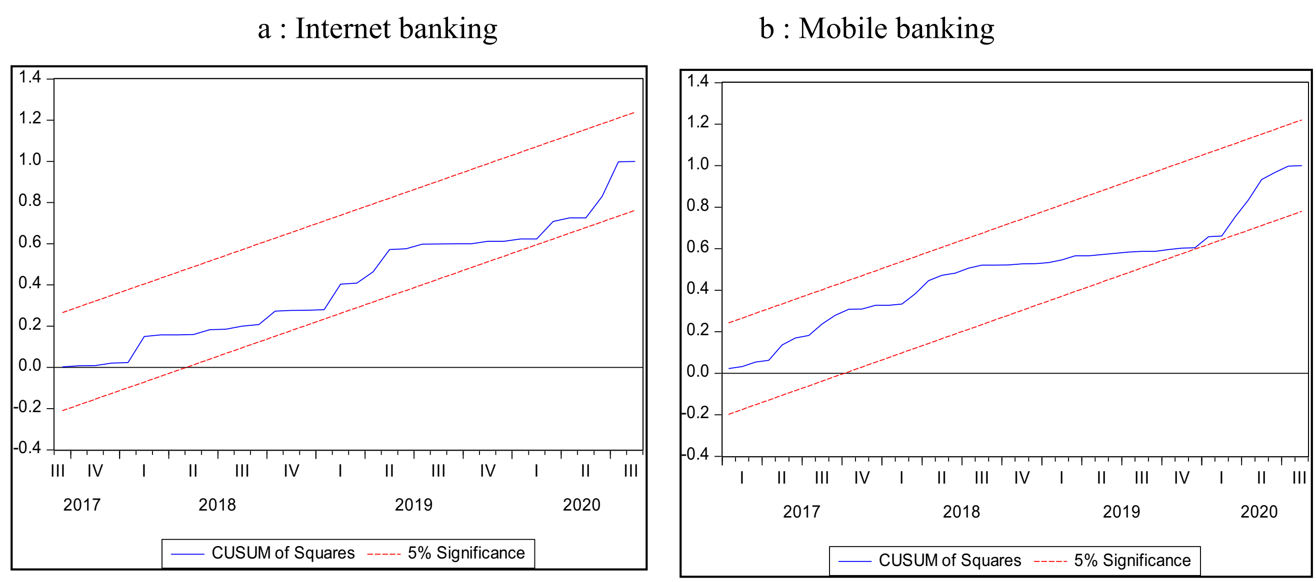


Fig. 4 **a** Internet banking. **b** Mobile banking

the short run. As for internet banking, credit card (CRE) and credit transfer (CT) affected internet banking significantly in the short run. Short run refers to a period where the customers could not take any action to change its current banking activities. The findings of this study found that not all cashless payment tools affect the utilization of internet banking and mobile banking significantly in the short run.

The findings indicated that mobile shoppers would pay for their shopping using charge cards, credit transfer and direct debit through mobile banking applications. Mobile banking applications allowed consumers to pay for their mobile shopping by charging to their charge card and debiting directly from their deposit account. Some consumers' credit transferred to their e-wallet to pay for their shopping for discounts and bonus points (Alam et al. 2021). A credit transfer could be done either through the mobile banking application or internet banking. Thus, credit transfer increased the usage of both the internet and mobile banking.

Credit cards allow consumers to time purchase and make payment for their expenses from the pre-approved credit limit. A credit card outstanding balance is usually paid using internet banking, which explains the short-run relationship.

This study also hypothesized that the usage of cashless payments (credit card, charge card, e-wallet, credit transfer and direct debit) affected the internet and mobile banking in the long run. Based on the H2 statement, only direct debit (DD) significantly affected internet banking and mobile banking in the long run at a 10% level. There was no significant evidence that all other cashless payment tools affect internet banking and mobile banking services in the long run.

Since internet banking was first introduced in Malaysia in mid-2000 (Bank Negara Malaysia 2007), consumers might be more familiar with direct debiting their deposit accounts to pay for their online shopping. With the recent improvement in broadband connections and mobile applications, consumers could also debit directly from their deposit accounts to pay for their shopping at lazada.com.my and shoppee.com.my.

Conclusion

The study discovered that charge cards, credit transfer and direct debit payments will significantly affect the usage of mobile banking applications in the short run. Credit card and credit transfer payments significantly affect the value of internet banking transacted per month in the short run. However, the diffusion of cash payment to cashless payment did not induce internet and mobile banking services in the long run, except direct debit.

There are two practical contributions to this study. First, existing banks can benefit from knowing that direct debit facilitates consumers' online shopping payments through internet and mobile banking. Physical debit cards are also the preferred choice of offline cashless payments. Second, as mobile banking usage increased, charge card payments would most likely run out of favour.

The Central Bank of Malaysia has to re-strategize its effort to promote cashless payments to induce internet banking and mobile banking services. Since direct debit significantly affects the internet and mobile banking in the long run, the development of cashless payments should include direct debit features of consumers' banking account. For example, the TnG e-wallet has recently enabled users to sweep their excess money into their Go + account that pays interest. The Go + function is similar to a savings deposit.

There are some limitations to this study. Besides an alternative to cash payments, the findings of this study are limited to the macro-level analysis of the usage of internet banking and mobile banking services. This study did not consider security issues, location and accessibility to financial services in the analysis. Future studies could study the causal effect of cashless payments due to the security of internet banking and mobile banking services, the location of consumers (rural versus urban) and consumers' access to financial services.

References

Aduba, J.J. 2021. On the determinants, gains and challenges of electronic banking adoption in Nigeria. *International Journal of Social Economics* 48 (7): 1021–1043. https://doi.org/10.1108/IJSE-07-2020-0452.

Alam, M.M., A.E. Awawdeh, and A.I.B. Muhamad. 2021. Using e-wallet for business process development: Challenges and prospects in Malaysia. *Business Process Management Journal*. https://doi.org/10.1108/bpmj-11-2020-0528.

Ananda, S., S. Devesh, and A.M. Al Lawati. 2020. What factors drive the adoption of digital banking? An empirical study from the perspective of Omani retail banking. *Journal of Financial Services Marketing* 25 (1–2): 14–24. https://doi.org/10.1057/s41264-020-00072-y.

Andreou, P.C., and S. Anyfantaki. 2021. Financial literacy and its influence on internet banking behavior. *European Management Journal*. https://doi.org/10.1016/j.emj.2020.12.001.

Atmaca, S., and H.A. Karadaş. 2020. Decision making on financial investment in Turkey by using ARDL long-term coefficients and AHP. *Financial Innovation* 6 (30): 1–22. https://doi.org/10.1186/s40854-020-00196-z.

Bank Negara Malaysia. 2007. Quarterly bulletin economic and financial developments in Malaysia in the second Quarter of 2007. *Quarterly Bulletin* 49–52.

Bank Negara Malaysia. 2011. Financial Sector Blueprint 2011–2020. Financ Sect Bluepr 2011–2020 1–198.

Chaffai, M., and P. Coccorese. 2019. How far away is the MENA banking system? Efficiency comparisons with international banks. *North American Journal of Economics and Finance* 49 (April): 378–395. https://doi.org/10.1016/j.najef.2019.04.013.

Chaouali, W., I. Ben Yahia, R. Lunardo, and A. Triki. 2019. Reconsidering the "what is beautiful is good" effect: When and how design aesthetics affect intentions towards mobile banking applications. *International Journal of Bank Marketing* 37 (7): 1525–1546. https://doi.org/10.1108/IJBM-12-2018-0337.

Cohen, N., A. Rubinchik, and L. Shami. 2020. Towards a cashless economy: Economic and socio-political implications. *European Journal of Political Economy* 61: 1–12. https://doi.org/10.1016/j.ejpoleco.2019.101820.

Danish, Bo Wang, and Z. Wang. 2018. Imported technology and CO_2 emission in China: Collecting evidence through bound testing and VECM approach. *Renewable and Sustainable Energy Reviews* 82: 4204–4214. https://doi.org/10.1016/j.rser.2017.11.002.

Dash, M., P.B. Bhusan, and S. Samal. 2014. Determinants of customers' adoption of mobile banking: An empirical study by integrating diffusion of innovation with attitude. *Journal of Internet Banking and Commerce* 19 (3): 1–21.

Del Gaudio, B.L., C. Porzio, G. Sampagnaro, and V. Verdoliva. 2021. How do mobile, internet and ICT diffusion affect the banking industry? An empirical analysis. *European Management Journal.* https://doi.org/10.1016/j.emj.2020.07.003.

Dua, P., and H. Kapur. 2018. Macro stress testing and resilience assessment of Indian banking. *Journal of Policy Modeling* 40 (2): 452–475. https://doi.org/10.1016/j.jpolmod.2018.01.005.

Elhajjar, S., and F. Ouaida. 2019. An analysis of factors affecting mobile banking adoption. *International Journal of Bank Marketing* 38 (2): 352–367. https://doi.org/10.1108/IJBM-02-2019-0055.

Ho, J.C., C.G. Wu, C.S. Lee, and T.T.T. Pham. 2020. Factors affecting the behavioral intention to adopt mobile banking: An international comparison. *Technology in Society* 63 (December): 1–9. https://doi.org/10.1016/j.techsoc.2020.101360.

Iheanachor, N., and A.E. Ozegbe. 2020. Dynamic linkages between mobile money and banks' performance in Nigeria: An autoregressive distributed lag (ARDL) approach. *International Journal of Management, Economics and Social Sciences*. https://doi.org/10.32327/ijmess/9.3.2020.12.

Jamshidi, D., and N. Hussin. 2016. Islamic credit card adoption understanding: When innovation diffusion theory meets satisfaction and social influence. *Journal of Promotion Management* 22 (6): 897–917. https://doi.org/10.1080/10496491.2016.1214206.

Jamshidi, D., and F. Kazemi. 2019. Innovation diffusion theory and customers' behavioral intention for Islamic credit card: Implications for awareness and satisfaction. *Journal of Islamic Marketing* 11 (6): 1245–1275. https://doi.org/10.1108/JIMA-02-2018-0039.

Jebarajakirthy, C., and A. Shankar. 2021. Impact of online convenience on mobile banking adoption intention: A moderated mediation approach. *Journal of Retailing and Consumer Services* 58: 1–12. https://doi.org/10.1016/j.jretconser.2020.102323.

Kachathan, S., and Y. Chalchotchuang. 2020. Assessment of prospect towards cashless society: A case of mobile payments in emerging markets. *Journal of ASEAN PLUS Studies* 1 (1): 8. https://doi.org/10.5958/2249-7137.2017.00080.5.

Kaur, P., A. Dhir, R. Bodhi, T. Singh, and M. Almotairi. 2020. Why do people use and recommend m-wallets? *Journal of Retailing and Consumer Services* 56: 1–11. https://doi.org/10.1016/j.jretconser.2020.102091.

Klyton, A. Van., J.F. Tavera-Mesías, and W. Castaño-Muñoz. 2021. Innovation resistance and mobile banking in rural Colombia. *Journal of Rural Studies* 81 (February): 269–280. https://doi.org/10.1016/j.jrurstud.2020.10.035.

Krivosheya, E. 2020. The role of financial innovations in consumer behavior in the Russian retail payments market. *Technological Forecasting and Social Change* 161: 1–8. https://doi.org/10.1016/j.techfore.2020.120304.

Mawejje, J., and P. Lakuma. 2019. Macroeconomic effects of Mobile money: Evidence from Uganda. *Financial Innovation* 5 (23): 1–14. https://doi.org/10.1186/s40854-019-0141-5.

Mhadhbi, K., C. Terzi, and A. Bouchrika. 2020. Banking sector development and economic growth in developing countries: A bootstrap panel Granger causality analysis. *Empirical Economics* 58 (6): 2817–2836. https://doi.org/10.1007/s00181-019-01670-z.

Mukhopadhyay, B. 2016. Understanding cashless payments in India. *Financial Innovation* 2 (1): 1–26. https://doi.org/10.1186/s40854-016-0047-4.

Mumtaza, Q.M.H., S.I. Nabillah, S. Amaliya, Y. Rosabella, and J.A.H. Hammad. 2020. Worldwide mobile wallet: A futuristic cashless system. *Bulletin of Social Informatics Theory and Application* 4 (2): 70–75.

Murthi, B.P.S., M. Girju, and E. Steffes. 2019. The effect of promotional interest rates on customer borrowing and payment behavior in the credit card industry. *Journal of Financial Services Marketing* 24 (1–2): 11–20. https://doi.org/10.1057/s41264-019-00063-8.

Oyelami, L.O., S.O. Adebiyi, and B.S. Adekunle. 2020. Electronic payment adoption and consumers' spending growth: Empirical evidence from Nigeria. *Future Business Journal* 6 (14): 1–14. https://doi.org/10.1186/s43093-020-00022-z.

Pesaran, M.H., Y. Shin, and R.J. Smith. 2001. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics* 16 (3): 289–326. https://doi.org/10.1002/jae.616.

Rahman, M., I. Ismail, and S. Bahri. 2020. Analysing consumer adoption of cashless payment in Malaysia. *Digital Business* 1 (1): 1–11. https://doi.org/10.1016/j.digbus.2021.100004.

Rogers EM. 1983. *Diffusion of innovations* (3rd ed.). New York, NY: The Free Press.

Semerikova, E. 2019. Payment instruments choice of Russian consumers: Reasons and pain points. *Journal of Enterprising Communities* 14 (1): 22–41. https://doi.org/10.1108/JEC-09-2019-0089.

Sharma, R., G. Singh, and S. Sharma. 2020. Modelling internet banking adoption in Fiji: A developing country perspective. *International Journal of Information Management* 53: 1–13. https://doi.org/10.1016/j.ijinfomgt.2020.102116.

Shy, O. 2020. Low-income consumers and payment choice. *Research in Economics* 74 (4): 292–300. https://doi.org/10.1016/j.rie.2020.09.001.

Tee, H.-H., and H.-B. Ong. 2016. Cashless payment and economic growth. *Financial Innovation* 2 (4): 1–9. https://doi.org/10.1186/s40854-016-0023-z.

Teng, S., and K.W. Khong. 2021. Examining actual consumer usage of E-wallet: A case study of big data analytics. *Computers in Human Behavior* 121: 1–18. https://doi.org/10.1016/j.chb.2021.106778.

Tiong, W.N. 2020. Factors influencing behavioural intention towards adoption of digital banking services in Malaysia. *International Journal of Asian Social Science* 10 (8): 450–457. https://doi.org/10.18488/journal.1.2020.108.450.457.

Trütsch, T. 2020. The impact of contactless payment on cash usage at an early stage of diffusion. *Swiss Journal of Economics and Statistics* 156 (5): 1–35. https://doi.org/10.1186/s41937-020-00050-0.

Urhie, E., Amonu, O. C., Mbah, C., Ewetan, O. O., Matthew, O. A., Adediran, O., Adesanya, O., Adekeye, A. (2021). Banking technology and cashless economy in selected Sub-Saharan African countries: does education matter? *Journal of Money Laundering Control* 24 (3): 584–595. https://doi.org/10.1108/JMLC-10-2020-0122.

Waheed, M., K. Kaur, N. Ain, and S.A. Sanni. 2015. Emotional attachment and multidimensional self-efficacy: Extension of innovation diffusion theory in the context of eBook reader. *Behaviour and Information Technology* 34 (12): 1147–1159. https://doi.org/10.1080/0144929X.2015.1004648.

Wang, Y.S., S.C. Wu, H.H. Lin, Y.M. Wang, and T.R. He. 2012. Determinants of user adoption of web ATM: An integrated model of TCT and IDT. *Service Industries Journal* 32 (9): 1505–1525. https://doi.org/10.1080/02642069.2010.531271.

Zagalaz Jiménez, J.R., and I. Aguiar Díaz. 2019. Educational level and Internet banking. *Journal of Behavioral and Experimental Finance* 22: 31–40. https://doi.org/10.1016/j.jbef.2019.01.004.

Zhou, Q., F.J. Lim, H. Yu, G. Xu, X. Ren, D. Liu, X. Wang, X. Mai, and H. Xu. 2021. A study on factors affecting service quality and loyalty intention in mobile banking. *Journal of Retailing and Consumer Services* 60: 1–8. https://doi.org/10.1016/j.jretconser.2020.102424.