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The determinants of bank profitability: A cross-country analysis

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ABSTRACT

This study investigates the determinants of bank profitability in 23 countries from 2002 to 2016 using the system generalized method of moments. The findings indicate that the number of bank cards issued, the number of automated teller machines (ATMs) and the number of point of sale (POS) terminals can improve bank profitability. Hence, this suggests a need for further expansion of these delivery channels. Also, the findings show the negative impact of market power on bank profitability, implying that competition improves bank profitability. Further, the positive relationship between capital market development and bank profitability suggests that they should be considered as complementary to one another.

1. Introduction

In the banking system, the introduction and development of new delivery methods for depositor services such as automated teller machines (ATMs), online banking and phone center may exhibit greater economies of scale than traditional branching networks. Also, advance in payment technology such as point of sale (POS) terminals, card issues with many built-in functions may have generated network economies and scale economies in back-office operations as well as facilitated fund transferring among individuals and organizations in a country. When direct costs for users of banking services are associated with the underlying differential expenses of electronic versus paper-based transactions, a nation's payment costs can fall in real terms. Humphrey et al. (2006) state that annual savings of 1% of gross domestic product (GDP) may be realized if a country can move away from paper-based to an electronic-based system, and effectively substitute ATMs for stand-alone branch offices. Therefore, it is necessary to account for the innovation in banking services when determining the factors affecting bank performance. Berger et al. (1999) also emphasize that technological progress may improve scale economies in producing financial services, creating opportunities to improve bank efficiency.

Several studies that attempted to examine the effect of the information technology (IT)-based method of banking services delivery on bank profitability have shown inconclusive findings. Early studies report a positive relationship between them (Hernando and Nieto, 2007; Ciciretti et al., 2009; Weigelt and Sarkar, 2012). However, others show opposite findings (Akhisar et al., 2015; Sathye and Sathye, 2016). Since this may result from the fact that those studies were based on bank-level data,[1] this study therefore provides a different view on the topic by investigating the determinants of bank profitability using the national aggregate data when considering IT-based methods of delivering in banking products and services (the number of cards issued, the number of POS terminals along with the ATM). Moreover, Akhisar et al. (2015)

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[1] Humphrey et al. (2006) may be one of few exceptions using the country aggregate data. However, their study focuses on the national payment system on operating costs of banking systems whereas our study primarily focuses on the technological innovation in terms of service delivery such as bank cards, ATMs, branches and POS terminals.

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may be one of the few exceptions that examined the impact of innovation in terms of service delivery. However, they failed to provide consistent results since the control variables related to the characteristics of the country such as the structure of the banking system, the financial market development, and other external factors are generally ignored in their model. In contrast, we construct our dataset by combining four different datasets, thus allowing us to include environmental factors to our model. Therefore, this would provide us a better understanding of the determinants of bank profitability when IT-based channels of banking services and products are accounted for.

The findings indicate that the IT-based methods of service delivery enhance bank profitability, thus, the expansions of these channels in providing banking products and services should be further promoted. The negative relationship between bank overhead expenses and profitability also confirms that bank systems should further reduce the number of branches by perhaps increasing the number of ATMs. Furthermore, the findings show the negative relationship between regulatory capital and bank profitability, thus, supporting the conventional risk-return hypothesis.[2] Also, the banking systems that face higher credit risk charge a higher interest rate to compensate for the default risk. More interestingly, the findings demonstrate the negative impact of market power on bank profitability, suggesting that a less concentrated banking system improves bank profitability. Also, greater financial development is found to have a positive impact on bank profitability, implying that the development of the financial market should enhance bank performance. Lastly, bank profitability is also affected by economic growth and the global financial crisis in 2007-08.

The remainder of this study is organized as follows. Section 2 provides a brief overview of relevant empirical studies on the relationship between technology in banking services and bank profitability. Section 3 provides methodology and data. Section 4 discusses the main findings while Section 5 concludes.

2. A brief overview of relevant empirical studies

It is noticed that the literature on the determinants of bank performance is significantly enormous (Dietrich and Wanzenried, 2014; Saona, 2016) while empirical studies on the relationship between information technology (IT) and bank performance are limited. Instead, this study attempts to provide a short overview of the impact of technology investments on bank performance. The literature in this field can be divided into two parts.

The first strand focuses on the impact of technology investments in terms of pure infrastructure or technological developments on bank performance (Willcocks and Lester, 1997; Ho and Mallick, 2010). Most studies in this strand are conducted by using the US and European data. The findings are mixed. Similarly, Berger (2003), using the US data, demonstrates that technological progress can reduce bank cost productivity and improve profit productivity. This finding is further supported by Berger and Deyoung (2006) who state that technological progress allows US banking organizations to reduce the agency costs that arise when non-lead affiliate banks are located far away from headquarters. These managerial improvements appear to be more substantial on the revenue side than on the cost side of banks' income statements. In contrast, Ho and Mallick (2010), using the US individual bank-level, showed that the banks' profits can decline due to the adoption and diffusion of information technology (IT) investment, reflecting negative network competition effects in this industry in the US. This is comparable with the findings of Arora and Arora (2013) who found that investment in IT in Indian banking has a negative impact on operating profits and profits per employee but has no impact on return on assets (ROA). In the same vein, DeYoung (2001) demonstrates that the US young internet-based banks earn low profits, low non-interest income, and low core deposits although they have low physical overhead. Furthermore, Beccalli (2007), using a sample of 737 European banks, indicated that there is little relationship between total IT investment and improved bank profitability or efficiency, thus a profitability paradox may exist. When breaking down IT investment, their findings show that investment in IT services from external providers impacted accounting profits and profit efficiency positively while the acquisitions of hardware and software tend to reduce bank performance. Nonetheless, the negative results may reflect the observation of Berger (2003) that banks with market share increases with IT may have substantially given away the benefits from IT as the industry became more competitive due to regulation, and rents from market power shifted to the consumers.

Because IT also places strong constraints on the type of products and delivery channels offered and the degree of customization possible, the second strand attempts to investigate whether the relationship between technological innovation in banking services and bank performance. Several studies that investigate the effect of electronic banking applications in service delivery on bank performance show the positive relationship between them (Hernando and Nieto, 2007; Ciciretti et al., 2009; Weigelt and Sarkar, 2012). These suggest that investment in this type of technological innovation provides a relatively low risk, high return, and low-cost advantages. Also, a few studies that examine the impact of ATM on bank performance indicate mixed findings. Holden and El-Bannany (2004), using the UK data, suggest that the number of ATMs installed by banks has a positive impact on bank profitability. In the same vein, Valverde and Humphrey (2009) pointed out that ATM and electronic payments are related to over 30 percent reduction in the ratio of bank operating costs to asset value across 11 European countries. They concluded that this non-pricing competition affects banking prices with the net effect being that net revenues are enhanced. However, Sathye and Sathye (2016), using Indian data, found that ATM intensity impacted bank performance negatively and assert that heavy investment in IT such as ATM by Indian banks need to be taken with great caution.

While most prior studies have attempted to investigate the relationship between investment in innovation in banking service and bank performance using bank-level data, we take a further step by examining the factors affecting bank profitability using the national aggregate data of 23 countries when controlling for IT-based delivery methods of banking services and products. Hence, this would provide more evidence on whether the technology would benefit banking systems.

3. Methodology

3.1. Generalized method of moments

Due to the structure of panel data used in this study, a generalized

[2] The risk-return hypothesis states that banks with a low level of capital, regarded as facing less risk, are expected to have greater returns (Goddard et al., 2013).

method of moments estimator (GMM) suggested by Arellano and Bover (1995) is used.[3] The objective of GMM is to control for unobserved heterogeneity and endogeneity problems (Arellano, 2002). The GMM estimator accounts for unobserved heterogeneity and the persistence of the dependent variable.[4] Hence, this estimator yields consistent estimations of the parameters. The estimated coefficients are more efficient as an ample set of instruments is used.

For the endogeneity problems,[5] the system GMM estimator uses lagged values of the dependent variables (in levels and differences) and lagged values of other regressors which potentially suffer from endogeneity as instruments. Following Bond (2002), we use the lagged values of the variables that are treated as endogenous as instruments. Our approach uses instruments for all regressors except for those which are clearly considered as exogenous.[6] Furthermore, the number of lags is determined by Arellano-Bond autocorrelation (AR) tests and the test for over-identifying restrictions (Hansen, 1982). If the null hypothesis of the Hansen test is rejected, the instruments do not meet the required orthogonality conditions. In addition, the moment conditions are valid only if there is no serial correlation in the idiosyncratic errors. If the null hypothesis at second-order autocorrelation (AR2) cannot be rejected, the moment conditions are still valid.

The above arguments suggest the application of a dynamic model of bank profitability that takes the following form[7]:

$$\pi_{i,t} = \alpha_{i,t} + \beta_1 \pi_{i,t-1} + \beta_2 CARD_{i,t} + \beta_3 ATM_{i,t} + \beta_4 POS_{i,t} + \beta_5 OH_{i,t} + \beta_6 CAP_{i,t} + \beta_7 NPL_{i,t} + \beta_8 STOCK_{i,t} + \beta_9 MP_{i,t} + \beta_{10} GDPGR_{i,t} + \beta_{11} INF_{i,t} + \beta_{12} CRISIS_t + \mu_i + \varepsilon_{i,t} \quad (1)$$

The definitions of variables in equation (1) are outlined below.

Bank profitability (π) can be proxied in many different ways in the existing literature. One is the net interest margin (NIM) that is the ratio of net interest income to interest-bearing assets (Beck et al., 2000). ROA, as measured by the ratio of net profits to total assets, is also used for robustness in this study.[8]

For the regressors, we include the banking system-specific and macroeconomic factors.

π_{t-1}, the lagged bank profitability, is used to measure the persistence of profits, i.e., the extent to which a bank remains in the same profit distribution. β_1, the coefficient of this variable presents the speed at which profits may adjust to long-run equilibrium (Athanasoglou et al., 2008). If β_1 is closer to 0, this indicates a high speed of adjustment, implying that the industry is highly competitive. If β_1 approaches 1, this demonstrates a very slow speed of adjustment, suggesting that the industry may be uncompetitive.

CARD, the natural logarithm of the number of cards issued in the banking system; ATM, the ratio of number of ATMs to the number of bank branches; POS, the natural logarithm of the number of POS terminals are used to control for the effects of electronic banking products. Technology-based service delivery offers a great opportunity for cost savings, thus improving bank profitability.

OH, the ratio of a bank's overhead costs to total assets, is used to control for bank efficiency. The efficient structure hypothesis posits that efficient banks enjoy lower production cost which is translated into lower pricing by applying better management or more advanced production technologies. This thus leads to increased sales and larger market shares, which ultimately generates greater profitability. Several studies indicate that bank efficiency is consistently related to higher profits (Berger, 1995a; Sharma et al., 2013).

CAP, the ratio of regulatory capital to risk-weighted assets, is used to control for the effects of capital adequacy. Several studies show a positive relationship between capitalization and bank profitability (Goddard et al., 2004; Berger, 1995b; Pervan et al., 2015). This can be explained by two complementary arguments. The expected bankruptcy costs hypothesis states that banks will increase their capital whenever exogenous factors increasing the expected bankruptcy costs are greater. Besides, the signaling hypothesis proposes that banks may disclose information to the market about their prospects and capacity to generate profits. Therefore, a signaling equilibrium may exist where banks that expect to have better future performance will exhibit a greater level of capital (Saona, 2016). On the other hand, high leverage reduces the agency costs of outside equity and increases firm value by providing incentives for managers to act more towards shareholders' interest. Accordingly, a bank with an excessively high capital ratio is operating overcautiously and ignoring opportunities to profitable growth, thus, increasing opportunity costs of capital (Berger, 1995a; Sharma et al., 2013).

NPL, the ratio of non-performing loans to total gross loans, is used to proxy for credit risk. Several studies found that increased exposure to credit risk is related to low profitability (Athanasoglou et al., 2008; Dietrich and Wanzenried, 2014; Miller and Noulas, 1997). Other studies, however, indicate that banks with more risky assets may require a higher profit to compensate for their greater risk of default (Figlewski et al., 2012). It may be true for emerging markets where macroeconomic volatility is much higher than developed markets, thus bank spreads may rise corresponding to higher default risk (De Blas and Russ, 2013; Gelos, 2009; Saona, 2016). Even, no impact of credit risk on bank profitability is also found by Le (2017a).

STOCK, the ratio of stock market capitalization to GDP, is used to control for the effects of financial market development. Banks and capital markets may be a substitute for each other as both of them develop at the expense of the other (Jacklin and Bhattacharya, 1988; Allen and Gale, 1999).

MP, assets of the three largest banks as a share of assets of all commercial banks, is used to control for the effects of market power. As per the structure conduct performance hypothesis, banks with market power collude to charge high fees on loans and advances and non-traditional activities and lower rates on customer deposits, thus earning higher profits (Saona, 2016; Dietrich and Wanzenried, 2014). Several studies, however, show opposite findings (Bolarinwa and Obembe, 2017; Mirzaei et al., 2013).

GDPGR, the annual GDP growth rate, is used to control for the

[3] With the dynamic nature of the bank profitability comprising a dynamic specification, estimators such as ordinary least square, fixed effects or random effects (Claeys and Vander Vennet, 2008; Maudos and Fernández de Guevara, 2004), generalized least squares (Angbazo, 1997) and weighted least squares (Demirgüç-Kunt and Huizinga, 1999) may become biased.

[4] This persistence is related to market competition barriers, charter capital requirements, information opacity and/or sensitivity to uncertainty, to the extent that there is a serial correlation between them.

[5] For example, more profitable banks may invest more in innovation, thus increasing the ATM. Also, they may hire more professional staff, thus resulting in higher operating costs. However, the costs for maintenance may reduce bank profitability.

[6] It is assumed that strictly exogenous variables are not correlated with the individual effects while the endogenous variables are predetermined.

[7] It is suggested that total deposits and loans to total assets have some impacts on bank performance. However, the former variable was dropped because it is highly correlated to CARD and POS; whilst the latter was also excluded due to its insignificant role in all models but reducing the goodness-of-fit of those models.

[8] We also used ROE, returns on equity as a dependent variable. The coefficients of CARD, ATM and POS are positive but statistically not significant. Nonetheless, the findings are robust although the table of results cannot be presented due to the length restrictions. However, this is available upon request.

Table 1
Descriptive statistics of variables used in this study.

Variables	Obs	Mean	Std	Min	Max	Sources
NIM	345	2.617	1.839	0.267	11.664	Beck et al. (2000)
ROA	344	0.893	0.787	−1.656	3.952	Beck et al. (2000)
CARD	279	18.226	1.853	10.317	22.536	Bank for International Settlements (2017)
ATM	264	7726.817	23496.62	357.39	210087.747	Bank for International Settlements (2017)
POS	256	13.296	1.26	10.065	17.016	Bank for International Settlements (2017)
OH	345	2.556	5.254	0.173	81.9	Beck et al. (2000)
CAP	230	15.306	2.783	9.966	26.884	International Monetary Fund (2018)
NPL	230	2.901	2.872	0.082	18.064	International Monetary Fund (2018)
STOCK	323	92.584	64.984	14.699	464.721	Beck et al. (2000)
MP	339	62.367	20.002	20.846	100	Beck et al. (2000)
GDPGR	345	3.032	3.312	−7.821	15.240	World Bank (2017)
INF	345	3.279	3.933	−2.983	44.964	World Bank (2017)
CRISIS	345	0.133	0.3400	0.000	1.000	Author's calculation

effects of economic growth. The literature shows mixed findings. Several studies show that economic growth has either no significant impact (Sharma et al., 2013) or a negative impact on bank profitability (Tan and Floros, 2012). Economic growth, however, may increase demand for financial products and services offered by banks during cyclical upswings, thus improving bank profitability (Athanasoglou et al., 2008; Demirgüç-Kunt and Huizinga, 1999; Dietrich and Wanzenried, 2014).

Furthermore, bank profitability may be influenced by inflation (INF) since it has a decisive role in the structure of the interest rate. A higher inflation rate will result in greater interest rates on loans, thus greater bank profitability. The increased interest rates, however, may raise the risk of loan repayment because a higher inflation rate has an impact on the borrowers' budgets, which ultimately threatens their liquidity and reduces their ability to service debts (Pervan et al., 2015).

Finally, CRISIS, a dummy variable that takes a value of 1 for the period of 2007-08 and 0 otherwise, is used to control for the effects of the financial contagion (Le, 2019; Le et al., 2019). Not all countries were affected by the recent global financial crisis in the same way. Several studies have documented that there was obvious evidence of the impact of the global crisis on bank performance (Andries and Ursu, 2016; Vu and Turnell, 2011). Several studies indicate that the global crisis has an adverse impact (Tzeremes, 2015) or no significant impact on bank performance (Gulati and Kumar, 2016).

3.2. Data

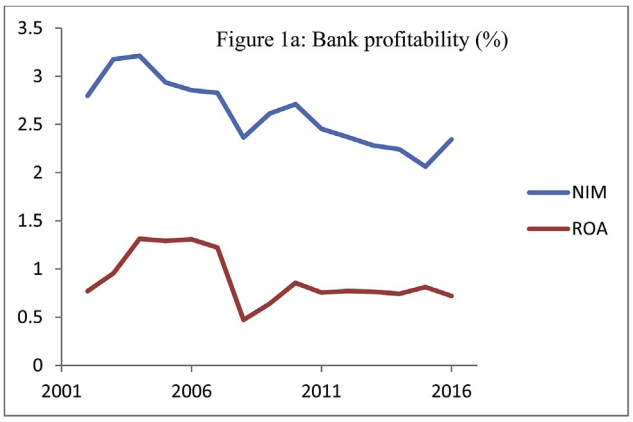
It is worth noting that our data is collected at a national or aggregate level, therefore it allows us to compare the performance of banking systems in different countries but unfortunately does not allow us to examine the effect of bank ownership structure on bank performance. In particular, the data on technology in banking services was collected from the Payment System Statistics (Bank for International Settlements, 2017)[9] while bank performance and other variables were extracted from the Financial Development and Structural dataset (Beck et al., 2000), the Financial Soundness Indicators (International Monetary Fund, 2018) as well as the World Development Indicators (World Bank, 2017). To examine the impact of technology in banking services (e.g. bank cards or ATMs) as well as its changes over time, countries with less than five consecutive years of data are excluded. Thereafter matching the four datasets, an unbalanced data of 23 countries[10] between 2002 and 2016 was obtained as described in Table 1. On average, the banking sectors in our sample have NIM of 2.6% over the entire period of 2002–2016. NIM is also far more diversified across countries, with the minimum and maximum values of 0.26% and 11.66%, respectively. The same is true for the case of ROA. Fig. 1a, however, shows a significant reduction in bank profitability in years 2007-08 due to the global crisis.

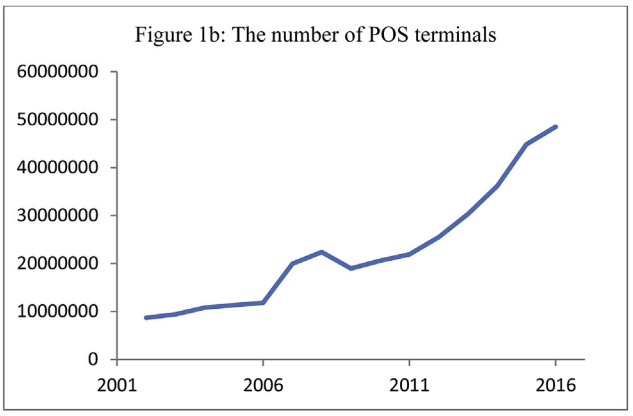
Furthermore, Fig. 1b–c shows an increase in the number of POS terminals and bank card issues over time, except for year 2009. This decrease may reflect the shrinking operation of banking systems as a result of the recent financial contagion, thus, reducing the non-interest income of banking systems. Additionally, Fig. 1d indicates the growth of the number of ATMs per branch over the examined period while the number of branches has leveled off or even started falling at the end of the period.

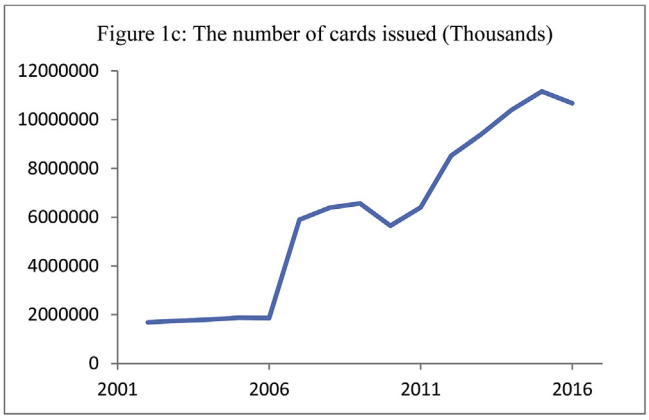
Table 2 shows that the average number of bank card issues, POS terminals, and the number of ATMs per branch in developing countries are greater than those in developed countries over the examined period. This reflects the fast growth of the economy and the characteristics of the population in these countries. To satisfy the customers' needs in a large population, the banking systems may increase the number of ATMs installed while maintaining the presence of the bank branch. To test the statistical significance of such differences, a non-parametric test was used. The Mann-Whitney test is used to verify the null hypothesis that there is no difference in technology in banking services (the number of card issues, the number of POS terminals, and the number of ATMs per branch) between developed and developing countries. As can be seen in Table 3, the null hypothesis can be rejected only in the case of the number of card issues.

[9] The Payment System Statistics database covers a set of 24 countries. Unfortunately, there are substantial missing data on mobile payment systems, online banking usage or other payment systems in most countries included in the database. Therefore, this would limit the scope of our study.

[10] Both developed and developing countries are considered in this study, including Australia, Belgium, Brazil, Canada, China, France, Germany, Hong Kong, India, Italy, Japan, Korea, Mexico, Netherlands, Russia, Saudi Arabia, Singapore, South Africa, Sweden, Switzerland, Turkey, United Kingdom, and United States. However, due to a small sample size issue, we cannot divide our sample into developed and developing markets for deeper analysis when using GMM.







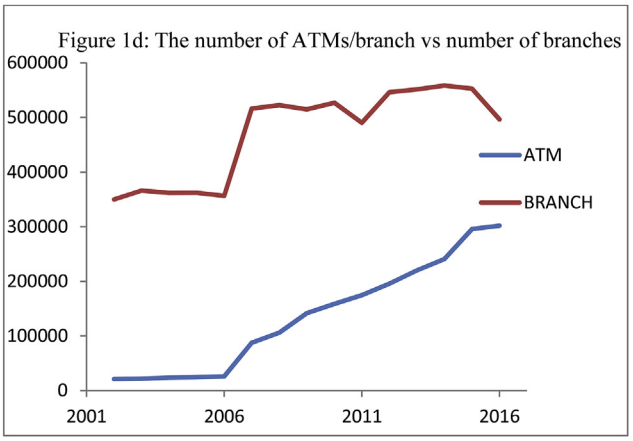


Fig. 1. **a**. Bank profitability (%). **b**. The number of POS terminal. **c**. The number of cards issued (Thousands). **d**. The number of ATM/branch vs number of branches.

4. Results

For the ease of exposition, we focus on the general interpretation of key variables. The data shown in Table 4 indicates that three measures of IT-based channels of offering banking services and products are significantly and positively associated with bank profitability. Additionally, the correlation between CARD and POS is relatively high, thus, we run the system GMM models for these two

Table 3
Mann-Whitney test (median values).

	CARD*	POS*	ATM
Developed countries	71,358	677	2671
Developing countries	219,858	753	3548
Ho: Equal means between two groups	Rejected	Not rejected	Not rejected
Z-value	−2.138	−1.268	−0.74
P-value	0.03	0.225	0.49

Table 2
The comparative analysis between developed countries and developing countries, 2002–2016.

		CARD*	POS*	ATM
Developed countries	Mean	182,771	957	4199
	Median	71,358	677	2671
	Std	310,208	1,197	3523
	Min	13,161	94	1357
	Max	988,518	4689	14,840
	No. countries	16		
Developing countries	Mean	733,937	2693	18,514
	Median	219,858	753	3548
	Std	1,239,001	3,329	38,884
	Min	68,334	317	964
	Max	3,498,000	9450	10,6597
	No. countries	7		

Notes: CARD*, the number of card issued in thousands, POS* is the number of POS terminal in thousands, ATM, the ratio of number of ATMs to the number of bank branches.

Table 4
Correlation matrix.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1.NIM	1												
2.ROA	0.716***	1											
3.CARD	0.406***	0.251***	1										
4.ATM	0.071	0.118	0.432***	1									
5.POS	0.375***	0.113	0.73***	0.477***	1								
6.OH	0.274***	0.067	0.092	−0.050	0.006	1							
7.CAP	0.201***	0.233***	−0.033	−0.139*	−0.163**	0.162**	1						
8.NPL	0.125*	−0.194***	0.131*	−0.145*	0.245***	0.277***	−0.054	1					
9.STOCK	−0.323***	−0.085	−0.279***	−0.083	−0.511***	−0.098	0.007	−0.348***	1				
10.MP	−0.523***	−0.388***	−0.546***	−0.211***	−0.567***	−0.298***	0.028	−0.349***	0.582***	1			
11.GDPGR	0.166**	0.36***	0.234***	0.299***	0.115	−0.048	−0.039	−0.259***	0.070	−0.262***	1		
12.INF	0.632***	0.454***	0.287***	−0.062	0.201***	0.297***	0.074	0.185**	−0.217***	−0.544***	0.276***	1	
13.CRISIS	0.055	−0.052	−0.103	−0.087	−0.076	−0.038	−0.235***	−0.131*	0.017	0.055	−0.008	0.141*	1

Table 5
Regression results.

Π	MODEL 1 (NIM)	MODEL 2 (NIM)	MODEL 3 (NIM)	MODEL 4 (ROA)	MODEL 5 (ROA)
π_{t-1}	0.475***(0.109)	0.334**(0.143)	0.469*(0.256)	0.554**(0.217)	0.463***(0.161)
CARD	0.139*(0.071)	0.130***(0.035)		0.207**(0.075)	
ATM	0.005**(0.002)	0.005***(0.002)	0.006***(0.001)	0.002***(0.001)	0.002*(0.001)
POS	−0.097(0.12)		0.185*(0.091)		−0.189(0.121)
OH	0.009(0.037)	−0.006(0.047)	0.01(0.014)	−0.002(0.006)	−0.022***(0.007)
CAP	−0.003*(0.002)	−0.002**(0.001)	−0.001(0.003)	0.0001(0.001)	−0.001(0.002)
NPL	0.119**(0.047)	0.089**(0.039)	0.080**(0.031)	0.003(0.032)	0.017(0.044)
STOCK	0.006(0.004)	0.013***(0.004)	0.009***(0.003)	−0.001(0.003)	0.002(0.003)
MP	−0.022*(0.012)	−0.0328**(0.009)	−0.023(0.016)	0.001(0.006)	−0.019***(0.007)
GDPGR	−0.022(0.012)	−0.016(0.01)	−0.030(0.02)	0.009(0.012)	0.033***(0.008)
INF	−0.003(0.04)	0.028(0.038)	0.05(0.049)	−0.02(0.037)	−0.024(0.053)
CRISIS	−0.003(0.134)	0.002(0.153)	0.164(0.350)	−0.199*(0.115)	−0.295(0.206)
No. of Obs	177	195	180	195	180
No. of groups	20	22	20	22	20
AR1 (p-value)	0.059	0.062	0.038	0.013	0.002
AR2 (p-value)	0.358	0.250	0.373	0.577	0.298
Hansen test (p-value)	0.198	0.508	0.855	0.900	0.951

Notes: The table contains the results estimated using the system GMM estimator following Arellano and Bover (1995). Robust standard errors are in parentheses. *, **, ***Significant at 10, 5 and 1 per cent levels, respectively.

variables separately.

As can be seen in Table 5, the coefficient of Π_{t-1} is positive and significant in all models, suggesting that profits are persistent over time. This is consistent with the early findings of Berger et al. (2000) and Goddard et al. (2004).

The coefficient of CARD is positive and significant in all models, suggesting that the more cards issued to the customers would increase bank profitability by collecting an annual fee from the users in addition to the net interest income. The same is true for ATM thus implying that banks with more ATMs may reduce operating expenses such as branch maintenance, labor costs, and other related expenses. Nonetheless, this finding is comparable to those of Valverde and Humphrey (2009) and Akhisar et al. (2015) who suggest that IT-based methods of service delivery are significantly associated with the substantial decrease in operating costs, thus improving bank profitability.

POS is found to have a positive impact on bank profitability, suggesting that banks with more POS terminals can generate higher interest income via interest charged on each transaction. This somewhat does not support the early finding of Akhisar et al. (2015) who found the negative relationship between POS terminals installed and bank profitability. The different results may be explained by the following reasons. We take the natural logarithm of the number of POS terminals as the distribution of this variable is highly skewed whereas the number of POS terminals is used in their study. In our model, we also include environmental factors to our model while these variables are ignored in their model. Instead, only variables proxied for innovation in banking service delivery

are included in their study. Our model therefore could reflect better the characteristics of the banking systems that are included in the sample.

Nonetheless, the positive relationship between POS and bank profitability partly supports the possibility of a cashless banking system in the future as the more customers use this service, the less cash can be transacted. Altogether these findings support the view that retail banking is one of the profitable sources for commercial banks.

The coefficient of OH is negative and significant in model 6, suggesting that inefficient banks have lower profitability. CAP is negatively and significantly associated with bank profitability, thus supporting the moral hazard hypothesis. This implies that more capitalized banks tend to invest in risky assets, which in turn lowers their profits. NPL is positively and significantly related to NIM, suggesting that a high level of credit risk may cause banks to increase their interest margins with a risk premium to compensate for possible default risk. This is comparable to the findings of Nguyen (2012) in a cross-country sample. This may be true for the case of the economic expansion where there is excessive credit growth. Furthermore, we also include the interaction terms between NPL with CRISIS to the model to examine the joint effect of these two variables. The results as shown in Appendix 1 indicate that the coefficients of NPL*CRISIS are negative and statistically significant. This implies that during the economic downturn as a result of GFC where there is a potentially increasing number of bankruptcies, banks may lower their interest margins to certain types of borrowers. Nonetheless, banks need to weigh the costs and benefits of restructuring problem loans, especially on their interest charged along with other terms and conditions.

Furthermore, STOCK is found to have a positive impact on bank profitability, thus, supporting the view that capital market development and bank performance are considered as complementary to one another. This further supports the earlier findings of Beccalli et al. (2006), Liadaki and Gaganis (2010) and Bossone and Lee (2004) who suggest that large capital markets help banks to not only improve their screening of potential borrowers but also monitor their investment more efficiently, thus increasing bank profitability. Also, we further include the interaction terms between STOCK with our main variables to examine the joint effect of them as presented in Appendix 2. We do not find any significant relationship between interaction terms and bank profitability.

This can be also explained by the following reason. A more developed capital market enables banks to manage their financial capital with relatively fewer non-financial resources, which may reduce costs for banks. Since banks want to produce more output and adjust their financial capital position accordingly, they may need to mobilize additional non-financial resources to manage and protect their financial capital. However, our finding is somewhat different from Ngo and Le (2019) who demonstrate the negative relationship between financial market development and the technical efficiency of the global banking system. The different result may be because their study measured technical efficiency using Data Envelopment Analysis while our study concentrates on bank profitability.

Another interesting finding is the negative relationship between market power (MP) and bank profitability. A more concentrated banking system is associated with lower profitability. This is comparable to earlier studies in the individual country such as García-Herrero et al. (2009) in China, Bolarinwa and Obembe (2017) in Nigeria and Le (2017b) in Vietnam or the cross-country such as Mirzaei et al. (2013). This can be explained by the following reasons. First, non-price competition may be more intense in more concentrated markets and so bank profitability is lower. Second, managers in more concentrated markets can more easily engage in expense-preference behavior so bank costs in such markets are higher, thus lowering profitability (Edwards, 1977). Last, managers in concentrated markets may opt for a 'quiet life' by taking less risky assets, thus earning lower returns (Heggestad, 1977). Furthermore, when the competition becomes tough, the effect of the number of ATMs, bank card issues and POS terminals on bank profitability may be higher. We therefore include the interaction terms between our main variables and MP in the model.[11] As shown in Appendix 3, the coefficient of ATM*MP is positive and statistically significant related to bank profitability although it is relatively weak. Nonetheless, this finding further confirms our above findings under the increasingly competitive market.

GDPGR is positively and significantly associated with bank profitability, suggesting that economic growth fosters profitability as generally perceived. This is in line with the well-documented literature on the association between economic growth and financial sector performance. Accordingly, economic growth may increase demand for financial products and services offered by banks during cyclical upswings, thus improving bank profitability (Athanasoglou et al., 2008; Demirgüç-Kunt and Huizinga, 1999; Dietrich and Wanzenried, 2014).

CRISIS is found to have a negative impact on ROA, implying that the global financial crisis reduced profitability. The countries in the examined sample are greatly integrated into the global financial market, thus the negative impact of the global crisis on bank profitability is already expected.

5. Conclusion

This study re-examines factors affecting bank profitability in 23 countries from 2002 to 2016 using system GMM. The findings indicate that IT-based methods of service and product delivery such as the number of issued bank cards, the number of ATMs, and the number of POS terminals can improve bank profitability. Therefore, these findings support the view that retail banking is one of the main profitable sources for banks. This is also supported by the negative relationship between bank overhead costs and profitability. Furthermore, the more capitalized banking system is found to have lower profitability, thus suggesting a banking system with a higher level of capital that is operating overcautiously would have a lower chance of investing in potentially profitable opportunities. The banking systems that face higher credit risk charge higher interest rates to compensate for the default risk. More interestingly, the findings demonstrate the negative impact of market power on bank profitability, suggesting that a less concentrated banking system improves bank profitability. Greater financial development is also found to have a positive impact on bank profitability, suggesting that the development of the financial market should enhance bank performance. Lastly, economic growth and the global financial crisis have impacted bank profitability.

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Appendix 1. Regression results when using the interaction terms between NPL and CRISIS

[11] We thank an anonymous referee for their suggestion of this variable.

π	MODEL 1 (NIM)	MODEL 2 (NIM)	MODEL 3 (NIM)	MODEL 4 (ROA)	MODEL 5 (ROA)
π_{t-1}	0.544***(0.128)	0.482***(0.148)	0.683***(0.107)	0.438**(0.207)	0.581**(0.217)
CARD	−0.051(0.41)	0.380(0.765)		0.274(0.303)	
ATM	0.003(0.008)	−0.005(0.004)	−0.004(0.002)	0.0002(0.003)	−0.002(0.002)
POS	0.166(0.464)		0.451(0.414)		0.033(0.291)
STOCK	0.018(0.077)	0.096(0.164)	0.01(0.055)	0.061(0.069)	0.003(0.045)
CARD*STOCK	0.002(0.006)	−0.006(0.009)		−0.004(0.004)	
ATM*STOCK	−0.0001(0.0001)	0.0001(0.0001)	0.0001(0.0001)	0.00001(0.0002)	0.0001(0.0001)
POS*STOCK	0.003(0.004)		−0.001(0.005)		−0.001(0.003)
Constant	−0.202(4.216)	−5.132(14.165)	−6.076(5.825)	−3.949(5.171)	0.52(3.952)
No. of Obs	177	195	180	193	178
No. of groups	20	22	20	22	20
AR1 (p-value)	0.114	0.046	0.095	0.002	0.034
AR2 (p-value)	0.472	0.354	0.408	0.395	0.534
Hansen test (p-value)	0.890	0.995	0.997	0.984	0.995

Notes: The same set of variables in equation (1) is used. The table contains the results estimated using the system GMM estimator following Arellano and Bover (1995). Robust standard errors are in parentheses. **, ***Significant at 5 and 1 per cent levels, respectively.

Appendix 2. Regression results when using the interaction terms between STOCK and the main variables

Π	MODEL 1 (NIM)	MODEL 2 (NIM)	MODEL 3 (NIM)	MODEL 4 (ROA)	MODEL 5 (ROA)
π_{t-1}	0.734***(0.148)	0.697***(0.069)	0.598***(0.119)	0.451**(0.161)	0.64***(0.101)
CARD	0.451*(0.231)	0.014(0.036)		0.119(0.112)	
ATM	0.005**(0.002)	0.009***(0.002)	0.003(0.002)	0.002(0.001)	0.0004(0.001)
POS	−0.452(0.328)		0.058(0.113)		0.024(0.103)
NPL	0.035(0.03)	0.033(0.039)	0.035(0.033)	−0.049(0.049)	0.009(0.037)
CRISIS	1.713(0.572)	−0.034(0.633)	0.843(0.536)	−0.607***(0.184)	−0.545*(0.311)
NPL*CRISIS	−0.771**(0.312)	−0.041(0.308)	−0.400*(0.228)	0.151(0.109)	0.109(0.099)
Constant	−0.912(1.932)	0.261(0.832)	0.526(1.695)	3.404(2.146)	0.297(1.833)
No. of Obs	177	195	180	193	178
No. of groups	20	22	20	22	20
AR1 (p-value)	0.055	0.075	0.082	0.007	0.004
AR2 (p-value)	0.894	0.338	0.807	0.315	0.431
Hansen test (p-value)	0.992	0.414	0.657	0.998	0.896

Notes: The same set of variables in equation (1) is used. The table contains the results estimated using the system GMM estimator following Arellano and Bover (1995). Robust standard errors are in parentheses. *, **, ***Significant at 10, 5 and 1 per cent levels, respectively.

Appendix 3. Regression results when using the interaction terms between MP and the main variables

π	MODEL 1 (NIM)	MODEL 2 (NIM)	MODEL 3 (NIM)	MODEL 4 (ROA)	MODEL 5 (ROA)
π_{t-1}	0.627***(0.194)	0.625***(0.138)	0.6**(0.245)	0.46**(0.198)	0.671***(0.156)
CARD	2.099(2.007)	0.035(0.594)		−0.586(0.351)	
ATM	−0.006(0.017)	−0.003(0.006)	0.01(0.007)	0.001(0.002)	−0.006(0.004)
POS	−1.416(1.824)		0.076(0.244)		−0.393(0.373)
MP	0.227(0.393)	−0.019(0.140)	−0.024(0.052)	−0.183**(0.077)	−0.075(0.081)
CARD*MP	−0.024(0.025)	0.001(0.007)		0.009**(0.004)	
ATM*MP	0.0001(0.0002)	0.0001(0.0001)	−0.0001(0.0001)	−0.0001(0.0001)	0.0001*(0.0001)
POS*MP	0.013(0.028)		0.002(0.004)		0.003(0.006)
Constant	−17.034(24.015)	0.805(11.482)	−2.254(3.475)	12.516*(6.22)	6.751(5.525)
No. of Obs	177	195	180	193	178
No. of groups	20	22	20	22	20
AR1 (p-value)	0.078	0.063	0.076	0.006	0.023
AR2 (p-value)	0.235	0.340	0.561	0.179	0.307
Hansen test (p-value)	0.993	0.963	0.293	0.825	0.994

Notes: The same set of variables in equation (1) is used. The table contains the results estimated using the system GMM estimator following Arellano and Bover (1995). Robust standard errors are in parentheses. *, **, ***Significant at 10, 5 and 1 per cent levels, respectively.

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