The effect of the Internet on commercial bank profitability: Global bank-level panel data evidence

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Abstract

The Internet has changed every aspect of economic life. Much research has studied whether the Internet affects cross-border trade, service trade, foreign direct investment, economic growth and inflation. In addition to these studies, our paper analyzed the effect of the Internet on bank profitability. A bank profitability equation is estimated by using global bank-level panel data of 58 countries from 1996 to 2008. The use of the Internet turned out to improve bank profitability after controlling for total assets, GDP growth rate, net interest margin, number of employees, equity ratio and loan-loss reserves.

Keywords: Internet, bank profitability, panel data, panel GMM

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1 Introduction

We have witnessed the fast development of the Internet, deeply penetrating our daily life. It has also influenced the economic environment. The Internet increased cross-border trade (Freund and Weinhold, 2004), service trade (Choi, 2010), and foreign direct investment (Choi, 2003). Furthermore, the Internet affected macroeconomic variables. Yi and Choi (2005) found that the use of the Internet led to low inflation through cost reduction, etc. Choi and Yi (2009) found that the Internet contributes to economic growth by knowledge spillover.

Several previous researchers used an Internet banking-adoption dummy in analyzing the impact of the Internet on bank profitability. Delgado et al. (2007), DeYoung et al. (2007), and Hernando and Nieto (2007) found a positive effect of the Internet on bank performance, but DeYoung (2005) found the opposite result.

In contrast, Holden and El-Bannany (2004) showed that automated teller machines (ATMs) increased return on assets (ROA). Nevertheless Kondo (2010) found that ATM usage does not influence bank profits in Japan. Choi and Yi (2011) found that the Internet improves bank profitability by utilizing country-level panel data on 11 OECD countries from 1990 to 2005. The limitation of Choi and Yi (2011) is that only a representative bank data in a country is used and thus data on individual banks are not used.

In our paper, however, bank-level panel data on individual commercial banks of 58 countries are used to analyze the effect of the Internet on bank performance. In section 2, we set up a simple bank-profitability equation incorporating the number of Internet users as an explanatory variable. Section 3 presents estimation results for the bank-profitability equation. Section 4 concludes the paper.

2 Model

To analyze the impact of the Internet on bank profitability, we set up a bank profitability equation,

$$\begin{aligned} ROA_{it}^{j} = {} & \beta_0 + \beta_1 \log(Internet_t^{j}) + \beta_2 \log(asset_{it}) + \beta_3[\log(asset_{it})]^2 \\ & + \beta_4 \text{margin}_{it} + \beta_5 \log(employees_{it}) + \beta_6 equity_{it} \\ & + \beta_7 \log(loan\ \ loss\ reserves_{it}) + u_{it} \end{aligned} \tag{1}$$

where $u_{it} = \eta_i + \nu_t + \varepsilon_{it}$, η_i is an individual (bank) effect, ν_t is a time effect, j denotes country, and ε_{it} is independently and identically distributed among countries and years. ROA_{it}^{j} is the return on assets (ROA, %) at commercial bank i of country j and year t; $Internet_t^{j}$ is the Internet users per 100 people of country j and year t[1]; *asset* is the total assets in thousand US dollars; *margin* represents the net interest margin, which is defined as the net interest income expressed as a percentage of total earning assets; *employees* is the number of employees divided by total assets. *Equity* represents the equity ratio, defined as equity expressed as a percentage of total assets. *Loan loss reserves* is defined as a percentage of gross loans and indicates how much of the total portfolio has been provided for but not charged off.

The coefficient of Internet is expected to be positive, as it may contribute to cost reduction and bank accessibility through the Internet. Both log(asset) and $[\log(asset)]^2$ are included as explanatory variables to consider the possible presence of optimal asset size. Greater net interest margin can have a positive effect on bank profitability. A large number of *employees* relative to total assets, incurring high cost, are expected to have a negative impact on bank profitability. A higher *equity* ratio implies a sound financial condition and effective pursuit of business opportunity, and thus contributes to higher profitability (Athanasoglou et al., 2008). Higher *loan loss reserves* per gross loan is associated with lower profit.

[1] As bank-specific Internet data are not available, country-specific Internet data are used as a proxy for bank-specific Internet data.

3 Data and empirical results

We extracted the 1,000 biggest commercial banks worldwide ranked by total assets from Bankscope. Of those, 888 commercial banks of 58 countries from 1996 to 2008 were actually used in estimating the effect of the Internet on bank profitability. Data on ROA, total assets, net interest margin, the number of employees, equity ratio, and loan-loss reserves per gross loans are from Bankscope. The number of Internet users per hundred people is from World Development Indicator (WDI) online on the World Bank homepage. Descriptive statistics are listed in Table 1.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
roa	7,194	0.84	2.93	-100.41	36.57
Internet	7,194	39.15	26.10	0.1	90
asset	7,194	60,100,000	196,000,000	4,096	3,070,000,000
margin	7,194	3.43	3.08	-41.73	45.34
employees	4,090	10,867	34,015	1	511,425
equity	4,090	8.36	7.51	-129.21	94.82
loan loss reserves	4,090	2.90	4.09	0.01	83.33

Robust standard errors from Huber/White/sandwich estimator are used in all the regressions (Huber 1967, White 1980). Clustering bias from country specific Internet variable is corrected in the estimation. Table 2 lists the estimation results for the bank profitability equation. The p-values of the Hausman test statistics in equations (a) and (b) are both 0.000. The Hausman test shows that the null hypotheses that random effects would be consistent and efficient are rejected at the 1% significance level. Thus, fixed-effects models are employed through all the equations (a) to (f), as fixed effects would certainly be consistent. Multicollinearity turns out to be nonexistent through the variance inflation factor test.

Estimation results from fixed effects are listed in equations (a) and (b). The estimated coefficient of Internet is 0.353 and significant at the

1% level. When the number of the Internet users per hundred people increases by 1%, the ROA increases by 0.00353 percentage points. This implies that the Internet contributes to the increase in ROA due to cost reduction and enhanced bank accessibility through the Internet. The estimated coefficients of both log(asset) and $[\log(\text{asset})]^2$ are insignificant. The coefficient of net interest margin (*margin*) is 0.972 and significant at the 5% level. The higher the net interest margin is, the higher the ROA becomes.

To check robustness, we added three more explanatory variables in equation (b). They are the number of employees divided by total assets (*employees*), equity ratio (*equity*), and loan-loss reserves divided by gross loans (*loan loss reserves*). After including these three explanatory variables, the coefficient of the Internet is 0.255 and significant at the 5% level. The estimated coefficients of both log(asset) and $[\log(\text{asset})]^2$ are 5.114 and -0.159 and significant at the 5% level. The coefficient of net interest margin (*margin*) is 0.994 and significant at the 1% level. The coefficient of *employees* is -0.296 and significant at the 1% level. This means that as the number of employees in the bank increases, the ROA becomes smaller. The coefficient of *equity* is 0.165 and significant at the 5% level. This implies that as the equity ratio increases, bank profitability improves.[2] The coefficient of loan-loss reserves as a percentage of gross loans (*loan loss reserves*) is -0.739 and significant at the 1% level. As loan-loss reserves relative to gross loans increase, the ROA becomes smaller.[3]

The above estimation assumes that all the explanatory variables are exogenous. As a robustness check, we employed GMM estimation. It is possible that ROA influences the explanatory variables. All the explanatory variables are assumed to be endogenous rather than exogenous. The possible endogeneity problem can be resolved by GMM estimation. As country-specific Internet data are used as a proxy for bank-specific Internet data, measurement error problem can occur. The measurement error problems also can be corrected by GMM estimation.

Columns in (c) to (f) list the regression results from GMM estima-

[2] Goddard et al. (2004) and Athanasoglou et al. (2008) obtained the same positive relationship between capital-asset ratio and bank profitability.

[3] Athanasoglou et al. (2008) obtained the same negative relationship between the loan-loss-reserves ratio and bank profitability.

tion. The results become more significant than those from (a) and (b). All the estimated coefficients of explanatory variables from (c) to (f) are

Table 2. The Internet and Bank Profitability[1,2]

	(a)	(b)	(c)	(d)	(e)	(f)
	Fixed effects		Panel GMM[3,4]			
VARIABLES	roa	roa	roa	roa	roa	roa
Log(Internet)	0.353***	0.255**	0.887***	0.700***	0.836***	0.632***
	(0.106)	(0.104)	(0.084)	(0.105)	(0.079)	(0.090)
Log(asset)	0.438	5.114**	3.954***	3.429***	3.867***	4.050***
	(0.926)	(2.342)	(0.645)	(0.490)	(0.627)	(0.464)
[Log(asset)]^2	-0.009	-0.159**	-0.130***	-0.115***	-0.124***	-0.132***
	(0.025)	(0.067)	(0.022)	(0.017)	(0.021)	(0.015)
Margin	0.972**	0.994***	1.022***	0.972***	1.148***	1.069***
	(0.433)	(0.224)	(0.042)	(0.057)	(0.014)	(0.049)
Log(employees)		-0.296***		-0.248***		-0.288***
		(0.100)		(0.069)		(0.064)
Equity		0.165**		0.034***		0.050***
		(0.071)		(0.007)		(0.008)
Log(loan-loss reserves)		-0.739**		-0.239**		-0.237***
		(0.186)		(0.090)		(0.084)
Constant	-8.343	-47.355**				
	(9.402)	(20.720)				
R-squared	0.342	0.588	0.468	0.513	0.452	0.517
Hansen *J*-statistics			9.784	6.653	11.427	8.357
			[0.201]	[0.466]	[0.248]	[0.499]
Degree of freedom			7	7	9	9
Observations	7,194	4,090	2,978	2,618	2,978	2,618
Number of banks	888	677	534	472	534	472

Notes:

1. ** and *** indicate significance at the 5% and 1% level, respectively.
2. Robust standard errors from Huber/White/sandwich estimator are in parentheses. Cluster ing bias from country specific Internet variable is corrected in the estimation.
3. P-values are in brackets.
4. Instruments employed are as follows.

(c) Log(Internet)$_{-1}$, Log(Internet)$_{-2}$, Log(asset)$_{-1}$, Log(asset)$_{-2}$, [Log(asset)]$^2_{-1}$, [Log(asset)]$^2_{-2}$, Margin$_{-1}$, Margin$_{-2}$, Log(employees)$_{-2}$, Equity$_{-2}$, Log(loan-loss reserves)$_{-2}$

(d) Log(Internet)$_{-1}$, Log(Internet)$_{-2}$, Log(asset)$_{-1}$, Log(asset)$_{-2}$, [Log(asset)]$^2_{-1}$, [Log(asset)]$^2_{-2}$, Margin$_{-1}$, Margin$_{-2}$, Log(employees)$_{-1}$, Log(employees)$_{-2}$, Equity$_{-1}$, Equity$_{-2}$, Log(loan-loss reserves)$_{-1}$, Log(loan-loss reserves)$_{-2}$

(e) ROA$_{-1}$, ROA$_{-2}$, Log(Internet)$_{-1}$, Log(Internet)$_{-2}$, Log(asset)$_{-1}$, Log(asset)$_{-2}$, [Log(asset)]$^2_{-1}$, [Log(asset)]$^2_{-2}$, Margin$_{-1}$, Margin$_{-2}$, Log(employees)$_{-2}$, Equity$_{-2}$, Log(loan-loss reserves)$_{-2}$,

(f) ROA$_{-1}$, ROA$_{-2}$, Log(Internet)$_{-1}$, Log(Internet)$_{-2}$, Log(asset)$_{-1}$, Log(asset)$_{-2}$, [Log(asset)]$^2_{-1}$, [Log(asset)]$^2_{-2}$, Margin$_{-1}$, Margin$_{-2}$, Log(employees)$_{-1}$, Log(employees)$_{-2}$, Equity$_{-1}$, Equity$_{-2}$, Log(loan-loss reserves)$_{-1}$, Log(loan-loss reserves)$_{-2}$

significant at the 1% level except that of loan-loss reserves in (d). Estimated coefficients of the Internet range from 0.632 to 0.887.

To sum up, the Internet turned out to increase bank profitability across all regressions. This means that the development of the Internet may be associated with decreases in banking-industry costs and increases in revenue by enhancing clients' bank accessibility.

4 Conclusion

It is hypothesized that the Internet has a positive impact on bank profitability, because the implementation of the Internet in the banking industry can reduce bank costs and increase customers' accessibility to banking services. A bank profitability equation is estimated by using global bank-level panel data of 58 countries from 1996 to 2008. The use of the Internet turned out to improve bank profitability after controlling for total assets, net interest margin, number of employees, equity ratio and loan-loss reserves. However, whether the profit increase with Internet use results from cost reduction or sales increase will be our future research with more relevant Internet data. The policy implication is that in the banking industry, investment in the Internet is desirable to improve bank profitability.

References

Athanasoglou, P.P., Brissimis, S.N. and Delis, M.D., "Bank-specific, industry-specific and macroeconomic determinants of bank profitability," *Journal of International Financial Markets, Institutions and Money* 18, 2008, 121–136.

Choi, C., "Does the Internet stimulate inward FDI?" *Journal of Policy Modeling* 25, 2003, 319–326.

Choi, C., "The effect of the Internet on service trade," *Economics Letters* 109, 2010, 102–104.

Choi, C. and Yi, M.H., "The effect of the Internet on economic growth: Evi-

dence from cross-country panel data," *Economics Letters* 105, 2009, 39–41.

Choi, C. and Yi, M.H., "Does the Internet Affect Bank Profitability?: Evidence from Cross-Country Panel Data," *Journal of Finance and Knowledge Studies* 9(1), 2011, 119-129.

Delgado, J., Hernando, I. and Nieto, M. J., "Do European primarily Internet banks show scale and experience efficiencies?" *European Financial Management Journal* 13, 2007, 643–671.

DeYoung, R., "The performance of Internet-based business models: Evidence from the banking industry," *Journal of Business* 78, 2005, 893–947.

DeYoung, R., Lang, W.W. and Nolle, D.L., "How the Internet affects output and performance at community banks," *Journal of Banking and Finance* 31, 2007, 1033–1060.

Freund, C. and Weinhold, D., "The effect of the Internet on international trade," *Journal of International Economics* 62, 2004, 171–189.

Goddard, J., Molyneux, P. and Wilson, J.O.S., "The profitability of European banks: A cross-sectional and dynamic panel analysis," *Manchester School* 72, 2004, 363–381.

Hernando, I. and Nieto, M.J., "Is the Internet delivery channel changing banks' performance? The case of Spanish banks," *Journal of Banking and Finance* 31, 2007, 1083–1099.

Holden, K. and El-Bannany, M., "Investment in information technology systems and other determinants of bank profitability in the UK," *Applied Financial Economics* 14, 2004, 361–365.

Huber, P.J., The behavior of maximum likelihood estimates under nonstandard conditions, in *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability* Vol. 1, University of California Press, Berkeley, CA, 1967, 221–233.

White, H., "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity," *Econometrica* 48, 1980, 817–830.

Yi, M.H. and Choi, C., "The effect of the Internet on inflation: Panel data evidence," *Journal of Policy Modeling* 27, 2005, 885–889.

Data

Bankscope, <https://bankscope2.bvdep.com>
World Development Indicators on-line, World Bank, <http://data.world-bank.org/data-catalo