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Banking Crises and Diffusion of Information and Communication Technologies

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Abstract

In this study, the relationship between Information and Communication Technologies (ICT) penetration and banking crises is investigated using a panel logit model of the incidence of banking crises. The period under investigation is between 1990 and 2011, and the largest sample of the study consists of 182 countries. For robustness, four ICT indicators and bivariate models, as well as multivariate models, are used. Our empirical investigation suggests that the diffusion of ICT technologies increases the possibility of banking crises, controlling for other factors that may cause banking crises. Among ICT indicators used in the study, the number of fixed broadband subscriptions per 100 people has the largest effect on the probability of a banking crisis. This paper contributes to the literature on banking crises by presenting the first empirical evidence on the relationship between ICT penetration and banking crises.

Keywords

Banking Crises, information and communication technologies, panel study.

JEL Classification: G01, O33, C23

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1. Introduction

The diffusion of information and communication technologies (ICT) has affected almost all sectors in the world economy. The banking sector has been greatly affected by adoption of ICT and is an ICT-incentivized and dependent sectors. Consequently, the use of ICT has profoundly altered the banking service activities.

ICT products have begun to be used intensively in every area of the banking industry ranging from account opening and maintenance, credit evaluation, automated teller machines and electronic funds transfers to internet banking and mobile banking.

The influence of ICT on the banking sector appears in the literature both in case studies and empirical studies. Evidence from previous empirical studies indicates that the utilization of ICT in the banking sector help banks reduce transaction costs, overhead expenses, the cost of customer service delivery and operational costs (Classens et al., 2001; Simpson, 2002; Kozak, 2005), as well as improve efficiency, productivity, revenue, profitability, portfolio management, risk control and risk management and securitization (Simpson, 2002; Furst et al., 2002; Kozak, 2005; De Young et al., 2007; Casolaro and Gobbi, 2007; Cyree et al., 2009). ICT in the banking sector also enhances the effectiveness of services offered to customers, the quality and speed of customer service delivery, the quality, variety and marketing of financial services and instruments, customer satisfaction (Berger, 2003; Aliyu and Tasmin, 2012; Al-Azzawi and Altmimi, 2015) and the access of poor people in rural areas to financial services (Classens et al., 2001).

One of the least studied effects of ICT on the banking sector is the impact of ICT on banking crises. The effect of ICT on the banking sector is theoretically ambiguous. On the one hand, the use of ICT can decrease the incidence of banking crises because ICT can improve data and information management and the forecasting capabilities of central banks, enhance market insight, facilitate the effective management of financial stability and help them to prevent, manage, respond to and resolve banking crises and financial crises in a more effective way. ICT can promote financial stability because, with the use of ICT in their operations, the central bank and other regulatory and supervisory authorities can control markets, conduct risk evaluations and assessments, detect risks and potential problems, identify and evaluate systemic risk and take action against threats before they cause problems in more dramatic ways. Moreover, the use of ICT technologies causes regulatory and supervisory authorities to observe the soundness of banks more effectively and take precautions against banks carrying risky portfolios and involving moral hazard problems from the start (Cartens and Jacome, 2005; Wilkinson et al., 2010; Galac, 2010).

On the other hand, ICT can increase the incidence of banking crises. Globalization and ICT penetration help local finance organizations become global players and magnify financial system complexity, which make central banks or regulatory authorities unable to fully control and monitor markets and market agents. Under these circumstances, minor liquidity problems can be aggravated and spread globally, as happened in the recent global financial crises of 2008 (Visco, 2013).

The use of ICT in the banking sector can also exaggerate informational asymmetries among depositors and accelerate bank runs. In a classical model of a bank run, depositors hear rumours or bad news about the bank at which they deposited and queue up in front of the bank that is believed to be in a bad position to withdraw their deposits, because banks use a a first come, first served principle (Diamond and Dybvig, 1983). A bank run can turn into a banking panic or banking crises if the depositors run on all banks in the banking system without differentiating between sound and problematic banks (Demirguc-Kunt and Detragiache, 2002). With technological improvements in the banking sector, such as internet and mobile banking, during a bank run, depositors no longer need to queue in front of the bank – they can just electronically transfer their deposits to banks considered to be more financially stable. Thus, technological developments in banking can increase the speed of withdrawals, shorten the survival time of failing banks and shorten the time span between rumours and a bank run. A solvent but illiquid bank can be subject to a bank run more easily than before, and a bank run can also more easily turn into a banking panic and banking crisis than before (Janson, 2009; He and Manela, 2016).

This paper empirically tests the impact of ICT on banking crises to shed light on the theoretical discussions mentioned above. The next section presents the data and methodology, while section 3 provides the estimation results. The final section contains the conclusions.

2. Data and Methodology

The probability of banking crises is estimated using a logit model and unbalanced data. The model is based on the previous studies of Demirguc-Kunt and Detragiache (1997) and Cihak et al. (2012). The influence of ICT penetration on banking crises is analysed using four ICT indicators. The period under investigation is between 1990 and 2011. The largest sample of the study consists of 182 countries.[1] The following random effect logit model is estimated:

$$\Pr ob(y_{it}=1)=\frac{\exp(x'_{it}\beta+\alpha_i)}{1+\exp(x'_{it}\beta+\alpha_i)}\equiv\Lambda(x'_{it}\beta+\alpha_i),$$

with its largest presentation:

$$x'_{it}=\beta_1+\beta_2 ICT_{it}+\beta_3 GDPGRO_{it}+\beta_4 DEPR_{it}+\beta_5 DCPGRO_{it}+\beta_6 CORR_{it}$$

$y_{it}=1$ when a banking crisis takes place in *i*-th country at time *t*, otherwise $y_{it}=0$. The country-specific random effect for the *i*-th country is represented by α_i.

The dependent variable of our model is a dummy variable for a crisis and is equal to one if a country experienced a systemic banking crisis at any point during the period of study as defined by Cihak et al. (2012), otherwise it is equal to zero.

Our main explanatory variable of interest in this study is ICT penetration. ICT penetration in the above models is represented by four variables. The definitions and data sources for ICT penetration variables are given in Table 1. As explained in the first section of the study, the expected sign of the coefficient on ICT variables is ambiguous.

Table 1 List of ICT Variables

Variables	Definition	Source
INTU	The internet users per 100 people.	International Telecommunication Union
SIS	Secure internet servers per 1 million people.	Netcraft (www.netcraft.com)
FBS	Fixed broadband subscriptions per 100 people.	International Telecommunication Union
MCS	Mobile cellular subscriptions per 100 people.	International Telecommunication Union

In addition to the ICT variables, we introduced four more determinants of banking crises suggested by previous studies (Demirguc-Kunt and Detragiache, 1997; Cihak et al., 2012) to analyse the association between banking crises and ICT penetration: annual GDP growth rate (GDPGRO), depreciation rate (DEPR), percentage change in the ratio of domestic credit to the private sector (DCPGRO) and control of corruption from the Worldwide Governance Indicators (WGI). The definitions and data sources of the other independent variables are given in Table 2 below.

[1] The sample includes the following countries: Afghanistan, Albania, Algeria, Andorra, Antigua and Barbuda Angola, Argentina, Armenia, Aruba, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bermuda, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Central African Rep., Chad, Chile, China, Colombia, Comoros, Congo, Costa Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Faroe Islands, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Korea Republic, Kuwait, Kyrgyzstan, Lao P.D.R., Latvia, Lebanon, Lesotho, Liberia, Libya, Liechtenstein, Lithuania, Luxembourg, Macao, Macedonia, Madagascar, Malawi, Maldives, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Micronesia, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Palestinian Authority, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Rwanda, Saint Lucia, Samoa, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovakia, Slovenia, Solomon Islands, South Africa, Spain, Sri Lanka, Sudan Republic, Suriname, Swaziland, Swe-den, Switzerland, Syrian Arab Republic, Taiwan, Tajikistan, Thailand, Tanzania, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vanuatu, Venezuela, Viet Nam, Yemen, Zambia, Zimbabwe.

Table 2 List of Independent Variables

Variables	Definition	Source
GDPGRO	GDP growth (annual %)	WDI
DEPR	The rate of depreciation of local currency against the us dollar.	WDI
DCPGRO	Percentage change in domestic credit to private sector (% of GDP)	WDI
CORR	Control of corruption	WGI Data Set of World Bank

GDPGRO is the annual growth rate of the Gross Domestic Product. Adverse macroeconomic shocks impair the balance sheets of banks by increasing the share of non-performing loans and thus reducing the value of the banks' assets relative to their liabilities. In our model, the impact of deteriorating macroeconomic shocks on banking crises is captured by the GDP growth rate. The relationship between the GDP growth rate and banking crises is therefore expected to be negative in our model.

DEPR is the rate of deprecation of the local currency against the US dollar. It is used in our model to test whether banking crises are related to foreign exchange risk. Currency crashes often lead to banking crises (Kaminsky and Reinhart, 1999). Unexpected currency depreciation can adversely affect the banking sector, which is highly exposed to exchange rate risk and can carry currency-mismatched portfolios (Davis and Karim, 2008). Currency mismatch occurs when banks borrow foreign currency denominated funds from abroad and extend credit in the local currency. If the banks do not hedge themselves against currency risk, they can be faced with failure in the case of sudden currency depreciation. Even if banks do not carry currency-mismatched portfolios, they can still face problems if their customers have currency mismatched portfolios. Thus, a positive relationship between the rate of depreciation of the local currency against the US dollar and banking crises is expected.

DCPGRO is the percentage change in the ratio of domestic credit to the private sector to GDP. Although credit booms are not necessarily followed by banking crises, most major recent banking crises have been preceded by credit booms and busts. Dell'Ariccia et al. (2012) report that one third of booms in their sample were followed by a banking crisis within three years of ending. Rapid credit growth periods tend to be accompanied by loosening lending standards. During these periods, banks finance riskier projects and carry riskier portfolios. Lending booms that result in banking crises are generally those that lead to sharp rises in equity, asset and real estate prices. The end of credit booms is triggered by a sharp fall in prices and stagnant economic conditions, thus causing banking crises. In our model, the expected relationship between the rate of growth of domestic credit to the private sector as a percentage of GDP and banking crises is negative.

CORR is derived by multiplying the Control of Corruption variable from the World Governance Indicators by −1. The control of corruption variable is scaled between −2.5 to 2.5, as higher scores correspond to lower corruption and multiplying by −1 clarifies this so that the higher the score, the higher the corruption, thus facilitating interpretation.

Corrupt environments form the roots of banking crises. Corrupt countries tend to have a highly corrupt banking sector, which displays excessive risk-taking behaviour (Park, 2012). Under corrupt and mismanaged banking systems, firms that are not creditworthy receive credit through their corrupt ties with bank and government officials (Levine, 2004). Banks are also inclined to raise credit above the optimal level (Mehrez and Kaufmann, 2000) and low-rated banks are able to borrow foreign currency denominated funds with implicit or explicit public guarantees for bank liabilities (Radelet and Sachs, 1998). Corruption reduces official supervisory power and monitoring and thus the soundness of the banking system. We therefore expect that countries experiencing more corrupt practices are more likely to face banking crises.

3. Estimation Results

Bivariate estimation results for four different ICT indicators are presented in Table 3. Table 3 has four columns (models), and as such we model each ICT indicator separately in the different equations because modelling different ICT indicators in the same equation may potentially cause multicollinearity problems. The marginal effects are presented in Table 4.

Table 3 Random Effect Logistic Bivariate Model Estimation Results

	Model 1	Model 2	Model 3	Model 4
Constant	**-3.58252**	**-11.9245**	**-6.97377**	**-3.22703**
P-value	0.000	0.000	0.000	0.000
INTU	**0.016717**			
P-value	0.000			
SIS		**0.004627**		
P-value		0.000		
FBS			**0.179078**	
P-value			0.000	
MCS				**0.041158**
P-value				0.000
Num. of Obs.	3618	1736	1776	1769
Num. of Country	200	199	196	183
Log likelihood	-887.295	-283.855	-298.815	-268.862
Wald chi sq. statistic	30.16	82.23	67.7	41.4
Wald chi sq. P-value	0.000	0.000	0.000	0.000
LR test statistic	125.01	228.67	150.54	167.74
LR test P-value	0.000	0.000	0.000	0.000
McKelvey & Zavoina's R-sq.	0.0258	0.0795	0.203	0.204

Table 4 Bivariate Model Marginal Effects

	Model 1	Model 2	Model 3	Model 4
INTU	**0.000949**			
P-value	0.000			
SIS		**0.000965**		
P-value		0.018		
FBS			**0.005612**	
P-value			0.000	
MCS				**0.0010495**
P-value				0.000

The findings are robust across the different ICT indicators. The estimated coefficients of INTU, SIS, FBS and MCS variables are positive and statistically significant at the 1% level in all models in the bivariate model estimations in Table 3 and in the bivariate model marginal effects in Table 4. The bivariate estimation and marginal effects results suggest that there is a strong positive correlation between ICT indicators and the probability of banking crises. Among the ICT indicators used in the study, fixed broadband subscriptions per 100 people has the largest effect on the probability of banking crises and the highest McKelvey and Zavoina's R-squared values are in Models 3 and 4. Moreover, the Wald chi-squared statistics show that each model is statistically significant as a whole, and the LR test statistics prefer the panel model against the pooled model as appropriate in each model.

To test the validity and robustness of our results, we included a number of control variables suggested by previous studies (Demirguc-Kunt and Detragiache, 1997; Cihak et al., 2012). Multivariate estimation results are presented in Table 5. Table 5 includes four columns (models) for each ICT indicator, and the marginal effects are presented at Table 6.

All of the coefficients of the INTU, SIS, FBS and MCS variables are positive and statistically significant at the 1% level in all models in the multivariate model estimations. The multivariate estimation results suggest that there is a strong positive correlation between ICT indicators and the probability of banking crises. In other words, the results indicate that the diffusion of ICTs has increased the probability of banking crises. Among ICT indicators used in the study, the number of fixed broadband subscriptions per 100 people has the largest effect on the probability of banking crises. Concerning the marginal effects of multivariate estimations, one unit increase in INTU, SIS, FBS and MCS leads to an increase in the probable occurrence of a banking crisis by 0.00125, 0.00009, 0.00460, and 0.00031 units, respectively. The diagnostic statistics also reveal that each model as a whole is statistically significant, and the panel model is chosen as the appropriate model for all models. The highest explanatory power is in Model 3.

Regarding the other variables, the coefficient for real GDP growth is negative and statistically significant in all models, indicating that negative macroeconomic shocks increase the incidence of banking crises. Similarly, the coefficient of the DCPGRO variable is negative and statistically significant at the 1% level in all models, suggesting that lending boom–bust cycles increase the probability of banking crises. The coefficient for the DEPR variable is not significant in any model. The coefficient for the CORR variable is positive and significant in two models, indicating that an increase in corruption leads to a rise in the incidence of banking crises.

Table 5 Random Effect Logistic Multivariate Model Estimation Results

	Model 1	Model 2	Model 3	Model 4
Constant	**-13.1924**	**-9.4275**	**-10.4247**	**-12.7937**
P-value	0.000	0.000	0.000	0.000
INTU	**0.11298**			
P-value	0.000			
SIS		**0.00668**		
P-value		0.000		
FBS			**0.32701**	
P-value			0.000	
MCS				**0.02960**
P-value				0.000
GDPGRO	**-0.25036**	**-0.21770**	**-0.16606**	**-0.25084**
P-value	0.000	0.000	0.005	0.000
DEPR	**0.00437**	**-0.00223**	**0.00055**	**0.00630**
P-value	0.320	0.709	0.913	0.133
DCPGRO	**-0.07733**	**-0.08241**	**-0.08308**	**-0.08249**
P-value	0.0000	0.0010	0.0000	0.0000
CORR	**1.56931**	**1.06763**	**1.81720**	**0.29679**
P-value	0.016	0.143	0.010	0.596
Num. of Obs.	1575	1301	1321	1597
Num. of Country	167	165	165	167
Log likelihood	-119.944	-101.001	-104.546	-131.405
Wald chi sq. statistic	56.25	38.99	46.82	53.01
Wald chi sq. P-value	0.000	0.000	0.000	0.000
LR test statistic	135.98	144.73	120.74	151.25
LR test P-value	0.000	0.000	0.000	0.000
McKelvey & Zavoina's R-sq.	0.9878	0.993	0.9942	0.9867

Table 6 Multivariate Model Marginal Effects

	Model 1	Model 2	Model 3	Model 4
INTU	**0.00125**			
P-value	0.000			
SIS		**0.00009**		
P-value		0.000		
FBS			**0.00460**	
P-value			0.000	
MCS				**0.00031**
P-value				0.000
GDPGRO	**-0.00278**	**-0.00301**	**-0.00233**	**-0.00268**
P-value	0.000	0.001	0.007	0.000
DEPR	**0.00004**	**-0.00003**	**0.00001**	**0.00006**
P-value	0.326	0.709	0.913	0.146
DCPGRO	**-0.00086**	**-0.00114**	**-0.00117**	**-0.00088**
P-value	0.0000	0.0000	0.0000	0.0000
CORR	**0.01746**	**0.01480**	**0.02559**	**0.00317**
P-value	0.016	0.144	0.010	0.596

4. Conclusion

The influence of ICT diffusion on banking crises is investigated using a panel logit model of the incidence of banking crises in 182 countries during the period between 1990 and 2011. The bivariate estimation results suggest that there is a strong positive correlation between ICT indicators and the probability of banking crises. The results were robust for the different ICT variables. For further robustness, multivariate models were estimated. The multivariate estimation results also suggested that the diffusion of ICT has increased the probability of banking crises. Among ICT indicators used in the study, the number of fixed broadband subscriptions per 100 people has the largest effect on the probability of a banking crisis.

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