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BANGKO SENTRAL NG PILIPINAS

Abstract

An Empirical Analysis of the Effect of ICT and E-Government on Financial Inclusion[a]

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The benefits of financial inclusion on human and economic development are well-documented in the literature. Many countries and organizations have developed financial inclusion policies, and strategies that often include increasing access to ICT platforms and infrastructure. This paper empirically studies the relationship of financial inclusion with ICT and e-government. The results suggest that, in general, higher level of ICT and e-government is associated with greater financial inclusion. However, this relationship varies across dimensions of financial inclusion and across forms of ICT and e-government. We also find that ICT and e-government are more strongly associated with usage of financial services than with availability of or access to such services. In addition, while the availability of online services promotes financial inclusion, developing crucial ICT infrastructure has greater marginal effect. The relationship of financial inclusion with ICT and e-government is also stronger in lower-income countries than it is in higher-income ones.

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Introduction

Financial inclusion refers to the ability of households and businesses to access and afford financial products and services (Demirguc-Kunt et al., 2017; Chatterjee, 2020) with the goal of helping them meet financial obligations and attain long-term financial goals. For firms, financial inclusion facilitates business growth and their potential to provide employment opportunities. Financial inclusion encourages savings, facilitates remittance, and promotes economic activity especially among women entrepreneurs (Misra, 2017). An appropriate mix of good quality services that are tailor-fit to meet the needs of vulnerable sectors (BSP, n.d.) allows financial inclusion to have far-reaching impact on broader development outcomes such as economic growth (Kim et al., 2018; Sethi and Acharya, 2018), poverty alleviation, and income equality (Levine, 2005; Beck et al., 2007; Demirguc-Kunt et al., 2017; Park and Mercado, 2018). [1]

Several studies have examined what factors drive financial inclusion. In general, the empirical literature categorizes the determinants of financial inclusion into two: (i) micro-level variables, such as socio-demographic and other household characteristics, and (ii) macro-level indicators like good governance and institutions. For the former, socioeconomic variables have been shown to influence the demand for financial products and services. Using household data in Africa, Zins and Weill (2016) showed that being male, having more education, and higher income are associated with greater financial inclusion. Also, using African data, Mhalanga and Denhere (2020) found evidence that being white and married positively affect financial inclusion. In India, financial literacy and clients' trust towards banks and lending institutions are important determinants of financial inclusion (Vaid et al., 2020).

At the macro-level, higher income and clear government regulations promote financial inclusion (Gebrehiwot and Makina, 2019; Eldomiaty et al., 2020). Using a cross-country panel, Eldomiaty et al. (2020) found that the quality of governance and institutions, particularly in terms of control of corruption, government effectiveness, and political stability help promote financial inclusion. Meanwhile, an emerging theme in promoting financial inclusion is the role of information and communication technology (ICT) infrastructure[2] and e-government.

There are several channels through which ICT and e-government can enhance financial inclusion. First, ICT reduces the transaction costs of availing financial services, particularly addressing the scarcity of physical banks in rural areas with accessibility problems (Sarma and Pais, 2011; Chatterjee, 2020). Second, ICT can lower the cost of providing financial services for banks and financial institutions, making them more affordable for consumers from marginalized sectors such as the low-income mass market. Also, ICT allows for cost reduction in information gathering, making it easier to determine the credit worthiness of a borrower. This is particularly useful for small businesses who are often excluded from formal financing because creditors lack access to information on their true financial state (Alshubiri et al., 2019; Earth Institute, 2016). This can also help lower the cost of borrowing, which is a financial inclusion deterrent among small businesses (Oshora et al., 2021). As for e-government, one way in which it enhances financial inclusion is when subsidies to the poor are disbursed electronically, increasing the share of the low-income population with bank accounts (World Bank, 2012).

These prompted policy makers and development organizations to include enhancing ICT infrastructure and digitalization in their financial inclusion strategies. For instance, the Alliance for Financial Inclusion (2022) urges its members to integrate digital

[1] See Duvendack and Mader (2020) and Ozili (2021) for a review of the empirical evidence on the benefits of financial inclusion.
[2] ICT infrastructure refers to digital telephone network, mobile phones, internet capability, internet servers, fixed broadband, and other technologies (Pradhan et al., 2018).

financial services in their national financial inclusion strategies (NFIS). Columbia University's Earth Institute, in its report on utilizing ICT to meet the Sustainable Development Goals (SDG), encouraged the enhancement of access to ICT in boosting financial inclusion. Many countries with an NFIS also have some form of digitalization or ICT development in their strategies.

The objective of this study is to empirically examine how financial inclusion is affected by the level of ICT development and e-government.[3] It adds to the existing empirical literature on what drives financial inclusion which is currently dominated by macroeconomic, governance, socioeconomic, and demographic factors. There are a few studies on the effect of ICT, but they focus on narrow components of ICT, such as mobile access (Gebrehiwot and Makina, 2019). This study's contribution is a systematic test of the effect of a more general measure of ICT and e-government on financial inclusion. Further, the study disaggregates financial inclusion and ICT into different components and tests if the relationship, if any, varies across these components. From a policy perspective, the study can also lend credence to the financial inclusion strategies of several development organizations and countries, part of which is promoting ICT and digitalization to enhance financial inclusion.

Using cross-country panel data, we show that higher levels of ICT and e-government are associated with greater financial inclusion. However, the relationship is nuanced across dimensions of financial inclusion and across forms of ICT and e-government. Moreover, our results show that the relationship varies across country income levels.

The paper is organized as follows. The data and methodology section describes the variables, data sources and quantitative techniques. The results section discusses the principal component analysis and regression analysis and methodology. The conclusion section summarizes and offers policy implications.

Data and Methodology

Defining and Measuring Financial Inclusion

Financial inclusion has been defined in different ways in the literature. Amidzic et al. (2014) provide one of the most often-quoted and broadest definitions: financial inclusion is a general economic state in which individuals and firms can access basic financial services. There are two classifications of financial exclusion: voluntary or involuntary (World Bank, 2014). Those who opt for voluntary financial exclusion are individuals with no need for financial services, or do not access financial services due to cultural or religious reasons. Meanwhile, involuntary exclusion includes those with insufficient income or cannot access financial services because of discrimination, lack of information, and other market barriers. In this study, we use the general definition of financial inclusion, so we do not distinguish between voluntary and involuntary exclusion.

While there are merits to focus on the involuntarily excluded, we argue that general financial exclusion is the appropriate approach and motivation. The benefits of financial inclusion are well documented in the literature and these benefits accrue even to those who are voluntarily excluded. In fact, it is difficult to imagine a situation wherein an individual has absolutely no need for financial services, except perhaps for very young children. In addition, one aspect of involuntary financial exclusion—lack of information—may be tied to voluntary exclusion. Lack of information on the benefits of financial inclusion may cause some individuals to voluntarily exclude themselves from the financial

[3] In this paper, we use *e-government* and *e-governance* interchangeably. Yildiz (2007) and Bernhard and Wihlborg (2014) noted that although there are no universally acceptable definitions that would clearly differentiate these terminologies, the elements of e-government overlap with e-governance.

system, particularly in developing countries (Ozili, 2018). Gender-based voluntary exclusion, specifically among women in areas like Africa, is also high (Zins and Weill, 2016). This is a problem that regulators in developing countries must address (Ozili, 2018).

Selecting Indicators

The measurement of financial inclusion involves two steps: (i) selection of indicators and (2) aggregating the variables. In creating a composite index, authors commonly include indicators that measure two dimensions of financial inclusion—access and usage of financial services (for example, see Chakravarty and Pal, 2010; Amidzic et al., 2014; Mojica and Mapa, 2017; Park and Mercado, 2018). The access dimension refers to the presence of financial services available for use by the general population. It is usually expressed in terms of number of financial service facilities for a given population or land area. However, to realize the benefits of these financial services, it is not enough that they are accessible. They must also be used by consumers. The usage dimension is commonly expressed in terms of the number of financial product/service users per given population.

Camara and Tuesta (2014) proposed an additional dimension which they referred to as barriers to financial inclusion that adversely affect unbanked individuals. These include factors such as distance from one's home to a financial institution, lack of trust in the financial system, cost of opening a bank account, and absence of documents required to access a financial product or service. However, Park and Mercado (2018) argued that including the barriers dimension may not be appropriate because it combines the causes of having and not having financial access thus producing a less clear measure of financial inclusion. We agree with this point, in addition to our observation that these barriers are impediments to being financially included, rather than a measure of financial inclusion.

Table 1 summarizes the indicators under each dimension used in this study. The indicators are similar to Chakravarty and Pal (2010) and Amidzic et al. (2014) but differ from Sarma (2012) and Park and Mercado (2018) particularly on the use of deposit and credit indicators expressed as share to gross domestic product (GDP).

In some countries, although a large fraction of the population may own a bank account, most deposit holders have very small balances so that the ratio of total deposits (or loans) to GDP may provide a more balanced picture. However, in a country with high wealth inequality, a large deposit (or loans)-to-GDP ratio may be driven by the ultra-rich. Given these divergent possibilities, deposit, and credit indicators as share to GDP have been excluded.

Table 1. Dimensions and indicators of financial inclusion

Dimension	Indicators	Variable Name
Access	Number of commercial bank branches per 100,000 adults	*bank_percap*
	Number of ATMs per 100,000 adults	*atm_percap*
	Number of commercial bank branches per 1,000 sq. kms.	*bank_area*
	Number of ATMs per 1,000 sq. kms.	*atm_area*
Usage	Number of deposit accounts with commercial banks per 1,000 adults	*deposit*
	Number of loan accounts with commercial banks per 1,000 adults	*loans*
	Number of depositors with commercial banks per 1,000 adults	*depositors*
	Number of borrowers with commercial banks per 1,000 adults	*borrowers*

In recent years, other financial inclusion indicators such as mobile payment transactions have become available. Since these new indicators are not available for many

countries, including them in this study will drastically reduce the sample of countries and periods in our panel data.

Alternatively, there are common measures of financial inclusion that are suitable since other forms of financial inclusion depend on or overlap with these indicators. For example, some mobile payment applications would require access to a bank account or those with an online commercial bank account are captured in the data on the number of deposit accounts and number of depositors. Also, two of the common indicators (i.e., number of ATMs and number of commercial bank branches) are used in monitoring achievements under SDG target 8.10 to 'strengthen the capacity of domestic financial institutions to encourage and to expand access to banking, insurance and financial services for all' (IMF, 2022).

Aggregating Indicators

Since financial inclusion is an abstract concept, it is not measurable in a straightforward manner. However, determining an underlying latent structure that can organize the set of indicators (Camara and Tuesta, 2014) allows the aggregation of the indicators into one composite index. Similar to the construction of other indexes of financial inclusion, we applied a two-step aggregation process: the individual indicators were aggregated into dimensions, which were then aggregated into an index.

Prior to aggregation, the individual indicators are normalized to be comparable. There are several normalization methods. In *basic standardization process*, each observation is subtracted by the mean and divided by the standard deviation (Camara and Tuesta, 2014). *Min-max rule* trans-forms observations by subtracting the minimum and dividing by the range (Chakravarty and Pal, 2010; Park and Mercado, 2018; Sarma, 2012). In *distance-to-reference (DTR) normalization*, each observation is divided by a reference value, usually the maximum or a set target value (Amidzic et al., 2014). Mojica and Mapa (2017) used a *modified DTR method*, in which the denominator is the maximum value, while excluding observations considered as outliers.

In constructing an index there are two primary types of aggregation: non-parametric and parametric. In non-parametric methods, the weight of each indicator is exogenous and dependent on the researcher's a priori knowledge on which indicators contribute more strongly to financial inclusion. In parametric aggregation, the weights are determined endogenously through Principal Components Analysis (PCA) or other similar methods. Camara and Tuesta (2014) and Park and Mercado (2018) used PCA-based weighting of indicators, while Chakravarty and Pal (2010), Sarma (2012) and Mojica and Mapa (2017) used exogenous or equal weights.

In this study, we used the min-max rule in normalizing the indicators where each observation is transformed as follows:

$$x^t = \frac{x^a - m_x}{M_x - m_x}$$

where x^t is the transformed value of indicator x, x^a is the actual value of indicator x, m_x is the minimum of x, and M_x is its maximum. It normalizes the values of the variables into a range of zero to one (unlike with standardization), making the interpretation of results easier. It is also a common normalization method that is used not only in financial inclusion but in some other well-known indexes, such as the Human Development Index.

PCA-based weights are used for the two-step aggregation. Endogenously determining the weights avoids the problem of arbitrarily assigning weights to each

indicator and dimension. In the first step, the index score of each dimension is derived by multiplying each of the min-max normalized indicators with their corresponding weights, and then summing up the products, i.e.,

$$d_k = \sum_{i=1}^{n} w_i I_i \ ; k = 1, 2$$

where $d_k,\ k = 1, 2$ is the index score of each of the two dimensions (access and usage), I_i is the min-max normalized value of indicator *i*, w_i is the weight assigned to indicator *i*, and *n* is the number of indicators (in this case, four).

The scores of the two dimensions are then aggregated into a composite financial inclusion index using the same method, i.e.,

$$FI = \sum_{j=1}^{k} w_j d_j$$

where FI is the financial inclusion index, d_j is the index score of dimension *j*, w_j is the weight of dimension *j*, and *k* is the number of dimensions (in this case, two).

Following Camara and Tuesta (2014), the weights are computed by summing up the product of each principal component and the corresponding eigenvalue, and then dividing by the sum of the eigenvalues. For the aggregation from indicators to dimension, the weight of each indicator *i* is

$$w_i = \frac{\sum_{m=1}^{n} \lambda_m P_m^i}{\sum_{m=1}^{n} \lambda_m}$$

where w_i is the weight of indicator *i*, P_m^i is the *m*th principal component of indicator *i*, λ_m is the eigenvalue of principal component *m*, and *n* is the number of principal components / indicators / eigenvalues, which in this case is four. The computed weights are then normalized to make the weights sum up to one. The same weighting formula is applied in aggregating the two dimensions into one financial inclusion index.

Similar to Camara and Tuesta (2014) and Park and Mercado (2018), we accounted for 100 percent of the variation in the variables to compute for index weights using PCA. This means that we used all principal components instead of only the first few to ensure that no information is discarded.

Data Sources and Estimation Strategy

Financial inclusion indicators were derived from the Financial Access Survey (FAS), an annual cross-country dataset produced by the International Monetary Fund (IMF). Published since 2004, FAS covers 189 countries and measures 121 variables. However, many indicators are available only for a few countries.

Complementing the FAS is the E-Government Development Index (EGDI), a publication of the United Nations Department of Economic and Social Affairs (UN DESA). The release of the EGDI was intermittent following its initial release in 2001. Starting in 2008, the report has been published bi-annually. The EGDI assesses the level of e-government development using a composite index of three equally-weighted sub-indices: the Telecommunications Infrastructure Index (TII), the Online Service Index (OSI), and the Human Capital Index (HCI). TII captures the level of internet and mobile phone use, while OSI measures the degree by which government services can be availed online. OSI uses a

checklist of public services—the more services are available online, the higher the score. Meanwhile, HCI is composed of indicators on the quality of human capital, such as literacy rate, enrollment ratio, and years of schooling (UN DESA 2022).

Using these data sources, we created a panel dataset of 70 countries[4] spanning the years 2008 to 2021. Given the difference in frequency between EGDI and FAS, we aggregated two years of FAS variables into one period by calculating for the average. For instance, the 2008 EGDI data is matched with the average of 2008 and 2009 FAS, the 2010 EGDI is matched with the average of 2010 and 2011 FAS, and so on.[5] The same transformation was implemented for the control variables that have annual frequency. For example, the earlier EGDI (i.e., 2008 vs 2009) was matched with the average 2008-2009 FAS on the assumption that the base or current level of ICT and e-government development could potentially affect financial inclusion over the 2008–2009 period.

To empirically examine the relationship between financial inclusion on one hand and ICT and e-governance on the other, we estimated the following econometric equation (1):

$$FI_{it} = \beta_0 + \beta_1{}^{*} IEG_{it} + \boldsymbol{\beta_2 X_{it}} + \mu_{it}$$

where FI_{it} is an indicator of financial inclusion for country *i* at time *t*, IEG_{it} is an indicator of e-government and ICT development of country *i* at time *t*, $\boldsymbol{X_{it}}$ is a vector of control variables, and μ_{it} is the error term. The variables β_0, β_1, and $\boldsymbol{\beta_2}$ are parameters to be estimated. The primary parameter of interest is β_1, which measures the relationship between financial inclusion and e-government and ICT development.

The vector of controls includes variables known to affect financial inclusion such as demographic characteristics, per capita income, and quality of governance (Eldomiaty et al., 2020; Gebrehiwot and Makina, 2019; Zins and Weill, 2016). We also included an interaction term between IEG_{it} and per capita income to determine if the effect of ICT and e-government on financial inclusion varies among higher-income and lower-income countries. An interaction term between IEG_{it} and the quality of governance variable was also added to determine if good governance can enhance the influence of IEG on financial inclusion.

Since we are interested on how the overall financial inclusion index and its two sub-indexes (usage and access) are related to three variables: the overall EGDI index, the OSI score, and the TII score,[6] equation (1) was estimated separately for the overall financial inclusion index, the usage index, and the access index as the dependent variable FI_{it}.

Figure 1 shows two sets of histograms: (top) the overall financial inclusion index (*fi_comp*), the financial inclusion usage score (*fi_usage*), and the financial inclusion access index (*fi_access*), and (bottom) the overall EGDI score, the online services index (OSI), and the telecommunication infrastructure score (TII). Table 2 shows the summary statistics of the dependent and independent variables, along with the description of each control variable.

[4] The countries included in the study are listed in Annex 1.

[5] Note that FAS as calculated here has a forward component to help control for possible endogeneity (i.e., past values can affect future values, but future values are unlikely to affect past values).

[6] The HCI was excluded given that it is largely a measure of the quality of human capital which is beyond the scope of this study.

Figure 1: Histogram of the financial inclusion indexes (top) and EGDI overall index and sub-indexes (bottom)

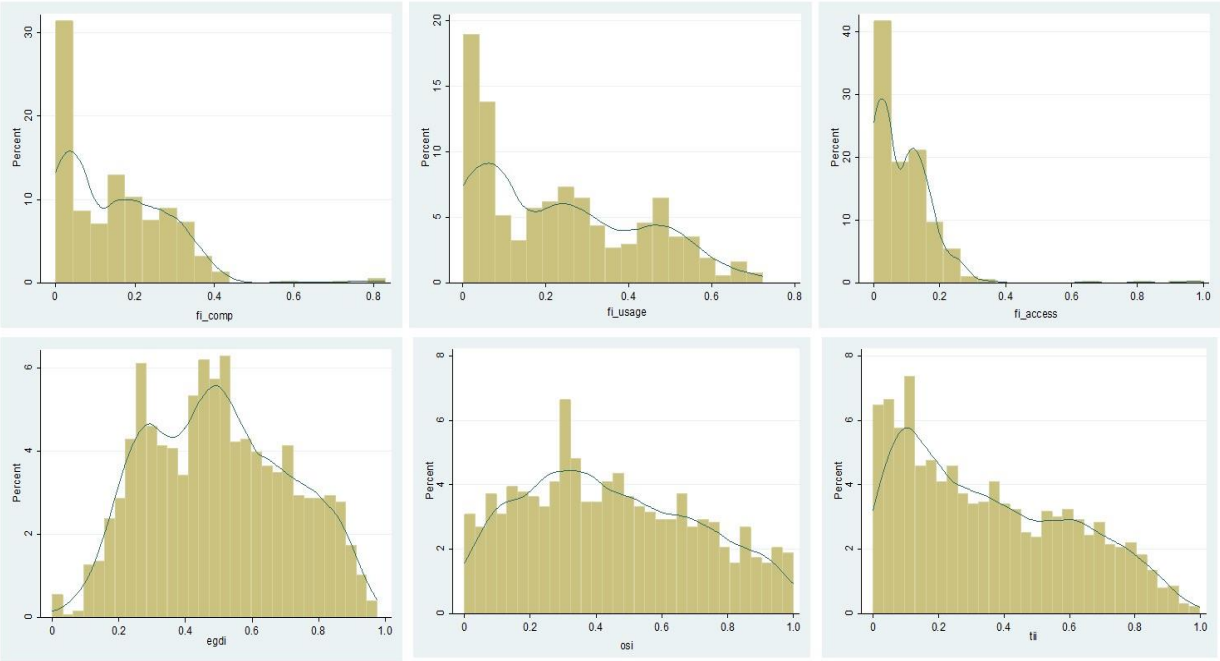

Table 2. Variables description and summary statistics

Variable Name	Variable Description	Mean	Standard Deviation		
			Overall	Between	Within
fi_comp	Composite financial inclusion index	0.150	0.118	0.116	0.028
fi_usage	Usage financial inclusion index	0.239	0.191	0.183	0.047
fi_access	Access financial inclusion index	0.089	0.075	0.077	0.019
egdi	EGDI overall score	0.455	0.195	0.194	0.066
osi	EGDI online services index score	0.411	0.253	0.242	0.118
tii	EGDI telecommunication infrastructure index score	0.296	0.228	0.212	0.109
gdppercap	GDP per capita in constant 2015 US$	7,037.33	8,136.21	8,206.26	744.69
age_0to14	Zero to 14 years old share to total population	30.67	10.46	10.49	1.04
age_65up	65 years old and up share to total population	6.79	5.22	5.32	0.61
mobile	Mobile phone subscriptions per 100 people	94.51	42.26	40.57	16.35
internet	Internet users, percent of population	39.60	28.00	26.11	11.45
pop_density	Population per sq. km land area	166.74	296.48	302.69	31.31
urban	Percent of urban population	52.60	21.80	22.35	1.51
governance	Governance effectiveness score in the Worldwide Governance Indicator	-0.290	0.777	0.794	0.135

Results

Principal component analysis

The PCA methodology transforms the correlated dimensions of the variables into linearly independent components with corresponding eigenvalues reflecting the relative importance of each component. Table 3 summarizes the PCA results for the access dimension index (Table 3a), the usage dimension index (Table 3b), and the financial inclusion index (Table 3c).

In Table 3a, as expected the eigenvalue for the first principal component (PC1) is significantly higher than the eigenvalues for PC2, PC3 and PC4. PC1 is moderately correlated with the four variables and no single component dominating the PCA results for the access dimension. Although number of ATMs per 100,000 adults (*atm_percap*) shows the highest correlation, it is closely followed (in descending order) by number of bank branches per 100,000 adults (*bank_percap*), number of ATMs per 1,000 square kilometers of land area (*atm_area*), and number of bank branches per land area (*bank_area*). PC2 is highly correlated with *atm_percap*, PC3 is inversely correlated with *bank_percap* while PC4 is significantly correlated with bank area. The last two columns in Table 1 show that *atm_percap* has the largest weight in computing for the access dimension index. However, the weights are not too far apart, suggesting that the four indicators have similar contributions to the access index. The last column shows the normalized weights which sum up to one.

This pattern is similar to the results for the usage dimension index (Table 3b). The four indicators have an average correlation of 0.5 with PC1. Among the indicators, *loans* shows the highest positive correlation with PC2, *borrowers* is negatively correlated with PC3, while *deposits* and *depositors* show opposing influence on PC4. The last two columns show that *loans* and *borrowers* have the largest weights in computing for the usage dimension index. However, similar to the access dimension index, the endogenously-determined weights of the four indicators are not too far apart.

Table 3(c) shows the calculated weights for aggregating the two dimensions into a single index. The access dimension is more prominent (62.3%) than the usage dimension (37.7%). Note that the PCA methodology assigns greater weights to variables with more variation, so this could explain the greater weight assigned to the access dimension.

There is a long-standing issue on whether financial inclusion interventions should focus on either providing access to or promoting usage of financial services. We note that high usage rates do not always mean higher positive impact. For example, borrowing through digital credit can be welfare-enhancing, but over-borrowing can lead to financial distress. Also, repeated use of a financial service (e.g., online financial transactions through a specific facility) can enhance efficiency, but it could also indicate lack of meaningful choices. While usage of financial services remains a suitable measure of financial inclusion, access is as important especially among developing economies. Access retains customers' ability to choose among options that are best suited for their needs (Beck, 2020).

Table 3. Principal Components Analysis Results: (a) access dimension index, (b) usage dimension index, (c) overall financial inclusion index

(a) weights in calculating the access dimension index

Indicator	PC1	PC2	PC3	PC4	Weight	Weight (Normalized to sum up to one)
atm_area	0.525	-0.353	0.532	-0.563	0.362	**0.234**
atm_percap	0.400	0.836	0.337	0.167	0.470	**0.304**
bank_area	0.535	-0.402	-0.007	0.744	0.342	**0.221**
bank_percap	0.528	0.125	-0.777	-0.319	0.375	**0.242**

Indicator	PC1	PC2	PC3	PC4	Weight	Weight (Normalized to sum up to one)
Eigenvalue	3.033	0.699	0.231	0.037		

(b) weights in calculating the usage dimension index

Indicator	PC1	PC2	PC3	PC4	Weight	Weight (Normalized to sum up to one)
borrowers	0.507	0.384	-0.717	-0.284	0.437	**0.262**
deposits	0.512	-0.413	0.395	-0.642	0.379	**0.228**
depositors	0.497	-0.559	-0.199	0.633	0.352	**0.211**
loans	0.484	0.607	0.539	0.326	0.498	**0.299**
Eigenvalue	3.327	0.468	0.136	0.069		

(c) weights in calculating the overall financial inclusion index

Indicator	PC1	PC2	Weight	Weight (Normalized to sum up to one)
access	0.707	0.707	0.707	0.623
usage	0.707	-0.707	0.427	0.377
Eigenvalue	1.604	0.396		

Regression Results

The results of the regressions are reported in Tables 4 to 6. Table 4 shows the estimates involving the overall financial inclusion index, while Tables 5 and 6 show the results where access and usage are the dependent variables, respectively. Each table reports the result with the overall EGDI and (5) include both country fixed effects and year effects, while columns (2), (4), and (6) capture country fixed effects. Year effects were included as robustness check and because some literature found a consistent upward time trend in some financial inclusion indicators (Barajas et al., 2020; Espinosa-Vega et al., 2020).

Results in Table 4 show that higher IEG is associated with greater overall financial inclusion (fi_{comp}). An additional point in the EGDI score is associated with 0.157 to 0.186 higher financial inclusion score, while the OSI score has a marginal effect of 0.075 to 0.094. TII also turned positive and statistically significant, with marginal effect of 0.131 to 0.173. The usage score (fi_{usage}) is also positively associated with IEG. An additional point in the EGDI score is associated with 0.296 to 0.325 higher fi_{usage} score. OSI score has a marginal effect of 0.143 to 0.164, while TII has a marginal effect of 0.235 to 0.287. A similar pattern is observed in the results shown in Table 6 (usage index).

In contrast to the composite financial inclusion and usage indexes, the result for access score (fi_{access}) is not as robust (Table 5). The EGDI and OSI scores are statistically insignificant in some regressions. Coefficients that turned significant are only at the 10% level. In the regressions where EGDI and OSI are statistically significant, the marginal effects on fi_{access} are 0.090 and 0.045, respectively, while TII has a marginal effect of 0.059 to 0.095. The results in Table 5 suggest that IEG have weaker effects on access than on usage. In contrast, the weights shown in Table 3(c), i.e., where access has greater weight than usage, pertain to the construction of the overall financial inclusion index.

Results also suggest that the relationship of financial inclusion with IEG varies across country income level. The interaction terms between per capita income and EGDI, OSI, and TII are negative, statistically significant, albeit small. This indicates that the marginal effect of IEG on financial inclusion is smaller when per capita income is greater. For example, Table 5 shows that the marginal effect of EGDI on *fi_comp* is lower by 0.112 to 0.113 index point for every 1,000 dollar higher per capita GDP. While IEG development has a

positive effect on financial inclusion, this effect is greater among lower-income countries, holding other variables constant. Potentially, the quality of governance is in part already captured by the level of ICT and e-government development.

Meanwhile, none of the interaction terms between governance and the IEG turned significant, suggesting that the marginal effect of e-government and ICT on financial inclusion is the same regardless of quality of governance. This suggests that, holding other factors constant, IEG has the same effect on financial inclusion in countries with good governance and in countries without.

Table 4. Regression results (overall financial inclusion)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: financial inclusion overall index					
egdi score	0.186**	0.157**				
	(0.0743)	(0.0667)				
osi score			0.0935***	0.0754**		
			(0.0308)	(0.0292)		
tii score					0.173**	0.131**
					(0.0679)	(0.0545)
egdi*gdp per capita	-1.12e-05**	-1.13e-05**				
	(4.89e-06)	(4.82e-06)				
osi*gdp per capita			-6.05e-06**	-5.75e-06**		
			(2.48e-06)	(2.52e-06)		
tii*gdp per capita					-7.41e-06**	-7.51e-06**
					(3.38e-06)	(3.29e-06)
egdi*governance	0.0695	0.0783				
	(0.0594)	(0.0587)				
osi* governance			0.0414	0.0458		
			(0.0315)	(0.0317)		
tii* governance					0.0326	0.0473
					(0.0483)	(0.0459)
constant	-0.215	-0.151	-0.200	-0.144	-0.111	-0.0444
	(0.211)	(0.213)	(0.216)	(0.224)	(0.199)	(0.206)
Controls?	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Year effects?	Yes	No	Yes	No	Yes	No
No. of observations	342	342	342	342	342	342
No. of countries	70	70	70	70	70	70
R-squared	0.469	0.457	0.465	0.451	0.482	0.467

Note: FE=fixed effects. Robust standard errors in ( );
*Significant at 10%; ** Significant at 5%; ***Significant at 1%

Table 5. Regression results (access index)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: financial inclusion access index					
egdi score	0.0902*	0.0610				
	(0.0472)	(0.0472)				
osi score			0.0447*	0.0289		
			(0.0228)	(0.0228)		
tii score					0.0953**	0.0594*
					(0.0409)	(0.0341)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: financial inclusion access index					
egdi*gdp per capita	-7.93e-06**	-8.08e-06**				
	(3.32e-06)	(3.37e-06)				
osi*gdp per capita			-3.65e-06**	-3.34e-06*		
			(1.64e-06)	(1.79e-06)		
tii*gdp per capita					-5.49e-06**	-5.78e-06***
					(2.12e-06)	(2.09e-06)
egdi*governance	0.0382	0.0449				
	(0.0362)	(0.0363)				
osi* governance			0.0202	0.0252		
			(0.0197)	(0.0208)		
tii* governance					0.0270	0.0416
					(0.0277)	(0.0259)
constant	0.00789	0.0715	0.0175	0.0863	0.0737	0.133
	(0.177)	(0.180)	(0.182)	(0.188)	(0.181)	(0.186)
Controls?	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Year effects?	Yes	No	Yes	No	Yes	No
No. of observations	342	342	342	342	342	342
No. of countries	70	70	70	70	70	70
R-squared	0.427	0.402	0.415	0.385	0.438	0.411

Note: FE=fixed effects. Robust standard errors in ( );
*Significant at 10%; ** Significant at 5%; ***Significant at 1%

Table 6. Regression results (usage index)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: financial inclusion usage index					
egdi score	0.325**	0.296**				
	(0.130)	(0.112)				
osi score			0.164***	0.143***		
			(0.0524)	(0.0473)		
tii score					0.287**	0.235**
					(0.119)	(0.0947)
egdi*gdp per capita	-1.12e-05**	-1.13e-05**				
	(4.89e-06)	(4.82e-06)				
osi*gdp per capita			-9.54e-06**	-9.26e-06**		
			(4.63e-06)	(4.58e-06)		
tii*gdp per capita					-1.02e-05*	-1.00e-05*
					(5.85e-06)	(5.71e-06)
egdi*governance	0.0695	0.0783				
	(0.0594)	(0.0587)				
osi* governance			0.0724	0.0759		
			(0.0551)	(0.0549)		
tii* governance					0.0407	0.0556
					(0.0837)	(0.0812)
constant	-0.540*	-0.473	-0.516	-0.479	-0.380	-0.302
	(0.312)	(0.312)	(0.317)	(0.327)	(0.289)	(0.298)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: financial inclusion usage index					
Controls?	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Year effects?	Yes	No	Yes	No	Yes	No
No. of observations	342	342	342	342	342	342
No. of countries	70	70	70	70	70	70
R-squared	0.449	0.443	0.450	0.440	0.458	0.449

Note: FE=fixed effects. Robust standard errors in ( );
*Significant at 10%; ** Significant at 5%; ***Significant at 1%

As a robustness check, we ran the same regressions with the financial inclusion index constructed using equal weighting of indicators. In this scenario, practically all the EGDI, OSI, and TII variables that turned significant in Tables 4 to 6 are also significant in the equal weighting scenario. In addition, most interaction terms involving these three variables have the same sign and level of significance when PCA-based weighting is used. These regression results are in the Annex.

Discussion

In general, higher level of IEG is linked with greater financial inclusion. Country-year pairs with higher scores in their EGDI, OSI, and TII indexes have more financially included population. This relationship, however, varies across financial inclusion dimensions. IEG is more strongly associated with usage of financial services than it is with availability of or access to such services. In fact, there is some evidence that there is no significant relationship between IEG and availability of or access to financial services. This suggests that IEG affects different dimensions of financial inclusion differently.

Similarly, the form of IEG also matters in the relationship with financial inclusion. While the overall EGDI index consistently has positive and significant relationship with overall financial inclusion and with the usage dimension, the TII score (which captures the level of internet and mobile phone use) has about twice larger marginal effects compared to the OSI score (or the extent of public services available online). This suggests that while the presence of online public services is vital in promoting financial inclusion, developing and improving ICT infrastructure could foster greater use of online services. This, in turn, has a stronger effect on promoting financial inclusion.

The finding that usage of financial services has greater effect on financial inclusion compared to availability or access renders support for the development of ICT and e-government. It also aligns with the current thrust of countries, particularly developing economies, of leveraging the widespread use of mobile phones and digital platforms to promote financial inclusion. Digital innovations have the potential to reach a greater number of individuals and households and help address a significant part of the unmet demand for payment services and credit needs of the poorest groups of the population and of micro, small, and medium enterprises (MSMEs) ADB (2017). Access and use of digital financial services by the unbanked and underserved segments of the population have increased, particularly in Africa and Asia, even where traditional financial inclusion was stalling or declining Sahay et al. (2020). Moreover, digital financial services fill the gaps in areas where the traditional delivery of financial services is less present. Nonetheless, while digitalization holds promise for greater financial inclusion, concerns have been raised about the possibility of a digital divide. Differences in the access and usage of ICT and digital innovations could worsen existing social inequalities and possibly lead to financial exclusion, instead of inclusion. Thus, the necessity of developing crucial ICT and digital infrastructure and improving access to them is vital. Digital financial services will not be of

much use to consumers if they do not have access to the needed infrastructure, such as good internet and mobile connection.

Another notable finding is that ICT and e-government have a greater impact on financial inclusion in lower-income economies than in higher-income ones. A probable explanation for this observation is that high income countries have relatively higher proportions of financially included individuals and households in their populations, thus, interventions will only have marginal effects on financial inclusion. However, for developing and least-developed countries, this finding underscores the importance of developing ICT and e-government to help promote financial inclusion. In addition, results suggest that the quality of governance, which is a common problem among middle- and low-income economies, does not affect the effect of ICT and e-government on financial inclusion. The marginal effect is the same whether governance quality is high or low.

Conclusion

Financial inclusion strategies commonly espouse the development of ICT platforms and digital infrastructure to achieve a broader reach to unbanked and underserved sectors of the economy. Our results suggest that, in general, higher level of IEG is associated with greater financial inclusion. However, there are nuances to this relationship given variations across dimensions of financial inclusion and across forms of IEG. IEG is more strongly associated with usage of financial services than with availability of or access to such services. In addition, while making various services available online promotes financial inclusion, developing crucial ICT infrastructure and improving access to it have greater marginal effect. The relationship of financial inclusion with IEG is also stronger in lower-income than in higher-income countries, but financial inclusion does not vary with quality of governance.

References

ADB (2017). Accelerating financial inclusion in Southeast with digital finance: technical report. Routledge.

Alshubiri, F., Jamil, S. and Elheddad, M. (2019), 'The impact of ICT on financial development: Empirical evidence from the Gulf Cooperation Council countries', *International Journal of Engineering Business Management* 11(1), 1–14.

Amidzic, G., Massara, A. and Mialou, A. (2014), 'Assessing countries' financial inclusion standing – a new composite index', *International Monetary Fund Working Paper* 14(36).

Barajas, A., Beck, T., Belhaj, M., Naceur, B. and S. (2020), 'Financial inclusion: What have we learned so far what do we have to learn', *International Monetary Fund Working Paper* 20/08.

Beck, T. (2020), 'Fintech and financial inclusion: Opportunities and pitfalls', *ADBI Working Paper Series* 1165, 1–25.

Beck, T., Demirguc-Kunt, A. and Levine, R. (2007), 'Finance, inequality and the poor', *Journal of Economic Growth* 12(1), 27–49.

Bernhard, I. and Wihlborg, E. (2014), Municipal Contact Centres: A Slower Approach Towards Sustainable Local Development by E-government. Routledge, Utgivare.

BSP (n.d.), National Strategy for Financial Inclusion 2022-2028, Bangko Sentral ng Pilipinas.

Camara, N. and Tuesta, D. (2014), 'Measuring financial inclusion: A multidimensional index', *BBVA (Banco Bilbao Vizcaya Argentaria) Research Working Paper* 14(26).

Chakravarty, S. and Pal, R. (2010), 'Measuring financial inclusion: An axiomatic approach', *Indira Gandhi Institute of Development Research Working Paper* 2010(003).

Chatterjee, A. (2020), 'Financial inclusion, information and communication technology diffusion, and economic growth: A panel data analysis', *Information Technology for Development* 26(3), 607–635.

Demirguc-Kunt, A., Klapper, L. and Singer, D. (2017), 'Financial inclusion and inclusive growth: A review of recent empirical evidence', *World Bank Policy Research Working Paper* (8040).

Duvendack, M. and Mader, P. (2020), 'Impact of financial inclusion in low- and middle-income countries: A systematic review of reviews', *Journal of Economic Surveys* 34(3), 594–629.

Earth Institute (2016), ICT & financial inclusion, in 'How Information and Communications Technology can Accelerate Action on the Sustainable Development Goals: ICT and SDGs', The Earth Institute Columbia University, pp. 32–45.

Eldomiaty, T., Hammam, R. and El Barky, R. (2020), 'Institutional determinants of financial inclusion: Evidence from world economies', *International Journal of Development Issues* 19(2), 217–228.

Espinosa-Vega, M., Shirono, K., Carcel Villanova, H., Chhabra, E., Das, B. and Fan, Y. (2020), 'Measuring financial access: Ten years of the IMF's financial access survey', *International Monetary Fund Statistics Department Paper* 20/08.

Gebrehiwot, K. and Makina, D. (2019), Macroeconomic determinants of financial inclusion: Evidence using panel data analysis, in D. Makina, ed., 'Extending Financial Inclusion in Africa', Elsevier Academic Press, Cambridge, pp. 167–191.

IMF (2022), Financial Access Survey: 2022 Trends and Developments, International Monetary Fund, Washington.

Kim, D., Yu, J. and Hassan, M. (2018), 'Financial inclusion and economic growth in OIC countries', *Research in International Business and Finance* 43, 1–14.

Levine, R. (2005), Finance and growth: Theory and evidence, in P. Aghion and A. Durlauf, eds, 'Handbook of Economic Growth Volume I Part A', North Holland, Amsterdam, pp. 865–934.

Mhalanga, D. and Denhere, V. (2020), 'Determinants of financial inclusion in Southern Africa', *Oeconomica* 65(3), 39–52.

Misra, H. (2017), Facilitating financial inclusion through e-governance: Case based study in Indian scenario, in '2017 Fourth International Conference on e-Democracy & e-Government', pp. 226–231.

Mojica, M. and Mapa, C. (2017), 'An index of financial inclusion in the Philippines: Construction and analysis', *The Philippine Statistician* 66(1), 59–74.

Oshora, B., Desalegn, G., Gorgenyi-Hegyes, E., Fekete-Farkas, M. and Zeman, Z. (2021), 'Determinants of financial inclusion in small and medium enterprises: Evidence from Ethiopia', *Journal of Risk and Financial Management* 14(7), 286–304.

Ozili, P. (2018), 'Impact of digital finance on financial inclusion and stability', *Borsa Instanbul Review* 18(4), 329–340.

Ozili, P. (2021), 'Financial inclusion research around the world: A review', *Forum for Social Economics* 50(4), 457–479.

Park, C. and Mercado, R. (2018), 'Financial inclusion: New measurement and cross-country impact assessment', *Asian Development Bank Economics Working Paper Series* (539).

Pradhan, R. P., Mallik, G. and Bagchi, T. P. (2018), 'Information communication technology infrastructure and economic growth: A causality evinced by cross-country panel data', *IIMB Management Review* 30(1), 91–103.

Sahay, M., von Allmen, M., Lahreche, M., Khera, P., Ogawa, M., Bazarbash, M. and Beaton, M. (2020), The promise of fintech: Financial inclusion in the post COVID-19 era, International Monetary Fund.

Sarma, M. (2012), 'Index of financial inclusion – a measure of financial sector inclusiveness', *HTW Berlin University of Applied Sciences Working Papers on Money, Finance, Trade and Development* 2012(07).

Sarma, M. and Pais, J. (2011), 'Financial inclusion and development', *Journal of International Development* 23(5), 613–628.

Sethi, D. and Acharya, D. (2018), 'Financial inclusion and economic growth linkage: Some cross-country evidence', *Journal of Financial Economic Policy* 10(3), 369–385.

Vaid, Y., Singh, V. and Sethi, M. (2020), 'Determinants of successful financial inclusion in low-income rural population', *The Indian Economic Journal* 68(1), 82–100.

World Bank (2012), General Guidelines for the Development of Government Payment Programs, The World Bank, Washington.

World Bank (2014), Global Financial Development Report 2014: Financial Inclusion, World Bank, Washington.

Yildiz, M. (2007), 'E-government research: Reviewing the literature, limitations, and ways forward', *Government Information Quarterly* 24(3), 646–665.

Zins, A. and Weill, L. (2016), 'The determinants of financial inclusion in Africa', *Review of Development Finance* 6(1), 46–57.

Annexes

Table A. List of countries

Afghanistan	Eswatini	Peru
Albania	Gabon	Poland
Argentina	Georgia	Moldova
Bangladesh	Guinea	Rwanda
Belize	Haiti	Samoa
Botswana	Hungary	Sao Tome and Principe
Brazil	Italy	Saudi Arabia
Brunei Darussalam	Kiribati	Seychelles
Bulgaria	Kyrgyzstan	Solomon Islands
Burundi	Lao PDR	South Sudan
Cameroon	Latvia	Suriname
Central African Republic	Lebanon	Syria
Chad	Lesotho	Thailand
Colombia	Madagascar	Tonga
Comoros	Malawi	Uganda
Costa Rica	Malaysia	United Arab Emirates
Cyprus	Maldives	Tanzania
Democratic Republic of the	Malta	Uzbekistan
Djibouti	Mauritania	Vanuatu
Dominican Republic	Mauritius	Zambia
Ecuador	Myanmar	Zimbabwe
Egypt	Namibia	Macedonia
Equatorial Guinea	Pakistan	
Estonia	Paraguay	

Table B.1. Regression results (overall financial inclusion), equal weights

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: financial inclusion overall index					
egdi score	0.198**	0.171**				
	(0.0785)	(0.0693)				
osi score			0.100***	0.0829***		
			(0.0327)	(0.0301)		
tii score					0.181**	0.141**
					(0.0731)	(0.0579)
egdi*gdp per capita	-1.06e-05**	-1.06e-05**				
	(5.16e-06)	(5.08e-06)				
osi*gdp per capita			-5.98e-06**	-5.73e-06**		
			(2.62e-06)	(2.62e-06)		
tii*gdp per capita					-6.92e-06*	-6.93e-06*
					(3.59e-06)	(3.50e-06)
egdi*governance	0.0717	0.0803				
	(0.0640)	(0.0630)				
osi* governance			0.0455	0.0490		
			(0.0342)	(0.0341)		
tii* governance					0.0296	0.0425
					(0.0527)	(0.0500)
constant	-0.242	-0.185	-0.225	-0.183	-0.137	-0.0758
	(0.218)	(0.219)	(0.222)	(0.229)	(0.205)	(0.211)
Controls?	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Year effects?	Yes	No	Yes	No	Yes	No
No. of observations	342	342	342	342	342	342
No. of countries	70	70	70	70	70	70
R-squared	0.475	0.466	0.473	0.463	0.486	0.474

Note: FE=fixed effects. Robust standard errors in (); *Significant at 10%; ** Significant at 5%; ***Significant at 1%

Table B.2. Regression results (access index), equal weights

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: financial inclusion access index					
egdi score	0.0766*	0.0521				
	(0.0421)	(0.0423)				
osi score			0.0379*	0.0239		
			(0.0205)	(0.0206)		
tii score					0.0815**	0.0504
					(0.0358)	(0.0302)
egdi*gdp per capita	-6.93e-06**	-7.08e-06**				
	(2.94e-06)	(3.00e-06)				
osi*gdp per capita			-3.15e-06**	-2.86e-06*		
			(1.47e-06)	(1.61e-06)		
tii*gdp per capita					-4.81e-06**	-5.07e-06***
					(1.87e-06)	(1.84e-06)
egdi*governance	0.0335	0.0390				
	(0.0322)	(0.0324)				
osi* governance			0.0175	0.0217		
			(0.0176)	(0.0186)		
tii* governance					0.0239	0.0368
					(0.0245)	(0.0229)
constant	0.00236	0.0589	0.0105	0.0719	0.0588	0.111
	(0.150)	(0.153)	(0.155)	(0.160)	(0.153)	(0.158)
Controls?	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Year effects?	Yes	No	Yes	No	Yes	No
No. of observations	342	342	342	342	342	342
No. of countries	70	70	70	70	70	70
R-squared	0.449	0.423	0.438	0.406	0.460	0.432

Note: FE=fixed effects. Robust standard errors in (); *Significant at 10%; ** Significant at 5%; ***Significant at 1%

Table B.3. Regression results (usage index), equal weights

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: financial inclusion usage index					
egdi score	0.318**	0.291***				
	(0.126)	(0.108)				
osi score			0.162***	0.142***		
			(0.0518)	(0.0461)		
tii score					0.280**	0.231**
					(0.118)	(0.0929)
egdi*gdp per capita	-1.43e-05*	-1.42e-05*				
	(8.30e-06)	(8.22e-06)				
osi*gdp per capita			-8.80e-06**	-8.59e-06*		
			(4.41e-06)	(4.36e-06)		
tii*gdp per capita					-9.04e-06	-8.80e-06
					(5.76e-06)	(5.63e-06)
egdi*governance	0.110	0.122				
	(0.103)	(0.101)				
osi* governance			0.0735	0.0763		
			(0.0552)	(0.0550)		
tii* governance					0.0353	0.0481
					(0.0846)	(0.0815)
constant	-0.486	-0.430	-0.460	-0.438	-0.333	-0.263
	(0.322)	(0.319)	(0.324)	(0.332)	(0.303)	(0.307)
Controls?	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Year effects?	Yes	No	Yes	No	Yes	No
No. of observations	342	342	342	342	342	342
No. of countries	70	70	70	70	70	70
R-squared	0.464	0.458	0.465	0.456	0.472	0.464

Note: FE=fixed effects. Robust standard errors in (); *Significant at 10%; ** Significant at 5%; ***Significant at 1%