Institutional quality, information and communication technologies and gender inclusion nexus: global comparative evidence

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Abstract

Purpose – Despite the longstanding male dominance in the socio-politico-economic spheres, recent decades have witnessed remarkable improvements in gender inclusion. Although the issue of gender inclusion has been widely documented, answers to the question of whether institutional arrangements and information technology shape gender inclusion remain contentious. This study, therefore, empirically examines the effects of institutional quality and information and communication technology (ICT) penetration on gender inclusion on a global scale.

Design/methodology/approach – To control for the endogeneity of modeled variables and cross-sectional dependence inherent with large panel datasets, the study employs the Driscoll-Kraay fixed effects (DKFE) and the system generalised method of moments (GMM) estimators for a panel of 142 countries from 1996 to 2020.

Findings – The empirical findings from the DKFE and system GMM estimators reveal that strong institutions significantly enhance gender inclusion. Moreover, by disaggregating institutional quality into various governance indicators, we show that besides corruption control, which has a positive but insignificant effect on women's empowerment, other governance indicators significantly enhance gender inclusion. Furthermore, there is evidence that various ICT measures promote gender inclusion.

Practical implications – The study results suggest that policymakers in developing countries should implement stringent measures to curb corruption. Moreover, policymakers in low-income countries should create avenues to facilitate women's access to ICTs. Hence, policymakers in low-income countries should create and equip ICT training centers and render them accessible to all categories of women. Furthermore, developed countries with high-tech knowledge could help developing countries by organizing free training workshops and sensitization campaigns concerning the use of ICTs vis-à-vis women empowerment in various fields of life.

Originality/value – The present study fills a significant research gap by comprehensively exploring the nexuses between governance, ICT penetration and the socio-politico-economic dimensions of gender inclusion from a global perspective. Besides the paucity of studies in this regard, the few existing studies have been focused on either region and country-specific case studies in developed or developing economies. Moreover, this study is timely, given the importance placed on gender inclusion (SDG5), quality of institutions (SDG16) and ICT penetration (SDG9) in the 2015–2030 global development agenda.

Keywords Gender inclusion, Institutions, ICTs, Corruption

Paper type Research paper

1. Introduction
The question of gender inclusion has attracted unprecedented interest from academics, policymakers, and practitioners across the globe. In recent decades, one of the major concerns of stakeholders has been to seek ways of reducing gender exclusion, which is believed to be detrimental to sustainable development. The importance of gender inclusion was particularly stressed by Duflo (2012), who argued that women's economic empowerment is crucial for attaining sustainable development. Thus, despite the longstanding male dominance in the socioeconomic and political spheres, recent decades have witnessed remarkable improvements in women's socioeconomic and political inclusion (Ghasemi *et al.*, 2021) following an unprecedented growth in technological adoption. For instance, recent technological advancements and cultural attitudes have resulted in the development of more inclusive employment sectors (Ostry *et al.*, 2018), increasing women's economic empowerment.

However, the dream of achieving gender inclusion may remain futile if policymakers do not enhance and implement positive institutional mechanisms (Faulkner and Lie, 2007). Institutional arrangements are therefore crucial in ensuring gender inclusiveness. North (1993) defines institutions as the rules that guide peoples' interaction, shape agents' behavior, and help explain their performance in society. Thus, institutional theorists opine that institutions primarily exist to regulate socioeconomic interactions by providing incentives or constraints for the actions of individuals (Efobi, 2015). Consequently, there is a need for institutional arrangements to adopt measures to advocate for gender inclusion in the economic, social, or political spheres.

Despite the commendable efforts expended by the international community in curbing gender exclusion, recent statistics show that the gender gap is far from being filled. Great disparities regarding gender inclusion exist at the global and regional levels. For instance, data from the World Bank (2021) indicate that while male labor force participation rates (MLFP) have varied from 80% to 71% between 1990 and 2020, female labor force participation rates (FLFP) have remained below 52% over the same period. Moreover, MLFP has remained above the global average, while FLFP has consistently remained below the world average (see Appendix 1). Moreover, gender exclusion is even more visible across geographical regions (World Bank, 2021). Furthermore, the statistics reveal a high degree of male economic dominance across various regions (see Appendix 2). However, the Middle East and North African (MENA) zone is seen to experience the highest rates of gender exclusion. This low rate of women's economic inclusion may be explained by the fact that this zone is dominated by Arab nations, with cultural norms that inhibit women's empowerment (Geha, 2019; Metcalfe, 2011).

The prevailing situation can, however, be reversed following increased advocacy for feminist institutionalism. Proponents of feminist institutionalism believe that historical institutionalism is the origin of gender exclusion, as it enshrines a political culture of male dominance concerning leadership, economic participation, and strategic decision-making in society (Geha, 2019). Based on the preceding, governments are expected to step up efforts to encourage women to participate in politics to make their voices heard. In this regard, the importance of information and communication technologies (ICTs) cannot be overlooked. Concordantly, Chatterjee *et al.* (2020) argue that developing and adopting information technologies engenders innovation, which inherently enhances women's empowerment. The importance of ICTs in curbing unemployment, especially among women, was revealed during the COVID-19 pandemic, characterized by prolonged lockdowns (Pennington *et al.*, 2022).

Given the growing importance of information technologies (Chatterjee *et al.*, 2020) and institutional frameworks (Singh and Pradhan, 2022) in curbing the existing gender gap across the globe, it is necessary to explore the nexus between institutional quality, ICT adoption, and gender inclusion. Besides, several academics have explored various channels

through which gender inclusion can be enhanced. Consequently, contemporary research (Ofori *et al.*, 2021) reveals that the quality of institutions, ICT adoption, financial development, research and development (R&D), and ethnicity constitute the main determinants of gender inclusion. Among these factors, the quality of institutions remains crucial (Kabir *et al.*, 2018). Thus, there is evidence that good governance can empower women economically through job creation in the formal economic sectors (Asongu and Odhiambo, 2020). The practice of good governance is essential in the design and application of policies aimed at curbing gender exclusion from formal economic activities. Thus, global efforts to build strong institutions capable of achieving gender inclusion are visible in the recent sustainable development goals (SDGs). Specifically, while SDG5 outlines the world's determination to achieve gender equality and women empowerment, the resolve to build strong institutions is contained in SDG16 (United Nations, 2015).

Although the issue of gender inclusion has been widely documented, answers to the question of whether institutional arrangements and information technology shape gender inclusion remain contentious. Moreover, the growing importance of ICTs within the socio-politico-economic spheres in modern life is gradually reshaping gender narratives across the globe. Against this backdrop, this study examines the effects of institutional quality and ICT penetration on gender inclusion. While the respective effects of institutions and ICTs on women empowerment have been mainly investigated in isolation, this study attempts a holistic analysis of the institutions–ICT–gender inclusion nexus with the help of the robust Driscoll-Kraay Fixed Effects and system Generalised Method of Moments estimators.

Nevertheless, studies exploring the linkages among institutional quality, ICT penetration, and gender inclusion remain sparse. Additionally, despite the existence of a few studies in this light, there is no consensus among academics yet. Equally, the few extant studies have been particularly devoted to region or country-specific case studies in developed or developing economies. Thus, to the best of our knowledge, while extant studies by Asongu and Odhiambo (2020) and Efobi *et al.* (2018) remain the closest to the present one, their analyses are narrowed within the confines of sub-Saharan Africa. While Asongu and Odhiambo (2020) focus on the governance-gender economic inclusion nexus, Efobi *et al.* (2018) examine the links between ICT advancement and gender economic inclusion. The present paper, therefore, departs from these studies by comprehensively exploring the nexuses between governance, ICT penetration, and the socio-politico-economic dimensions of gender inclusion from a global perspective, and the empirical findings reveal that strong institutions and ICT adoption promote gender inclusion.

Therefore, the importance of this study cannot be overestimated. Specifically, this study not only fills an important gap in extant empirical literature but also provides salient policy recommendations necessary to foster the attainment of sustainable development. Moreover, this study is timely, given the importance placed on gender inclusion (SDG5), quality of institutions (SDG16), and ICT penetration (SDG9) in the 2015–2030 global development agenda. This study is therefore imperative as it provides a global comparative analysis of the effects of institutional quality and ICT penetration on gender inclusion for a panel of 142 countries (see Appendix 3 for a complete list of countries) over the 1996–2020 period.

The remainder of the paper is structured as follows. Section 2 provides a critical review of the literature. Section 3 outlines the methodological strategy, and the empirical results are discussed in Section 4. Section 5 concludes the study.

2. Literature review
Gender inclusion has taken the central stage in recent developmental programs. The world economy, therefore, stands a chance to benefit significantly and realize its developmental

targets if all stakeholders actively participate to ensure that women are veritably integrated into the socio-politico-economic life of nations. Although the theoretical linkage between institutional quality and gender inclusion can be traced to feminist institutionalism, the relationship between ICT penetration and gender inclusion is difficult to identify, and the underlying empirical relationship has only been sparingly explored. Regarding the institutional-gender inclusion nexus, several studies have confirmed that gender exclusion decreases with strong institutions characterized by good governance, democratic practices, and non-corrupt political systems (Geha, 2019; Goltz et al., 2015). Concerning the ICT penetration-gender inclusion relationship, Pohjola (2002) contends that the availability of ICT services, such as affordable internet connectivity, will likely curb gender exclusion through improved growth. Equally, ICT tools like mobile phones are key in educating, especially rural women. For instance, the use of mobile phones reduces the cost of information searching, increases social cohesion through the creation of information networks (Hossain and Samad, 2021), enables the exchange of information across the world and enhances communication among women and their peers, thereby rendering women happy (Joseph, 2013). The established networks are likely to increase awareness creation against gender exclusion. Concordantly, Chew et al. (2015) argue that women's exposure to information (either through the internet, TV, mobile phone, or radio) is essential for gender inclusion.

Notwithstanding, the theoretical foundations linking institutions, ICT penetration, and gender inclusion can be traced to the "theory of communicative action," propounded by Habermas (1985). In this theory, Habermas highlights how the various dimensions of social life are affected by the development of social systems. In this light, the development of social systems with regard to ICTs and institutional frameworks is likely to affect women's socioeconomic and political dynamics. Asongu and Odhiambo (2019a) contend that economic empowerment is contingent on the quality of institutions. Moreover, Goltz et al. (2015) opine that the socio-politico-economic impacts of institutions depend on implementing the enacted laws. These findings suggest that the quality of institutions plays a vital role in shaping societal outcomes. Likewise, given the importance of institutions in influencing technology adoption, it becomes imperative to explore the role of information technology to better comprehend the institutional frameworks that govern women's socio-politico-economic careers across the globe.

Empirically, this section primarily reviews two strands of salient literature. While the first focuses on the role of institutions in gender inclusion, the second is devoted to the ICT-gender inclusion nexus. Concerning the first strand of literature, extant empirical studies have been concerned with the effects of institutional quality on women's socioeconomic empowerment (Asongu and Odhiambo, 2019a) or women's political empowerment (Esarey and Schwindt-Bayer, 2019). From an economic perspective, Asongu and Odhiambo (2019a) reveal that good governance enhances gender inclusion. Parallelly, Singh and Pradhan (2022) contend that institutional quality is crucial in curbing the socioeconomic exclusion across South Asian countries. Likewise, Ofori et al. (2021) argue that economic integration, complemented with good governance, is crucial for enhancing economic gender inclusion in Sub-Saharan Africa. The authors further opine that good governance accelerates economic growth, creating avenues for female economic empowerment.

In a recent study, Geha (2019) contends that gender exclusion remains high in Arab countries. This perception particularly reflects the case of the Middle East and North African (MENA) zone, which is dominated by Arab nations with cultural norms that inhibit women's empowerment. Specifically, Metcalfe (2011) argues that women are economically and politically underrepresented across Arab states. Women's economic exclusion in these countries could thus be mitigated if policies that encourage high female educational attainment are adopted. However, government efforts to foster gender inclusion remain inefficient in countries with high levels of inequality (Asongu and Odhiambo, 2020).

From a political perspective, Iversen and Rosenbluth (2008) reveal that institutional arrangements relating to electoral systems play a key role in women's political inclusion. The authors stress that countries with mixed electoral systems (characterized by proportional representation) are friendlier to women's political inclusion than their counterparts with single-member plurality systems. The authors further contend that low female labor force participation rates further exacerbate female political exclusion. Likewise, Esarey and Schwindt-Bayer (2019) argue that corrupt electoral systems are believed to have a negative impact on women's political inclusion.

Regarding the second strand of literature, the importance of technology adoption in mitigating gender exclusion has been re-echoed by Chatterjee *et al.* (2020) and Asongu *et al.* (2021). In this regard, Asongu and Odhiambo (2018) investigated the modulating effect of ICTs on financial access and female economic participation and revealed the existence of a conditional effect of ICTs on gender inclusion. Specifically, the authors argue that ICT penetration modulates financial access to enhance women's economic empowerment. Similarly, Asongu and Odhiambo (2019b) argue that ICT penetration leads to abatement in the level of inequality, which is seen as a major hindrance to women's economic inclusion. This result is congruent with Asongu and Odhiambo (2020), who conclude that ICT diffusion enhances economic gender inclusion.

Similarly, Efobi *et al.* (2018) argued that ICT tools (mobile phone subscriptions, internet use and fixed broadband subscriptions) positively impact women's economic inclusion. Equally, the involvement of women in ICT transformation programs is likely to change and improve women's perceptions regarding the socio-politico-economic dynamics of society. Nevertheless, contrary to the highly documented importance of ICTs on gender inclusion, Hossain and Beresford (2012), in a study for Bangladesh, argue that if ICT programs do not integrate various causes of gender inequity, then the ICT revolution is likely to exacerbate gender exclusion because poverty mitigation programs through extensive deployment of ICTs in rural Bangladesh are strangely beneficial to men, even when primarily directed at women.

Besides highlighting studies concerned with the institutions-ICT-gender inclusion nexuses, it is important to point out that several studies have equally examined the role of institutional quality in varying aspects of the economy (encompassing economic growth, financial development, and foreign direct investments, among others), which can affect gender inclusion either directly or indirectly (Ofori *et al.*, 2021). For instance, Abdelbary and Benhin (2019) revealed that governance is essential in enhancing economic growth in the Arab region. These findings for Arab countries corroborate the results of studies focused on developing countries (Anyanwu, 2014) and South Asian economies (Singh and Pradhan, 2022). Moreover, Asongu and Nwachukwu (2016) established the existence of a synergy effect by governance interaction with ICT penetration and inclusive development in the context of Sub-Saharan Africa. If institutional quality is improved, coupled with increased female enlightenment through the increasing digitalization of world economies, the adoption of ICTs will inevitably enhance gender inclusion, which in turn could foster sustainable development (Achuo *et al.*, 2022a).

Based on the literature, it is evident that there is no consensus on the underlying relationships between institutional quality, ICT penetration, and gender inclusion. Moreover, most extant studies have explored institutional-gender inclusion or ICT-gender inclusion nexuses from regional or country-specific bases. The present study thus fills an important gap in the literature by comprehensively examining the institution-ICT-gender inclusion relationship from a global perspective encompassing both developed and developing economies and various income groups.

3. Research methodology

3.1 Model specification
As mentioned earlier, the theoretical foundations between institutions, ICT penetration, and gender inclusion can be traced to the "theory of communicative action" propounded by

Habermas (1985). According to Habermas's theory, using ICT tools can foster inclusive education and social cohesion among citizens who can participate in social groups on an equal basis. Thus, Habermas (1985) argued that citizens' participation in the life world through information sharing can also shape the political system.

Contingent on the aforementioned premises, a theoretical model wherein gender inclusion is explained principally by ICT penetration and institutional quality is provided as follows:

$$Gender\ Inclusion = f(Institutions, ICT) \tag{1}$$

Consequently, in order to empirically analyze the impact of institutions and ICT penetration on gender inclusion, and consistent with extant contemporary works of Asongu and Odhiambo (2020), the following econometric model is specified.

$$GI_{it} = \varphi_0 + \varphi_1 IQ_{it} + \varphi_2 ICT_{it} + \varphi_3 CV_{it} + \mu_{it} \tag{2}$$

where GI_{it} represents an indicator of gender inclusion (i.e. female labor force participation, women in parliament, and women business and the law index) of country i in period t; φ_0 is the intercept; φ_1, φ_2 and φ_3 are slope coefficients; IQ denotes institutional quality; ICT is information and communication technology; CV is a vector of control variables encompassing financial development, per capita GDP, and foreign direct investment inflows; μ is the random error term.

3.2 Data and description of variables
In order to examine the effects of institutional quality and ICT penetration on gender inclusion for a panel of 142 countries from 1996 to 2020, this study employs data from two principal sources. While data for various governance indicators are obtained from the Worldwide Governance Indicators (WGI) of the World Bank, data for the rest of the variables are obtained from the World Development Indicators (WDI) of the World Bank. The choice of included countries and timeframe are constrained by data availability for the dependent, independent, and control variables of interest.

3.2.1 Dependent variable. The dependent variable in this study is gender inclusion, which is captured by three main indicators. These proxies take into consideration the socioeconomic and political dimensions of gender inclusion. Consequently, this paper employs the "Women Business and the Law Index (WBLI)" as a proxy for socioeconomic gender inclusion. The WBLI, developed by the World Bank (2020), is believed to be a better measure of gender inclusion than other classical indicators. Adopting this indicator of women's socioeconomic empowerment is in line with a recent study by Achuo *et al.* (2022a). Secondly, we capture gender inclusion at the "female labor force participation rate (FLFP)," which is a proxy for economic gender inclusion. The employment of FLFP as a measure of gender inclusion is consistent with Asongu and Odhiambo (2020). Finally, consistent with Goltz *et al.* (2015), we take into consideration political gender inclusion by making use of the "proportion of seats held by women in national parliaments."

3.2.2 Independent variables. Two main explanatory variables are used in this paper: institutional quality and ICT penetration. As regards institutional quality, this study employs the average of the six WGI developed by the World Bank (Kaufmann *et al.*, 2010) as a proxy for institutional quality. However, we further take into consideration the effects of various disaggregated measures of governance (Corruption control, government effectiveness, political stability, voice and accountability, regulatory quality, and rule of law) in consonance with Asongu and Odhiambo (2020), who established a positive relationship between governance and women's economic empowerment. Consequently, a positive relationship was expected between institutional quality and gender inclusion in this study.

H1. Enhancements in institutional arrangements enhance gender inclusion.

The second independent variable used in this study was ICT penetration. However, three conventional measures of ICT penetration (notably, internet penetration, mobile phone subscription, and telephone penetration) are employed. The use of the various ICT proxies in this study is in line with Efobi *et al.* (2018), who argue that ICT advancement enhances women's economic inclusion. Consequently, a positive relation is expected in this study.

H2. Advancements in information and communication technologies (ICTs) positively impact gender inclusion.

3.2.3 Control variables. The first control variable used in this study is financial development, proxied by the domestic credit to the private sector. The employment of this measure of financial development is consistent with Park *et al.* (2018). According to Ayagi *et al.* (2021), a U-shaped relationship exists between financial development and economic gender inclusion. Specifically, Ayadi *et al.* (2021) argue that although the nexus between financial development and gender inclusion is initially negative, the effect becomes positive beyond a certain threshold. The positive effect is, however, contingent on institutional quality. A negative or positive effect of financial development on gender inclusion is thus expected in this study.

Secondly, we use foreign direct investment inflows (% GDP) as a control variable in accordance with Achuo (2022). Lai and Sarkar (2017) argue that foreign direct investment (FDI) inflows enhance gender inclusion. In this light, a positive effect is expected between FDI and gender inclusion. Finally, the study employs economic growth, proxied by gross domestic product (GDP) per capita, as a control variable. This measure of economic growth has been employed by several studies (Achuo *et al.*, 2021; Miamo and Achuo, 2021, 2022). In this study, a positive or negative relationship between GDP per capita and gender inclusion is expected. This expected relationship is consistent with extant studies that have revealed the existence of a U-shaped relationship between economic growth and female labor force participation (Mujahid and uz Zafar, 2012; Pampel and Tanaka, 1986). Further information regarding the summary of descriptive statistics and matrix of correlations for the various modelled variables is provided in Appendix 4 and Appendix 5, respectively.

3.3 Estimation technique

Nowadays, the growing interdependence of world economies and the co-movement of macroeconomic variables across various countries is unavoidable. Consequently, it is important to consider the presence of cross-sectional dependence among these variables (Achuo *et al.*, 2022b; Achuo, 2023). Thus, the empirical analysis of the effects of institutional quality and ICT penetration on gender inclusion is conducted with the help of the fixed-effects regression model with Driscoll and Kraay's (1998) robust standard errors. This estimation technique is adopted due to its inherent advantages over other classical econometric approaches. For instance, Driscoll-Kraay's approach can adjust for cross-sectional dependence, which is characteristic of large panel datasets. Accordingly, Hoechle (2007) argues that Driscoll-Kraay's approach yields consistent estimates regardless of the number of cross-sectional units. The Driscoll-Kraay Fixed Effects (DKFE) estimator is based on the Newey and West (1987) type adjustment to the sequence of cross-sectional averages of the moment conditions.

Moreover, besides being robust to general temporal and cross-sectional dependence forms, the DKFE estimators are heteroscedastic and autocorrelation consistent (Knight, 2014; Hoechle, 2007). Additionally, Achuo *et al.* (2022b) contend that the Driscoll–Kraay approach is more appropriate for models wherein the number of time periods (T) is small relative to the number of cross sections (N). Thus, Driscoll-Kraay's approach is appropriate in this study since N (142) exceeds T (25). However, the robustness of the DKFE estimators is authenticated in this study by the system GMM estimators, according to Roodman (2009).

4. Empirical results and discussion

4.1 Baseline analysis

The baseline results exploring the effects of institutions and ICT adoption on gender inclusion are contained in Tables 1–4. Firstly, the results show that institutions have a significantly positive effect on gender inclusion, irrespective of the indicator of gender inclusion. However, the impact is greater when a more inclusive socioeconomic indicator (models 1, 2, and 3) is used. According to Achuo *et al.* (2022a), the Women Business and the Law Index (WBLI) is a better measure of gender inclusion. Thus, unlike female labor force participation, which is limited to women's economic inclusion, WBLI is a composite index of eight (8) indicators capturing the socioeconomic dimensions of women's empowerment (World Bank, 2020). The positive impact of institutions on the socioeconomic and political dimensions of gender inclusion corroborates previous findings. For instance, Asongu and Odhiambo (2020) showed that good institutions enhance gender inclusion. However, their findings are limited to women's economic inclusion in the context of Sub-Saharan African countries.

Furthermore, the results show that various measures of ICT penetration (internet, telephone, and mobile) positively impact gender inclusion. However, the impact of ICT penetration is higher in the context of the socioeconomic indicator (models 1, 2, and 3) than when the political dimension is considered (models 4, 5, and 6). However, ICTs are the least impactful when the purely economic dimension is considered (models 7, 8, and 9). Additionally, the results in Table 1 reveal that the magnitude of internet penetration is greater than that of the other ICT measures for all the indicators of gender inclusion. Thus, in order of importance, the internet is followed by telephone subscriptions and mobile phone penetration.

Besides, to verify the consistency of the DKFE estimators, we employed the system generalised method of moments (GMM) approach due to its ability to control for endogeneity and cross-sectional dependence (Achuo *et al.*, 2023). Consequently, the system GMM results presented in Table 2 are largely consistent with our baseline findings obtained from the DKFE estimators.

The apparent effects of ICT penetration on gender inclusion are consistent with the results of Efobi *et al.* (2018). Nevertheless, the findings of Efobi *et al.* (2018) are limited to the analysis of women's economic empowerment in the context of Sub-Saharan Africa. However, given that the internet penetration is the most important measure of ICT that significantly empowers women (as depicted in Tables 1 and 2), we then verify the consistency of the baseline results in the presence of different measures of institutional quality. Consequently, the results for the respective measures of gender inclusion are presented in Tables 3–5.

Considering the socioeconomic gender inclusion (Table 3), we show that besides corruption control, which has a positive but insignificant effect on women's empowerment, other governance indicators (rule of law, regulatory quality, voice and accountability, political stability, government effectiveness) play a significant role in enhancing gender inclusion. Similar results are obtained when gender inclusion is measured by female labor force participation (Table 5). Surprisingly, although the rule of law, regulatory quality, and political stability do not significantly contribute to women's political empowerment, corruption (Table 4) seems to improve the proportion of women in parliament. This result is, however, consistent with the views of Armstrong *et al.* (2022), who argue that corruption is likely to enhance women's political empowerment. This view is particularly the case where some top government officials may advocate for women's inclusion to shield their abuse of public office. Conversely, Dutta (2018) opines that corruption negatively impacts gender inclusion, although the negative effect is contingent on globalization and information flows.

Despite the divergent role of various indicators of institutional quality with regard to different measures of gender inclusion, the effect of ICT penetration remains positive. Interestingly, although ICT penetration significantly enhances socio-politico-economic gender inclusion, the ICT coefficient is highest in the presence of two governance indicators (corruption

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
					Dependent variable				
	Women business and law index			Women in parliament			Female labour force participation		
Institutions	9.137***	7.814***	10.36***	3.223**	3.043**	3.983***	5.924***	5.661***	6.878***
	(2.435)	(2.449)	(2.653)	(1.526)	(1.498)	(1.497)	(1.780)	(1.928)	(1.928)
Findev	0.0186	0.0696**	0.0601**	0.00447	0.0359	0.0220	0.0333	0.0420	0.0510*
	(0.0251)	(0.0289)	(0.0277)	(0.0288)	(0.0275)	(0.0267)	(0.0273)	(0.0303)	(0.0307)
FDI	−0.0218	−0.0213	−0.0163	−0.0533***	−0.0491***	−0.0494***	−0.0311	−0.0251	−0.0190
	(0.0141)	(0.0166)	(0.0136)	(0.0159)	(0.0187)	(0.0182)	(0.0299)	(0.0358)	(0.0324)
GDP (log)	−4.325***	−1.940	−2.608	−2.538*	−0.0955	−1.616	−7.019***	−8.008***	−7.091***
	(1.631)	(1.916)	(1.739)	(1.421)	(1.234)	(1.276)	(1.368)	(1.484)	(1.386)
Internet	0.731***			0.406***			0.306***		
	(0.101)			(0.0611)			(0.0759)		
Telephone		0.248**			0.00905			0.200**	
		(0.107)			(0.0664)			(0.0838)	
Mobile			0.115***			0.0749***			0.0200*
			(0.0115)			(0.0110)			(0.0118)
Constant	101.6***	77.30***	79.86***	37.26***	16.57	24.92**	107.7***	114.5***	108.3***
	(13.19)	(14.45)	(13.85)	(12.02)	(10.09)	(10.48)	(11.27)	(11.72)	(11.22)
Observations	2,142	2,813	2,821	2,085	2,595	2,603	2,142	2,813	2,821
R-squared	0.417	0.348	0.394	0.177	0.121	0.189	0.141	0.153	0.141
Fisher	50.08***	39.08***	49.72***	18.87***	6.014***	26.85***	8.254***	6.727***	5.691***

Note(s): Findev, financial development; FDI, foreign direct investment inflows; DKFE, Driscoll-Kraay Fixed Effects; GDP, gross domestic product per capita; log, natural logarithm; Standard errors in parentheses; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Source(s): Computed by authors

Table 1.
DKFE estimates of the effect of institutions and ICT penetration on gender inclusion

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
	Women business and law index			Women in parliament (Dependent variable)			Female labour force participation		
Institutions	10.18***	11.35***	14.71***	7.889***	11.80***	7.574***	9.615***	12.21***	13.34***
	(0.542)	(0.238)	(0.184)	(0.440)	(0.316)	(0.483)	(0.299)	(0.377)	(0.189)
Findev	0.0500***	0.0175***	0.0759***	0.0480***	−0.0529***	0.0428***	0.0310***	0.0393***	0.0498***
	(0.00506)	(0.00170)	(0.00217)	(0.00453)	(0.00757)	(0.00565)	(0.00251)	(0.00814)	(0.00934)
FDI	−0.224***	−0.0314***	−0.0217***	−0.207***	−0.168***	−0.269***	−0.0432***	0.533***	0.533***
	(0.0135)	(0.00264)	(0.00263)	(0.0146)	(0.0214)	(0.0148)	(0.00414)	(0.0384)	(0.0202)
GDP (log)	−3.601***	−5.106***	−6.007***	−7.801***	−7.732***	−1.616***	−11.37***	−7.986***	−6.772***
	(0.334)	(0.128)	(0.0583)	(0.208)	(0.385)	(0.292)	(0.126)	(0.447)	(0.205)
Internet	0.672***			0.836***			0.520***		
	(0.0394)			(0.0158)			(0.0133)		
Telephone		0.412***			0.590***			0.205***	
		(0.00626)			(0.0311)			(0.0559)	
Mobile			0.104***			0.0258*			0.0154***
			(0.00187)			(0.0129)			(0.00203)
Constant	98.97***	103.0***	110.1***	78.62***	77.48***	32.72***	149.4***	107.4***	94.15***
	(2.701)	(0.954)	(0.464)	(1.743)	(2.596)	(1.745)	(1.146)	(3.949)	(2.197)
Observations	2,106	2,770	2,285	2,018	2,459	2,467	1,695	2,311	2,323
Instruments	25	31	25	25	25	25	25	31	25
AR(1)_prob	0.000119	1.13e-05	1.70e-05	0.000297	2.74e-05	5.58e-05	8.45e-05	4.89e-05	3.18e-05
AR(2)_prob	0.762	0.447	0.244	0.652	0.115	0.319	0.210	0.190	0.104
Hansen_prob	0.315	0.470	0.156	0.309	0.200	0.197	0.316	0.474	0.168
Fisher	5.172e+06***	248,122***	2.092e+06***	9,507***	5,885***	10,507***	920,730***	393,729***	2.570e+07***

Note(s): Standard errors in parentheses; GMM, Generalised Method of Moments; Lagged values of the explained variables are used in the system GMM estimations; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Source(s): Computed by authors

Table 2.
System GMM estimates of the effect of institutions and ICT penetration on gender inclusion

Variables	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent variable: women business and law index (WBLI)			
Rule of law	4.904**					
	(1.946)					
ICT	0.753***	0.701***	0.669***	0.788***	0.738***	0.803***
	(0.115)	(0.103)	(0.0862)	(0.121)	(0.102)	(0.123)
Financial development	0.0273	0.0152	0.0482*	0.0496*	0.00758	0.0484*
	(0.0243)	(0.0243)	(0.0288)	(0.0265)	(0.0259)	(0.0254)
FDI	−0.0159	−0.0227*	−0.0282**	−0.0247*	−0.0117	−0.0122
	(0.0153)	(0.0129)	(0.0143)	(0.0147)	(0.0147)	(0.0150)
GDP per capita (log)	−2.735*	−4.531***	−3.413***	−2.569*	−4.186**	−1.259
	(1.580)	(1.402)	(1.174)	(1.503)	(1.638)	(1.403)
Regulatory quality		9.654***				
		(2.042)				
Voice and accountability			9.355***			
			(1.951)			
Political stability				4.772***		
				(1.592)		
Government effectiveness					8.017***	
					(2.060)	
Corruption control						0.928
						(0.606)
Constant	87.41***	103.2***	92.55***	85.04***	100.6***	73.22***
	(12.38)	(11.09)	(10.05)	(11.41)	(13.14)	(10.78)
Observations	2,142	2,142	2,142	2,141	2,142	2,142
R-squared	0.363	0.418	0.501	0.378	0.389	0.350
Fisher	48.73***	53.29***	73.75***	42.56***	47.98***	40.78***

Note(s): ICT, Information and communication technology; FDI, foreign direct investment; GDI, Gross domestic product; Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Source(s): Computed by authors

Table 3.
Institutional quality,
ICT penetration and
socioeconomic gender
inclusion

control and political stability). This result suggests that the role of ICTs in curbing gender exclusion will be more impactful in politically stable economies and countries where corruption is highly contained. These findings corroborate the views of Singh and Mathur (2021), who argue that ICTs are crucial for women's empowerment in South Asia.

4.2 Sensitivity analysis

Table 6 highlights the sensitivity analysis with respect to the level of development and income group of various countries included in the global sample. Concerning the level of development, we find that while ICT penetration significantly enhances the socioeconomic empowerment of women in developed and developing countries, the effect of institutions is only significant in the context of developed economies. The insignificant role of institutions in developing countries may be justified by endemic corruption and socio-political tensions that characterize these countries (Hassan, 2022; Hope Sr, 2017). Hope Sr (2017) contends that despite the propagation of institutional and legal procedures aimed at curbing corruption in developing countries, the persistence of corruption in these economies engenders undesirable socioeconomic consequences. Corroboratively, Hassan (2022) argues that persistent corruption is responsible for the worsening social conditions in developing countries.

With regard to the level of income, the results in Table 6 show that the positive nexus between institutions and socioeconomic gender inclusion is consistent across various income groups. However, although the role of ICT penetration in socioeconomic gender inclusion is insignificant in Low-income countries, it has been shown to have an enhancing effect in Lower-

Variables	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent variable: women in parliament			
Rule of law	1.675					
	(1.951)					
ICT	0.414***	0.406***	0.410***	0.426***	0.394***	0.431***
	(0.0593)	(0.0583)	(0.0643)	(0.0647)	(0.0570)	(0.0660)
Financial development	0.00761	0.00741	0.0164	0.0152	−0.00901	0.0118
	(0.0300)	(0.0286)	(0.0282)	(0.0284)	(0.0301)	(0.0284)
FDI	−0.0512***	−0.0524***	−0.0527***	−0.0534***	−0.0496***	−0.0500***
	(0.0165)	(0.0165)	(0.0175)	(0.0175)	(0.0154)	(0.0171)
GDP per capita (log)	−1.951	−2.183	−1.787	−1.777	−3.150*	−1.664
	(1.595)	(1.535)	(1.095)	(1.280)	(1.636)	(1.149)
Regulatory quality		2.321				
		(1.646)				
Voice and accountability			1.631**			
			(0.797)			
Political stability				1.359		
				(1.120)		
Government effectiveness					4.442**	
					(1.962)	
Corruption control						0.778*
						(0.466)
Constant	32.03**	33.93***	30.14***	30.19***	43.11***	29.20***
	(13.83)	(12.92)	(8.909)	(10.59)	(14.14)	(9.319)
Observations	2,085	2,085	2,085	2,085	2,085	2,085
R-squared	0.160	0.165	0.166	0.162	0.188	0.166
Fisher	19.58***	17.66***	18.13***	18.05***	19.04***	18.79***

Note(s): ICT, Information and communication technology; FDI, foreign direct investment; GDI, Gross domestic product; Standard errors in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Source(s): Computed by authors

Table 4.
Institutional quality, ICT penetration and political gender inclusion

middle-income, Upper-middle-income, and High-income countries. Reddick *et al.* (2020) showed that social exclusion is apparent in low-income areas characterized by lower internet penetration. The high cost associated with high-speed internet adoption could be the reason for the insignificant effect of ICT penetration on women's empowerment in low-income countries.

5. Conclusion and policy implications

Although the issue of gender inclusion has been widely documented, answers to the question of whether institutional arrangements and ICT penetration shape gender inclusion remain contentious. Therefore, this study examined the effects of institutional quality and ICT penetration on gender inclusion from a global perspective.

In order to achieve this objective, we employed the Driscoll and Kraay robust standard error estimator to uncover the underlying relationships for a global panel of 142 countries from 1996 to 2020.

The empirical results reveal that institutional quality significantly enhances gender inclusion. Moreover, when institutional quality is disaggregated into various governance indicators (rule of law, regulatory quality, voice and accountability, political stability, government effectiveness, corruption control), we show that besides corruption control, which has a positive but insignificant effect on women's empowerment, other governance indicators significantly promote gender inclusion. Likewise, there is evidence that various measures of ICT penetration (internet adoption, mobile phone subscription, and telephone penetration) equally enhance gender inclusion.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent variable: female labour force participation (FLFP)			
Rule of law	3.930**					
	(1.820)					
ICT	0.313***	0.288***	0.325***	0.335***	0.299***	0.352***
	(0.0765)	(0.0728)	(0.0784)	(0.0749)	(0.0734)	(0.0782)
Financial development	0.0348	0.0317	0.0553**	0.0510**	0.0176	0.0505*
	(0.0258)	(0.0267)	(0.0268)	(0.0257)	(0.0250)	(0.0260)
FDI	−0.0278	−0.0315	−0.0280	−0.0392	−0.0245	−0.0249
	(0.0315)	(0.0282)	(0.0290)	(0.0290)	(0.0302)	(0.0286)
GDP per capita (log)	−6.279***	−7.097***	−5.279***	−6.742***	−7.545***	−5.187***
	(1.555)	(1.504)	(1.385)	(1.325)	(1.695)	(1.327)
Regulatory quality		6.116***				
		(2.016)				
Voice and accountability			1.909			
			(1.553)			
Political stability				5.454***		
				(1.647)		
Government effectiveness					6.669***	
					(1.925)	
Corruption control						0.939
						(0.670)
Constant	101.3***	108.2***	91.49***	104.8***	112.8***	90.77***
	(13.15)	(12.48)	(11.52)	(10.83)	(14.44)	(10.86)
Observations	2,142	2,142	2,142	2,141	2,142	2,142
R-squared	0.112	0.139	0.103	0.162	0.141	0.103
Fisher	6.376***	6.873***	6.364***	8.437***	7.042***	6.580***

Note(s): ICT, Information and communication technology; FDI, foreign direct investment; GDI, Gross domestic product; Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Source(s): Computed by authors

Table 5.
Institutional quality, ICT penetration and economic gender inclusion

Variables	(1) Developed economies	(2) Developing economies	(3) Low-income	(4) Lower-middle-income	(5) Upper-middle-income	(6) High-income
			Dependent variable: women business and law index			
Institutions	10.52***	3.696	14.71***	9.339*	8.413***	12.33*
	(2.543)	(2.258)	(3.948)	(5.275)	(3.011)	(6.150)
ICT	0.844***	0.402***	6.196	1.023**	0.945***	0.750***
	(0.286)	(0.0503)	(4.111)	(0.448)	(0.332)	(0.115)
Financial development	−0.00564	0.00211	0.433**	0.00473	−0.0687	0.0498*
	(0.0516)	(0.0243)	(0.180)	(0.0517)	(0.0840)	(0.0265)
FDI	0.176	−0.0322**	−0.0369	0.393	−0.617	−0.0311**
	(0.154)	(0.0141)	(0.194)	(0.278)	(0.654)	(0.0136)
GDP per capita (log)	−6.156***	−1.887	−20.25***	−2.767	−6.103	−7.193
	(1.711)	(2.991)	(2.379)	(4.742)	(3.874)	(4.581)
Constant	115.6***	94.40***	198.2***	88.72**	125.7***	122.7***
	(13.06)	(26.74)	(17.31)	(35.30)	(38.02)	(40.62)
Observations	1,494	648	208	608	518	808
R-squared		0.320				0.510
Fisher	8.254***	18.51***	90.49***	2.725**	6.341***	13.79***

Note(s): ICT, Information and communication technology; FDI, foreign direct investment; GDI, Gross domestic product; Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Source(s): Computed by authors

Table 6.
Institutions, ICT and socioeconomic gender inclusion taking into consideration the level of development and income groups

Furthermore, when the global panel is disaggregated into income groups and levels of development, the results show that while the gender inclusion-enhancing role of ICTs is consistent across developed and developing countries, it is divergent across income groups. Conversely, although the positive effect of institutional quality on gender inclusion is consistent across various income groups and developed countries, the effect is insignificant in the context of developing countries.

Contingent on these findings, the following policy recommendations are advanced. Policymakers in developing countries should put stringent measures in place to curb corruption, which remains a major impediment to gender inclusion. Moreover, policymakers in low-income countries should create avenues to facilitate women's access to information and communication technologies. Thus, policymakers in low-income countries should create and equip ICT training centers and render them accessible to all categories of women. Likewise, these ICT training programs should be subsidized for vulnerable women who are willing to undertake such courses but cannot afford the high training cost. In addition, developed countries with high-tech knowledge could help developing countries through the organization of free training workshops and sensitization campaigns, highlighting their success stories with regard to the use of ICTs vis-à-vis women empowerment in various fields of life. An increase in women's access to (use of) ICTs will likely reduce the socioeconomic and political gender exclusion characteristic of low-income developing countries.

Despite the global nature of this study, it, however, leaves room for future research endeavors. Future studies could consider country-specific case studies for the design of country-specific policies with regard to the nexuses between institutions, ICT penetration and gender inclusion. Moreover, future research could provide a more comparative analysis based on different sub-regional groupings for more concerted policies. Finally, future studies should consider exploring the modulating variables through which institutions and ICT penetration can affect gender inclusion.

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Further reading

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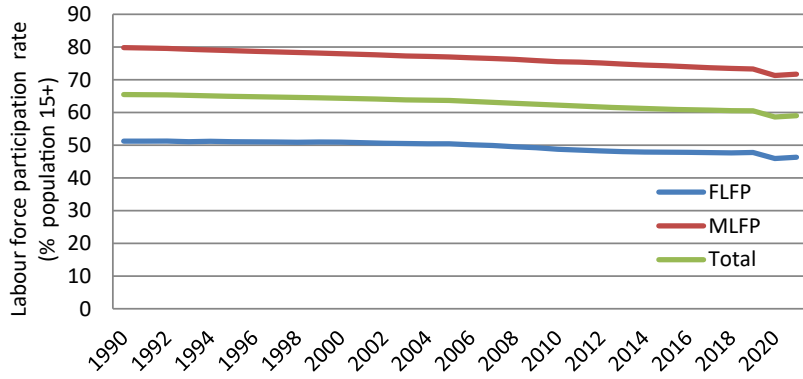
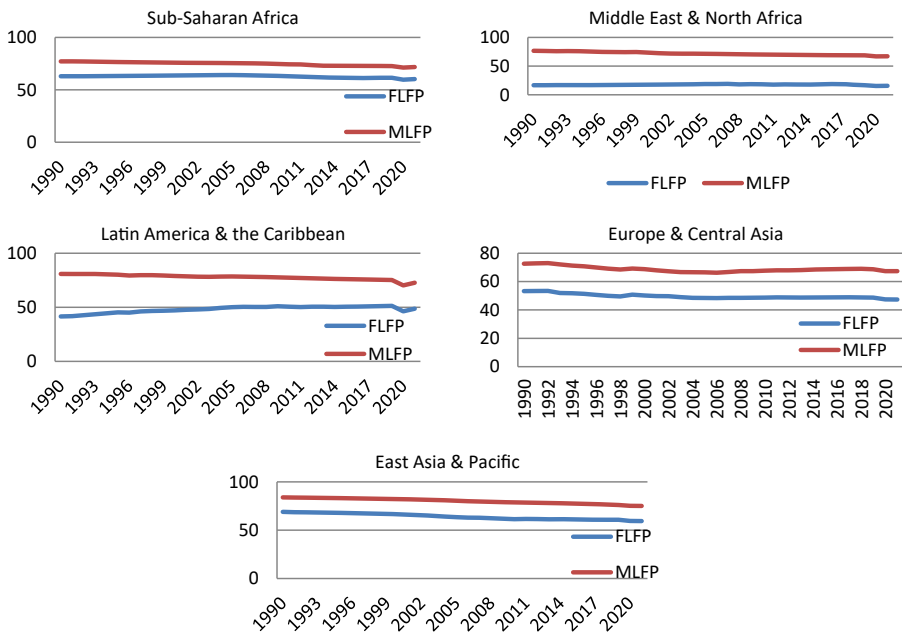**Figure A1.**
Evolution of labour
force participation at
the global scale

Note(s): FLFP = female labour force participation; MLFP = male labour force
participation
Source(s): Computed by authors from World Bank (2021) data

Appendix 2

Figure A2.
Evolution of male and
female labour force
participation across
regions

Source(s): Computed by authors from World Bank (2021) data

Appendix 3

Algeria, Angola, Argentina, Australia, Austria, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo Dem. Rep., Congo Rep., Costa Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Djibouti, Dominican Republic, Egypt, El Salvador, Equatorial Guinea, Eritrea

Estonia, Eswatini, Ethiopia, Finland, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Rep., Kuwait, Latvia, Libya, Lithuania, Madagascar, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea

Paraguay, Peru, Philippines, Poland, Portugal, Romania, Rwanda, Saudi Arabia, Senegal, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Sudan, Suriname, Sweden, Switzerland, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan. Vanuatu, Vietnam, Yemen, Rep., Zambia, Zimbabwe

Source(s): Constructed by authors

Table A1.
List of countries
included in the sample

Appendix 4

Variable	Obs	Mean	Std. Dev	Min	Max
Women business and law index	3,524	68.809	18.633	17.5	100
Women in parliament	3,234	18.018	11.641	0	63.75
Female labour force participation	3,408	51.807	15.262	6	87.68
Institutions	3,550	0.013	0.928	−2.1	12.768
Rule of law	3,550	0.002	0.992	−2.13	2.13
Corruption control	3,549	0.047	1.66	−1.816	67.603
Government effectiveness	3,547	0.056	0.99	−2.308	2.437
Political stability	3,543	−0.07	0.953	−3.006	1.878
Regulatory quality	3,548	0.061	0.96	−2.347	2.261
Voice and accountability	3,407	−0.02	0.98	−2.226	1.801
Internet	2,540	9.644	12.302	0	48.335
Telephone	3,485	18.298	18.494	0	74.988
Mobile	3,499	65.353	51.453	0	212.639
Financial development	2,980	51.383	45.072	0	304.575
Foreign direct investment	3,367	4.925	16.555	−40.33	449.083
GDP per capita	3,496	8.544	1.446	5.466	11.39

Source(s): Constructed by authors

Table A2.
Descriptive statistics of
variables

Appendix 5

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Women business and law	1.000															
(2) Women in parliament	0.502	1.000														
(3) FLFP	0.385	0.313	1.000													
(4) Institutions	0.546	0.287	0.068	1.000												
(5) Rule of law	0.489	0.256	0.022	0.942	1.000											
(6) Corruption control	0.292	0.203	0.048	0.769	0.576	1.000										
(7) Government effectiveness	0.524	0.307	0.050	0.926	0.954	0.570	1.000									
(8) Political stability	0.432	0.204	0.135	0.793	0.763	0.459	0.710	1.000								
(9) Regulatory quality	0.563	0.270	0.064	0.910	0.927	0.539	0.937	0.684	1.000							
(10) Voice and accountability	0.607	0.241	0.039	0.769	0.716	0.415	0.675	0.583	0.700	1.000						
(11) Internet	0.579	0.373	0.080	0.443	0.385	0.363	0.489	0.483	0.377	0.496	1.000					
(12) Telephone	0.480	0.204	−0.011	0.448	0.375	0.463	0.498	0.371	0.448	0.460	0.352	1.000				
(13) Mobile	0.307	0.232	−0.083	0.353	0.368	0.182	0.397	0.277	0.405	0.251	0.452	0.312	1.000			
(14) Financial development	0.415	0.219	0.050	0.452	0.511	0.409	0.429	0.462	0.474	0.416	0.503	0.472	0.378	1.000		
(15) FDI	0.061	−0.042	−0.015	0.129	0.134	0.070	0.120	0.128	0.133	0.101	0.102	0.147	0.053	0.191	1.000	
(16) GDP per capita	0.434	0.325	0.106	0.474	0.429	0.502	0.422	0.488	0.487	0.500	0.513	0.462	0.354	0.484	0.081	1.000

Source(s): Constructed by authors

Table A3.
Matrix of correlations