

Impact of information and communication technology (ICT) infrastructure on women's economic empowerment in West African Economic and Monetary Union (WAEMU) countries: the catalytic effect of democracy.

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Abstract:

The aim of this research is to examine the relationship between ICT infrastructure and the women's economic empowerment, considering the quality of democracy. Based on a fixed effects model covering the period 2005–2022 using a panel of WAEMU countries, our estimation results reveal that information and communication technology infrastructures negatively affect the economic automation of women in the region. Conversely, democracy positively influences the women's economic empowerment. Furthermore, the interaction between ICT infrastructure and democracy positively impacts women's participation in the labor market, thus confirming the catalytic role of democracy in the relationship between ICT infrastructure and women's economic empowerment. These results imply the need for efforts to strengthen the democratization of access to ICT infrastructure in order to promote the growth of women's empowerment in the study area.

Keywords: Democracy, ICT, women empowerment, catalytic effect, WAEMU.

INTRODUCTION

Developing countries, amid the transitions taking place within them, continue to be characterized by a significant gap and substantial inequalities in access to the labor market between men and women. Consequently, one of the major priorities emerging in these developing countries, particularly in the WAEMU region, remains the women's economic empowerment through their participation in the countries' economic activities. Information and communication technologies (ICT) play a crucial role in the transformation of modern economies, profoundly influencing the women's economic empowerment by facilitating access to the labor market. While these advancements offer new opportunities to populations, they also raise significant challenges regarding gender equality in access to these technologies. Moreover, democracy, by guaranteeing equal rights and inclusive participation, helps strengthen access for populations—especially women—to the various opportunities that ICT can provide, with a tangible impact on socio-economic inequalities. In this context, ICT plays a dual role. On one hand, they contribute to enhancing women's professional integration, education, and entrepreneurship. On the other hand, depending on the existing democratic framework, these technologies may either support empowerment or exacerbate pre-existing discrimination. Therefore, democracy is seen as a lever to guide these developments by promoting policies that ensure inclusive access to ICT resources.

Empirically, the analysis of the effects of ICT on the women's economic empowerment has been the subject of numerous studies with divergent results. In this regard, authors such as Shehata (2017), Obayelu and Ogunlade (2006), Hafeez et al. (2020), and Isa et al. (2021) observed a positive correlation between ICT infrastructure and the women's economic empowerment. Contrary to these authors, Chérif and Kouadri (2021) and Tuzemen et al. (2021) showed that, in the presence of unequal access to ICT, women appear to be in a discriminatory position that does not allow them to improve their economic empowerment.

Furthermore, according to AfDB statistics (2025), the ICT infrastructure index score in the WAEMU region increased significantly from 0.002 to 15.31. At the same time, women's participation in the labor force declined slightly, from 55.39% to 54.10% on average between 2005 and 2022, indicating a minor decrease in the share of women in total labor force participation (World Bank, 2025). The WAEMU region also experienced only modest improvements in its level of democracy, with the democracy score rising from 3.29 to 3.96 between 2005 and 2021 (ICRG, 2023), highlighting that strengthening democracy remains a significant challenge for countries in the region.

Thus, the absence of an empirical consensus amid the highly heterogeneous evolution of ICT infrastructures and efforts towards women's economic empowerment within the union, compounded by communication network failures, connectivity issues, and ongoing socio-political crises in the region. Hence the title of our subject of study: « Impact of information and communication technology (ICT) infrastructure on women's economic empowerment in WAEMU Countries: The Catalytic Effect of Democracy ».

The objective of this article is to analyze the effects of ICT infrastructure on women's economic empowerment, conditional on democracy. Our hypothesis is that democracy positively influences the relationship between ICT infrastructure and women's economic empowerment in the WAEMU region.

The contribution of this work is expected at two levels. Given the observed controversies surrounding the risks of aggravating challenges related to socio-political crises and women's economic empowerment arising from certain social restrictions and ICT infrastructure failures amid democratization efforts, this article appears to be the first specific study focused on the WAEMU region. Likewise, the value of this article lies in incorporating democracy through the introduction of an interaction variable to capture its catalytic effect on the relationship between ICT infrastructure and women's economic empowerment. Accordingly, we investigate the following question: does democracy determine how ICT infrastructure affects the women's economic empowerment in WAEMU countries?

This study adopts a positivist epistemological approach. Accordingly, based on a clearly articulated theoretical framework, we conduct an empirical investigation using macroeconomic data. We employ a quantitative research design drawing on data from the World Bank, the African Development Bank, and ICRG for the period 2005–2022 and implement a methodological strategy relying on a fixed-effects estimator.

The article is structured into three sections. Section 1 presents the theoretical and empirical literature review. Section 2 outlines the model, the data and the estimation strategy. Section 3 reports and discusses the empirical findings.

1. Literature review

1.1. Theoretical literature review

Economic empowerment is a key pillar enabling women to live with dignity and regain their identity and social status (Sajeev and David, 2011). In this context, Information and Communication Technology (ICT) infrastructures play a crucial role in women's economic emancipation by providing improved access to economic opportunities, education, and financial services, while also reducing the gender gap in employment (Shehata, 2017).

Similarly, Chérif and Kouadri (2021) argue that ICTs serve as a powerful lever for women's participation in the labor market. ICT facilitates access to information and education, enabling women to pursue online training and acquire digital skills. ICT also offers women the opportunity to work from home, thus reducing social and family constraints. Obayelu and Ogunlade (2006) revealed that ICT allows access to information that can enhance women's capacity for economic empowerment. Digital tools enable women to overcome mobility and family-related obstacles. According to Melhem et al. (2009), technologies offer new opportunities for knowledge sharing and information gathering that benefit everyone. The Economic Commission for Latin America (ECLAC, 2013) maintains that ICT can be a transversal support tool for economic, political, cultural, and social activities and contribute to ensuring equality and reducing the gender gap. Thus, ICT constitutes a source of improved living conditions, access to employment, education, and health services. Promoting development in Southern countries relies on ICT, which offers a variety of services and applications considered very useful for promoting development and poverty reduction (Kramer et al., 2007; Mathur and Ambani, 2005). Adoption of these information and communication means contributes to women's economic empowerment and the consolidation of gender equality. ICT is regarded as one of the drivers of women's empowerment and can help make the labor market more inclusive, innovative, and transparent (Hafeez et al., 2020).

Moreover, ICT can provide opportunities to women in developing countries characterized by significant gender inequalities. Hafkin and Taggart (2001) argue that these information technologies are a powerful lever for transforming the economic, social, and political lives of populations in general. For women, ICT offers better economic prospects, political participation, easy access to information, and the ability to acquire education and skills to overcome social restrictions. In this dynamic, these authors view ICT as a tool for women's economic empowerment and reducing the gender inequality gap in developing countries. ICT contributes to social change and economic development, leading Hafkin and Huyer (2007) and Ogato (2013) to acknowledge ICT as the fastest means to improve labor force participation among disadvantaged groups and female minorities. ICT facilitates access to reliable information, aiding women in decision-making. Thus, information and communication technologies offer opportunities for economic empowerment by increasing women's purchasing power and control over factors that improve their living standards. Rahman et al. (2017) assert that ICT helps women in emerging countries identify new prospects and engage in self-employment opportunities.

1.2. Empirical literature review

Empirical studies on the impact of ICT use on women's labor market participation remain contradictory. Hafeez et al. (2020) demonstrated a positive correlation between ICT use and women's economic empowerment in a panel of seven South Asian countries during 2000–2016. Using mean group and pooled mean group estimators robust to endogeneity and heterogeneity, they showed that a 1% increase in ICT use leads to a 13.24% improvement in women's economic empowerment over the long term. They also found that fertility rate negatively affects automation (coefficient -1.12), while labor force participation positively influences it (coefficient 0.64). However, country-specific estimates indicate a negative effect of ICT on Indian women, no effect for Bhutan, Maldives, and Sri Lanka, and a positive effect for women in Pakistan, Nepal, and Bangladesh.

Nikulin (2017), using a random-effects model on a panel covering 60 developing countries from 2000 to 2014, found statistically significant positive effects of internet and mobile phone use on women's labor market participation. Isa et al. (2021) showed that ICT use tends to improve women's labor market participation in a panel of developing countries between 2000 and 2017, suggesting that easy access and use of ICT provide opportunities to increase women's share in the active population. Islam (2015) employed various methods (fixed effects, random effects, panel-ARDL) to identify ICT effects on women's economic empowerment in South Asia, finding positive and significant influences of ICT. Using a technology acceptance model (TAM) to assess the impact of ICT on self-efficacy, social capital, and automation among 199 South African women micro-entrepreneurs through structural equation modeling, Crittenden et al. (2019) found that ICT's impact on social capital is moderated by self-efficacy. Further, ICT significantly affects personal efficacy and social capital, which are determinants of women's economic empowerment. Hilbert (2011) analyzed the gender relationship with the adoption of ICT, particularly mobile phones and the internet, in a panel of 12 Latin American and 13 African countries (2005–2008). He found a positive correlation between ICT use and being female, alongside negative links with education, employment, and income. The author also revealed that women do not significantly benefit from digital opportunities but are enthusiastic about adopting digital channels such as e-commerce and e-banking. Mainuddin et al. (2015) observed that various ICT indicators positively correlated with women's labor market participation in South Asia.

In Sub-Saharan Africa, Efobi et al. (2018), using ordinary least squares, fixed effects, and generalized method of moments (GMM), demonstrated that ICT use improves women's labor market participation with increasing magnitude. Broadband subscription has a greater impact

on women's economic empowerment than internet and mobile phone use. Wamala (2012) stated that ICT use enhances women's employability, contributing to their economic empowerment, development, and social participation. Asongu and Nwachukwu (2018) used data from Sub-Saharan African countries to show that inclusive human development is conditioned by mobile phone adoption and knowledge dissemination. In Malaysia, Suhaida et al. (2014) supported the role of ICT in women's decision-making to engage in labor market activities by providing necessary job opportunity information and facilitating home-based work. Contrary to these findings, some studies report negative effects of ICT access on women's empowerment. Chérif and Kouadri (2021) showed that ICT indicators have little or no effect on the women's economic empowerment in the MENA region, with fixed-line phone and broadband subscriptions negatively impacting women's economic empowerment in the long term. At short term, no ICT indicators had any effect. Tuzemen et al. (2021), using cointegration and an autoregressive distributed lag (ARDL) error correction model on Turkish data, found a negative influence of ICT adoption on women's labor market participation both short and long term.

Furthermore, democracy primarily fosters inclusive political representation, enabling consideration of gender equality issues, particularly economically. A strong female presence in elected positions, especially in parliaments within robust democratic institutions, is associated with adopting legislation promoting equal opportunities and improving women's economic rights. Consequently, democracy plays a decisive role in facilitating women's access to the labor market. Therefore, democratizing access to better ICT infrastructures would reinforce or modulate the effect of these infrastructures on women's economic empowerment (World Bank, n. d.).

2. Model, data and estimation strategy

2.1. Model specification

Inspired by the work of Hafeez et al. (2020), we specify a baseline equation expressing the relationship between ICT infrastructures and women's economic empowerment as follows:

$$Female_{it} = \alpha + \beta_1 Ict_{it} + \beta_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where: *Female*: female labor force participation rate, *Ict*: ICT infrastructure index, *X*: vector of control variables, μ_i : country-specific effect, λ_t : time-specific effect, ε_{it} : error term.

The control vector *X* includes five variables:

Trade: trade openness measured by (Exports + Imports) / GDP,

Fert: fertility rate measured as the number of children per woman,

GdP: per capita income captured by GDP per capita,

Inv: domestic investment level,

Inf: inflation rate or macroeconomic stability.

To verify the catalytic effect of democracy on the relationship between ICT infrastructure and women's economic empowerment, we introduce an interaction term between the ICT infrastructure index and democracy quality. The moderation model is specified as:

$$Female_{it} = \alpha_0 + \alpha_1 Idi_{it} + \alpha_2 Demo_{it} + \alpha_3 Idi_{it} * Demo_{it} + \alpha_4 X_{it} + \varepsilon_{it} \quad (2)$$

Where $Idi \times Demo$ is the interaction variable capturing the catalytic effect of democracy.

2.2.Data sources and estimation strategy

The data cover the period 2005–2022 and include seven of the eight WAEMU countries: Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo. Benin was excluded due to lack of democracy data for the analysis period. Data come from the ICRG (2022) for democracy, the African Development Bank for the ICT infrastructure index, and the World Development Indicators for other control variables. Table 1 describes the variables and their sources.

Table N°1: Sources and description of variables

Variables	Définitions	Sources
<i>Female</i>	Female labor force participation rate (% of total population)	WDI (2025)
<i>Ict</i>	ICT infrastructure index	AfDB (2025)
<i>Demo</i>	Quality of democracy	ICRG (2025)
<i>Fert</i>	Female fertility rate (children per woman)	WDI (2025)
<i>Trade</i>	Trade openness (% of GDP, exports + imports)	WDI (2025)
<i>GdP</i>	GDP per capita growth rate	WDI (2025)
<i>Inv</i>	Domestic investment (% of GDP)	WDI (2025)
<i>Inf</i>	Annual inflation rate	WDI (2025)

Source : Author

To empirically test the hypotheses, two traditional panel estimation methods are applied: fixed effects and random effects models. The Hausman specification test is used to determine the appropriate model choice.

3. Presentation and discussion of results

3.1.Statistical characteristics of the variables

To examine the effects of ICT infrastructure on women's economic empowerment, the study follows a series of steps starting with descriptive statistics presented in Table 2.

Table N°2: Descriptive statistics

Variables	Obs	Mean	Std. Dev	Min	Max
<i>Female</i>	126	54.839	9.221	34.634	70.056
<i>Ict</i>	126	5.646	6.22	0.0002	23.258
<i>Fert</i>	119	5.517	0.979	4.005	7.615
<i>GdP</i>	126	1.729	2.568	-7.314	8.5
<i>Trade</i>	126	54.984	10.453	31.333	80.991
<i>Dem</i>	119	3.374	0.924	1.917	5
<i>Inv</i>	126	22.192	5.168	13.726	45.593
<i>Inf</i>	126	2.461	3.053	-3.233	14.29

Source: Author's calculation

The average female labor force participation rate in the sample is approximately 54.83%, ranging from a minimum of 34.63% to a maximum of 70.05%. The mean ICT infrastructure index score is 5.64 with a standard deviation of 6.22. The highest ICT infrastructure index is 23.25, reflecting insufficient efforts to improve ICT access and use in some Sub-Saharan African countries, especially those in WAEMU, compared to Asian countries (UNCTAD, 2024). The relatively high standard deviation indicates significant disparities in ICT infrastructure across the union. The average annual GDP per capita growth is 1.72%, while the average number of children per woman is 5.51%.

A correlation test (Table 3) reveals generally weak correlation coefficients. The only notable multicollinearity concern is between the ICT infrastructure variable and the interaction variable, which is expected given the interaction construction.

Table N°3: Correlation coefficients

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Female	1.000								
(2) Ict	-0.201 (0.024)	1.000							
(3) Fert	0.650 (0.000)	-0.439 (0.000)	1.000						
(4) GdP	0.101 (0.263)	0.112 (0.211)	-0.077 (0.402)	1.000					
(5) Trade	-0.322	0.197	-0.432	-0.066	1.000				

	(0.000	(0.027	(0.000	(0.460					
))))					
(6) Dem	-0.203	0.261	-0.091	0.040	-0.365	1.000			
	(0.026	(0.004	(0.325	(0.662	(0.000				
)))))				
(7) Inv	-0.100	0.266	0.274	0.121	-0.059	0.122	1.000		
	(0.267	(0.003	(0.003	(0.177	(0.515	(0.185			
))))))			
(8) Inf	0.029	-0.017	0.109	-0.067	0.039	-0.020	-0.009	1.000	
	(0.744	(0.849	(0.238	(0.455	(0.661	(0.828	(0.922		
)))))))		
(9) Idi*Dem	-0.234	0.948	-0.457	0.120	0.096	0.416	0.242	-0.263	1.000
	(0.010	(0.000	(0.000	(0.193	(0.299	(0.000	(0.008	(0.004	
))))))))	

Note: (...) these are p-values

Source: Author's calculation

Allison (2002) recommends ignoring multicollinearity between an interaction term and its components, as it does not affect the p-value of the interaction variable.

3.2. Empirical results presentation and discussion

To choose between the fixed-effects model and the random-effects model for empirical estimation, we conducted the Hausman test. This test states that when within-individual variability exceeds between-individual variability, the fixed-effects model should be preferred; otherwise, the random-effects model is preferred. Table 4 presents the results of the Hausman test.

Table N°4: Hausman test results

	Direct model	Indirect model
Chi2(7)	$(b-B)'[(V_b - V_B)^{-1}](b-B)$	$(b-B)'[(V_b - V_B)^{-1}](b-B)$
	66.94	67.94
Prob>chi2	0.0000	0.0000

Source: Author's estimation

The results show that the p-values are less than 1%, confirming the suitability of the fixed-effects model for our empirical estimations. The estimation results are reported in Table 5. The estimation results indicate that ICT infrastructures negatively impact women's economic empowerment in WAEMU countries, with statistical significance only in the moderation model. This negative effect can be attributed to challenges such as high access costs, insufficient ICT infrastructure especially in rural areas, inadequate technical skills, poor network coverage, inappropriate regulations, and security issues (Mbunge et al., 2022; Dodoo et al., 2021).

Aruleba and Jere (2022) highlight low internet penetration and digital technology use in rural and marginalized communities. Our finding aligns with Chérif and Kouadri (2021) and Tuzemen et al. (2021), who found similar results in the MENA region and Turkey, respectively. In MENA, this outcome is explained by underdeveloped ICT sectors and the rapid diffusion of ICT contributing to the displacement of unskilled female workers. Hafeez et al. (2020) also found a negative ICT impact on female labor participation in Bhutan.

Table N°5: Fixed-effects estimation results

Variables	Direct model	Indirect model
ICT Infrastructures (<i>ICT</i>)	-0.028 (0.070)	-0,523*** (0,156)
Female Fertility (<i>Fert</i>)	1.983* (1.063)	2,674** (1,029)
GDP per capita (<i>GdP</i>)	0.207*** (0.068)	0,237*** (0,066)
Trade Openness (<i>Trade</i>)	-0.056** (0.026)	-0,070*** (0,025)
Democracy (<i>Dem</i>)	1.542*** (0.329)	0,754* (0,386)
Domestic Investment (<i>Inv</i>)	0.146*** (0.055)	0,114** (0,053)
Inflation (<i>Inf</i>)	-0.006 (0.068)	-0,021 (0,065)
Interaction (<i>Idi*Dem</i>)	-	0,148*** (0,042)
Constant	38.394*** (6.908)	38,459*** (6,567)
Observations	119	119
R²-Within	0.3413	0,4104
Number of countries	7	7
F-Fisher	7.77***	9,05***
Hausman test (<i>Khi2</i>)	66.94***	67,94***
<i>Standard errors in parentheses</i>		
*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$		

Source: Author's estimation

Therefore, investments in ICT infrastructure are imperative to improve connectivity and initiate economic growth aiming at an inclusive and resilient digital economy. Democracy exerts a positive and significant effect on women's economic empowerment, underscoring that strengthening democratic institutions encourages and facilitates women's labor market participation. This result echoes Högström (2015), who showed that democracy supports

women's participation in government cabinets across countries at various development levels. Despite the apparent direct negative influence of ICT infrastructures and the positive effect of democracy, the interaction variable between ICT infrastructure and democracy is positive and significant, indicating that stronger democracy amplifies the beneficial impact of ICT on women's economic empowerment. This confirms democracy's catalytic role in the relationship between ICT infrastructure and women's economic automation in WAEMU. Democracies promote access to ICT as a fundamental right and support policies aimed at reducing the digital divide, thereby enabling universal ICT access.

The coefficients related to fertility are positive and statistically significant, meaning that, all else equal, a 1% increase in fertility leads to a 1.983% increase in women's economic empowerment, rising to 2.674% when accounting for the interaction variable. Although this may appear ambiguous relative to dominant literature, it can be explained by socio-economic and demographic factors unique to the study area. Women with more children may be motivated to engage in economic activities to provide for their families, enhancing their economic empowerment—even if such responsibilities sometimes reduce working time and income. Multiple children may also encourage income diversification to ensure family survival and well-being, bolstering women's economic power (Aniwuyi and Houngue, 2020). This finding aligns with Hafeez et al. (2020) in Bangladesh and Nepal.

The GDP growth rate coefficients are positive and significant at the 1% level, where a 1% growth increase leads to a 0.207%–0.237% improvement in women's economic empowerment. Likewise, domestic investment positively and significantly affects women's automation, with a 1% investment increase raising female labor participation by 0.114% to 0.146%. These results suggest that investment and economic growth can be leveraged to advance women's economic empowerment in WAEMU. Conversely, trade openness negatively and significantly impacts women's economic empowerment, while inflation shows no significant influence. A 1% increase in trade openness induces a 0.056% to 0.070% reduction in women's economic empowerment. This negative effect reflects trade openness's repercussions on societal segments, often creating low-quality jobs where women tend to occupy lower-skilled or lower-paid positions in value chains. Additionally, trade openness may lead to local job losses as employment opportunities shift elsewhere. This finding concurs with Gaddis and Pieters (2017) and Islam (2015), who showed trade openness reduces female labor force participation.

CONCLUSION

This article aimed to revisit the non-linear relationship between Information and Communication Technology (ICT) infrastructures and women's economic empowerment, conditional on democracy. The analysis uses data from seven WAEMU countries for the period 2005–2022 and employs a fixed-effects estimation combining a linear and a moderation model. The results confirm the non-linearity between ICT infrastructures and women's economic empowerment, showing this relationship is particularly conditioned by democracy. Specifically, ICT infrastructures negatively affect women's economic empowerment, while democracy has a positive effect. Importantly, the positive and significant interaction term confirms democracy's catalytic role in the relationship between ICT infrastructure and women's economic empowerment. Consequently, countries with higher levels of democracy are more likely to facilitate women's labor market access and vice versa. Based on these findings, developing ICT infrastructure in WAEMU countries to enhance accessibility and use is necessary. Additionally, these countries should promote democracy as a vital lever for political and social stability. Investments in ICT infrastructure must increase to capitalize on the opportunities these technologies offer.

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