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Can digital transformation serve as a strategic lever for reducing gender-based disparities in access to and use of financial services in Sub-Saharan Africa?

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Abstract---This article examines the effect of digital transformation on disparities in access to and use of formal financial services in sub-Saharan Africa. To this end, it applies the double least squares method proposed by Lewbel (Lewbel-2SLS) and the fixed-effects model with clustered standard errors and instrumental variables (FE-IV + Clustered SE) to triennial data from the Global Findex for the period 2011-2021, across 28 sub-Saharan African countries. The results reveal that digital transformation significantly improves access to and use of formal financial services among both men and women. It also appears that gender-based inequalities in access to and use of these services are narrowing in this region as a result of digital transformation. These findings show that the digitalisation of banking helps women to gain better access to financial services. It helps to reduce the barriers that often hinder their access to traditional banks, thereby helping to reduce inequalities. Consequently, this article highlights the need for financial intermediaries, particularly banks, to invest more in mobile banking and digital financial instruments in order to expand financial inclusion amongst marginalised groups, particularly women, and to reduce gender disparities.

Keywords---Digital transformation, financial access, disparities, sub-Saharan Africa.

JEL codes: G21, G23, O31

1. Introduction

Universal access to financial services is very important for developing economies. It enables them to achieve inclusive economic growth (Bernanke & Blinder, 1988; Demirgüç-Kunt et al., 2022; Gurley & Shaw, 1956; Levine, 1997). From this perspective, financial inclusion is considered an effective tool and an important lever for sustainable development in developing countries in general, and in sub-Saharan Africa in particular (Beck et al., 2014; Nchofoung et al., 2024). The current trend towards tackling financial exclusion, particularly for women, recognizes the crucial role that access to financial services plays in reducing extreme poverty and promoting shared prosperity (Alom et al., 2025; Kim, 2022). When women have easy and affordable access to it, they are better able to manage their spending, plan for the future, and increase their savings (Loaba, 2022; Ouma et al., 2017; Ozili, 2024a). The savings they accumulate or the loans they take out from banking institutions enable them to improve their income-generating activities (Akileng et al., 2018; Loaba et al., 2025; Swamy, 2014). Consequently, this contributes to their financial empowerment. Furthermore, this financial empowerment of women improves their social status, boosts their self-confidence, and enhances their decision-making capacity (Alom et al., 2025; Kulkarni & Ghosh, 2021). This not only helps to reduce their socio-economic vulnerabilities (Ouma et al., 2017), but also stimulates economic activity, leading to stronger growth (Levine, 1997).

However, in low- and middle-income economies, such as those in sub-Saharan Africa, gender inequalities in access to financial institutions are considerable and have persisted for a long time (Demirgüç-Kunt et al., 2022; Nzilano & Magoti, 2025; Swamy, 2014). Women are over-represented among those who lack access to financial services (Demirgüç-Kunt et al., 2022; Kumar & Rani, 2025). Indeed, statistics show that gender inequality in access to financial services in sub-Saharan Africa has widened, rising from 5 per cent in 2011 to 12 per cent in 2021 (Global Findex Database, 2022). These figures remain well above the global average (4 per cent compared with 8 per cent) and those of certain regions, such as Latin America and the Caribbean (8 per cent in 2021 compared with 9 per cent in 2011) or East Asia and the Pacific (3 per cent in 2021 compared with 5 per cent in 2011). From a theoretical perspective, this persistence of inequality in developing countries can be explained by several factors that limit women's participation in the financial market.

According to the theory of barriers to access to financial services (Beck and Cull, 2014; Beck & De La Torre, 2007; Demirgüç-Kunt & Klapper, 2018) and the theory of economies of scale and network externalities (Berger and Humphrey, 1994), the geographical dispersion of the population and the low density of people are hampering the expansion of bank branches in Africa. According to these authors, this exacerbates the financial exclusion of women compared with men, due to their limited mobility. Added to this are the high costs of financial services relative to women's low incomes, their domestic responsibilities, gender bias in the financial market, and information asymmetry (Becker, 2010; Morsy et al., 2019; Phelps, 1972; Staveren, 2001). According to proponents of the discrimination theory, these factors reduce women's presence in this market and exacerbate gender-based disparities in access to financial services. To overcome these

obstacles, some theoretical work (Barr, 2004; Beck, 2020; Ozili, 2024b) suggests that recent financial innovation, particularly digital transformation (DT), offers a major opportunity to improve access to financial services and reduce disparities in this area.

This DT is defined as an innovative process enabling banks to offer financial services to the public via mobile phones, computers, the internet, or any other suitable digital tool (Ahmed & Wamugo, 2018; Avom et al., 2023; Nzilano & Magoti, 2025; Saeed & Donkoh, 2024). These digital financial services, such as mobile banking, online banking, and credit and debit cards, have revolutionised the way banking and financial transactions are carried out. Indeed, they enable consumers to make mobile payments, transfer funds remotely without having to travel, make deposits and access loans online (Apostoaie & Bilan, 2026; Kulkarni & Ghosh, 2021; Loaba, 2022; Ozili, 2018). According to data from the Financial Access Survey (2022), the average volume of mobile and online banking transactions across 28 sub-Saharan African countries has grown exponentially by some 6, 289 per cent, rising from 742 transactions per 1,000 adults in 2011 to 47,406 in 2021.

However, theoretical predictions regarding the impact of this technology on accessibility and inequalities in access to formal financial services are mixed. Indeed, transaction cost theory (Williamson, 1985) highlights the ability of financial institutions to reduce the costs of accessing financial services for customers, whether in terms of physical distance, waiting times or information costs. The digital transformation undertaken by banks could thus help to overcome these obstacles by bringing marginalised groups (young people, women and the poor) closer to these services, and by reducing the access gap between men and women. This theoretical approach is supported by the institutional theory of financial innovation (Barr, 2004; Beverly & Sherraden, 1999), as well as by theories of financial inclusion through digital agency and the inclusion of vulnerable groups (Ozili, 2024a, 2024b). These views are, however, qualified by theories of risk and technology acceptance (Allen & Gale, 1994; Davis, 1989; Rogers, 1962; Venkatesh et al., 2003). According to these authors, women are indeed more risk-averse and take longer to make a decision than men. This reluctance could hinder their adoption and use of digital platforms and, in turn, exacerbate gender disparities in financial inclusion (Venkatesh et al., 2003). At the same time, empirical research on the link between digital transformation and financial inclusion is also subject to controversy.

Research carried out at the national level (Avom et al., 2023; Kim, 2022; Loaba, 2022; Nzilano and Magoti, 2025) concludes that the use of mobile money helps to accelerate financial inclusion amongst the population. By contrast, other studies (Demombynes & Thegeya, 2012; Ky et al., 2018; Porteous, 2007) conclude that mobile money has a limited impact on people's access to financial services. The study by Saeed and Donkoh (2024), meanwhile, finds that mobile bank transfers have a significant negative impact on financial inclusion. However, most research on the link between financial technologies and financial inclusion focuses on the impact of mobile money on access to, or overall use of, financial services. The effects of this digital transformation on access and usage have been little analysed at the sub-regional level (sub-Saharan Africa), and, to our knowledge, there is

virtually no evidence of a possible reduction or increase in gender inequalities in the region.

Based on this observation, this research aims to determine whether digital transformation (DT) can help reduce gender-based disparities in access to and use of formal financial services in this region. More specifically, the aim is to explore whether DT helps to reduce gender disparities in access to formal financial services in this region. Furthermore, the aim is to examine whether DT also helps to reduce gender disparities in the use of formal financial services in SSA. This research, therefore, posits that:

- DT reduces gender-based disparities in access to formal financial services in the Sahel-Saharan region;
- DT also reduces gender-based disparities in the use of these services in the region.

Despite empirical evidence of the impact of financial innovation on financial inclusion, gaps remain in the literature. Indeed, most empirical studies on the effects of digital financial innovation have been limited to the overall accessibility of financial services for the population (Avom et al., 2023; Ky et al., 2018; Ong et al., 2023; Ouma et al., 2017; Saeed & Donkoh, 2024). This failure to distinguish between men and women in their analyses makes it impossible to determine whether women from marginalised social groups actually benefit from formal financial services to the same extent as men. The few studies that have examined the impact of mobile money on women's access to financial services have been limited to a correlation analysis at the national level, using a single indicator of financial innovation (Kim, 2022; Nzilano and Magoti, 2025). The findings of these studies are therefore very limited. This article addresses these shortcomings by broadening the scope of the analysis (to sub-Saharan Africa) and by adopting a diversified approach to labour market indicators, as well as robust econometric tools that take endogeneity issues into account. Finally, this article makes a significant contribution by examining whether the tax on savings and current accounts helps to reduce gender inequalities in the use of financial services. To the best of our knowledge, no empirical study has yet been conducted in the region to analyse this issue.

Furthermore, this article is situated within the theoretical framework of financial inclusion through digital banking developed by Ozili (2024), within the institutional theory of financial innovation and inclusive finance (Barr, 2004; Beverly & Sherraden, 1999; Demirgüç-Kunt & Klapper, 2018), as well as the unified theory of technology acceptance and use (Venkatesh et al., 2003). These theories suggest that digital technology can be a powerful tool for bringing people closer to financial services and reducing social disparities in this area. This research also forms part of the United Nations' 2030 Sustainable Development Goals, which call on countries around the world to promote technological innovation (digital transformation) and to reduce gender inequalities in the financial sector (financial inclusion) as well as in other areas of development.

The rest of the article is structured as follows: The second section is devoted to the theoretical and empirical literature on financial innovation and access to financial services. The third section sets out the methodology. The fourth section

presents the results of the estimation. The fifth section is devoted to a discussion of the results. The final section sets out the conclusions and the implications for economic policy.

2. Review of the literature on the effect of financial innovations on access to and use of financial services

2.1. Theoretical approach

The relationship between digital transformation and people's access to formal financial services is underpinned by theories of financial innovation, which are controversial on this subject. Thus, the theoretical analysis of the link between financial innovation and the financing of economic activity can be traced back, in particular, to the work of Schumpeter (1911, 1942), Miller (1986) and Merton (1992). According to Schumpeter's theory of creative destruction, financial innovation revolutionises financial practices by replacing old methods of providing financial services with new ones, such as digital payments. This improves the provision of financial services to the public. According to Miller (1986) and Merton (1992), financial innovation helps to reduce market imperfections, which would improve access to and use of financial services by the unbanked.

According to the institutional theory of financial innovation developed by Beverly and Sherraden (1999) and by Barr (2004), government incentives for financial and technological innovation (mobile and digital payments) could help to remove barriers and facilitate access to financial services for underserved households. This may help to reduce disparities in access to financial services between different sections of the population, particularly between men and women. This approach is supported by the theory of barriers to access and inclusive finance (Beck, 2020; Beck & Cull, 2014; Demirgüç-Kunt & Klapper, 2018). Indeed, these authors argue that digital technologies can help to increase financial inclusion amongst the unbanked by overcoming barriers related to distance, transport, and transaction costs. This increases their presence in the banking sector and could help to reduce disparities. Better still, Demirgüç-Kunt and Klapper (2018) and Duncombe and Boateng (2009) argue that mobile banking better meets the needs of women than men, due to their "limited mobility" and their socio-economic vulnerability (low incomes coupled with high costs of accessing financial services). Ozili (2018) adds that the convenience and privacy offered by these mobile banking services encourage more women to use them. In his view, this could help to increase the proportion of women in the financial market and reduce gender disparities in this sector.

In the same vein, the theory of digital agency in financial inclusion developed by Ozili (2024b) argues that digital technologies (mobile money accounts, fintechs, digital payments) help to bring vulnerable or underserved groups (young people, women and the poor) closer to financial services. Indeed, the author argues that the shift from physical bank branches to digital banking (which reduces barriers related to cost and distance) helps to increase financial inclusion amongst women and, in turn, reduces disparities in access to financial services between women and men (Ozili, 2024a). Donovan (2012), Fletschner and Kenney (2014), and Staveren (2001) share this view, aligning themselves with the theory of discrimination developed by Becker (2010) and Phelps (1972). They argue that, in

addition to family responsibilities, other factors contribute to women's financial exclusion compared with men. These include gender bias and restrictive socio-cultural norms that limit women's mobility and their access to finance. According to these authors, financial digitalisation would help to remove these barriers to financial access, whilst increasing women's participation in financial services. This would reduce gender inequalities.

Whilst some researchers are optimistic about the potential of digital transformation to reduce inequalities in access to banking services, others are more sceptical. This is the case with Allen and Gale (1994), who draw innovators' attention to the sophistication of financial technologies. They argue that the promotion of financial innovations aimed at ensuring efficient management and eliminating risks and uncertainties leads to greater sophistication in the range of financial products on offer. These authors believe that such a practice can lead to financial exclusion of certain groups, particularly women, which could widen the gender gap in access to financial services. Kingsley and Anderson (1998) argue that, due to negative experiences with innovative financial services, users are less inclined to adopt and use new digital financial technologies. This may widen the gaps in access to financial services between different social groups over time.

Furthermore, according to Rogers' theory of the diffusion of innovations (1962), financial technologies spread through an adoption cycle that varies depending on the economic actors involved. According to this theory, adopters can be divided into five groups: innovators, early adopters, the early majority, the late majority, and laggards. Those who are first to adopt digital technology will therefore benefit from faster access to digital financial services, which may reduce or exacerbate disparities based on gender and standard of living. At the same time, according to the theory of technology acceptance (Davis, 1989; Venkatesh et al., 2003), the intention to adopt a technology depends primarily on two factors: 'perceived usefulness' and 'perceived ease of use'. Thus, depending on their level of simplicity or sophistication, digital technologies may encourage or discourage certain socio-economic groups from adopting digital financial services, which could widen or narrow the gaps in access to these services between different sections of the population.

2.2. Review of empirical literature

A few studies have specifically examined the link between mobile financial services and people's access to formal financial services. However, the controversial findings of these studies show that the debate remains open and that further research is needed.

Some studies have found that mobile money services have a limited effect on people's access to formal financial services. Indeed, Porteous (2007) conducted a pioneering study in South Africa on the impact of mobile money between 2004 and 2006. Based on a correlation analysis, the results of this study reveal that mobile money has no positive effect on people's access to banking services. This finding is similar to that obtained in Kenya. Indeed, Demombynes and Thegeya (2012) examine the effect of mobile banking services on household savings in Kenya. Based on survey data collected in 2010, descriptive analyses indicate that the use of mobile services to mobilise formal savings is limited and remains the

preserve of the wealthy. Meanwhile, Chavan (2008) conducts research into gender disparities in access to banking services in India. Based on a descriptive analysis, the author finds that gender inequality in access to financial services worsens as the availability of banking services increases.

In contrast, Ouma et al. (2017) found a positive result in Kenya. Using a logistic regression covering the period 2007-2013, the authors found that mobile phone use is positively associated with formal savings. However, Ky et al. (2018) arrive at an ambiguous result for Burkina Faso. The authors apply the double least squares (DLS) method to survey data collected from 500 people in a single region of the country in 2014. They arrive at two conflicting results. The first indicates no correlation between the use of mobile money and household savings for foreseeable events. The second reveals that the use of mobile money is positively associated with savings set aside to cover unforeseen expenses.

Furthermore, Aker et al. (2016) conducted a study on the effect of mobile payments in 96 villages in Niger. They carried out an analysis of covariance (ANCOVA) on two datasets from surveys conducted in 2010 and 2011 involving 1,152 individuals. The results show that mobile payments help to reduce transaction costs and improve women's bargaining power, thanks to better access to financial services. More recently, Avom et al. (2023) examined the effect of mobile money on people's access to financial services in 50 African countries between 2004 and 2020. Using the propensity score matching (PSM) method, they concluded that mobile money promotes financial inclusion among populations. This finding is similar to those reported by Ong et al. (2023) across six countries in South-East Asia over the period 2000–2020. By measuring the digitalisation of processes through mobile and cellular subscriptions as well as broadband internet access, the authors find that digitalisation accelerates financial inclusion amongst the population. However, these findings do not specify whether this improvement in financial inclusion takes the female population into account.

In examining the effect of mobile banking services on financial inclusion in Ghana, Saeed & Donkoh (2024) reach ambiguous conclusions. Based on primary data collected from 65 respondents in 2024, they analyzed variance (ANOVA). They first found that mobile bank transfers have a significant negative impact on financial inclusion. Next, they show that mobile account management has a significant positive impact on financial inclusion. Finally, they indicate that there is no significant correlation between mobile banking payments and financial inclusion.

In contrast, Loaba (2022) examines the effect of mobile banking services on women's saving behaviour in seven West African countries over the period 2011-2017. Using a multinomial logit model, the author notes that the use of these services increases the likelihood of formal saving. Kim's (2022) work confirms this finding. The author assesses the effect of mobile money on women's financial inclusion in Nairobi. He carries out a correlation analysis on survey data collected from 358 people between 2015 and 2016. He finds that the use of mobile money improves financial inclusion for women. Similarly, Nzilano and Magoti (2025) examine the effect of mobile banking services on financial access for women entrepreneurs in Dodoma, Tanzania. They conducted descriptive analyses and

multiple regression using cross-sectional data collected from 117 women entrepreneurs in 2025. They conclude that digital banking services improve financial inclusion for these women.

3. Methodology for analysing the relationship between TD and disparities in access to financial services

3.1. Specification of the analysis model

This research aims to examine new perspectives for financial innovation by exploring the relationship between digital transformation and access to formal financial services among men and women. The empirical model used to establish this relationship draws in particular on the institutional theory of financial innovation (Beverly & Sherraden, 1999; Sherraden et al., 2003) and the theory of financial inclusion through digital agency (Ozili, 2024). Indeed, these theories establish a functional relationship between financial innovation and access to financial services. They show that innovation is one of the key determinants of access to financial services, alongside economic conditions, education, etc.

According to some authors (Loaba, 2022; Ouma et al., 2017; Saeed and Donkoh, 2024), financial innovations, such as digital financial services, promote financial inclusion by reducing traditional barriers to accessing formal financial services. Based on these theoretical relationships, the model to be estimated is as follows:

$$\text{FinancDisp}_{it} = \beta_0 + \beta_1 \text{DT}_{it} + \beta_2 \text{PIBH}_{it} + \beta_3 \text{Infl}_{it} + \beta_4 \text{IDE}_{it} + \beta_5 \text{Capital_H}_{it} \\ + \beta_6 \text{DensityP}_{it} + \beta_7 \text{Unemp}_{it} + \beta_8 \text{StabPol}_{it} + \varepsilon_{it}$$

Where FinancDisp is the dependent variable that captures the various dimensions of financial services (i.e. accessibility or usage, or inequality of access or usage); DT measures digital transformation; GDPH represents GDP per capita, which measures economic growth; Infl represents inflation; FDI represents foreign direct investment; Capital_H represents human capital; DensityP represents population density; Unemp represents the unemployment rate; StabPol represents political stability and the absence of violence or terrorism; $\beta_0, \dots, \beta_8$ represent the parameters to be estimated associated with each variable; i represents the country; t represents the period; and u represents the error term.

3.2. Variables used in the analysis and their expected effect on access to and use of financial services

We distinguish between two types of variables: variables of interest and control variables.

▪ Variables of interest:

These include the relevant dependent and explanatory variables. Indeed, the indicators “access to and use of financial services” and “gender inequalities in access and use” constitute the dependent variables in the model. According to the Global Findex database (2022), the “Women’s access to financial services” indicator corresponds to the percentage of women (aged 15 and over) who hold an account with a bank or financial institution. The same applies to the “Men’s access to financial services” indicator. In addition to accessibility, the “use of financial services” indicator for men (or women) represents the percentage of men (or women) who reported having saved or taken out loans from a bank or financial

institution in the past year (Global Findex Database, 2022). The indicator “disparity or inequality in access to financial services by gender” measures systematic differences between men and women in terms of access to formal financial services (Demirgüç-Kunt et al., 2018).

As for the explanatory variables of interest, these are represented by indicators of DT. Indeed, the financial literature (Ahmed & Wamugo, 2018; Loaba et al., 2025; Ozili, 2024b) identifies several indicators for measuring DT. These mainly include mobile and online banking services, and the issuance of debit and credit cards. In this study, we use these as indicators of digital transformation.

▪ **Control variables**

These consist of variables that capture a country's macroeconomic and institutional characteristics. They include:

Economic growth: Favourable economic conditions in a country help to accelerate financial inclusion (Saeed & Donkoh, 2024; Triki and Faye, 2013; Ugulumu et al., 2023). According to these authors, people with higher incomes are more likely to have a formal bank account than those who are less wealthy. On this basis, we expect a positive relationship between per capita income and access to financial services. However, we assume that these indicators have a negative effect on gender-based inequality in access to financial services. In this sense, inclusive economic growth is likely to improve the incomes of both women and men, thereby increasing women's access to financial services and reducing gender inequalities.

Human capital: According to Akileng et al. (2018), education is a prerequisite for investment awareness and a key factor in a country's financial inclusion. Loaba (2022) finds that secondary or higher education (used as a measure of human capital) is positively correlated with household saving behaviour within a formal financial system. We therefore hypothesise that human capital is positively correlated with financial inclusion.

External exchanges: the literature shows that foreign direct investment contributes to the creation of new jobs in the host economy. This enables beneficiaries to open bank accounts and improves financial inclusion in these economies (Baladevi et al., 2019; Khan et al., 2023). Remittances sent by expatriates to their families back home through legal channels increase the likelihood of those families accessing financial services (Ajefu & Ogebe, 2019). We therefore expect a positive relationship between these variables and access to financial services, as well as a negative relationship with inequality.

Institutional quality (political stability, the absence of terrorism, the rule of law, etc.) is a major motivating factor for economic agents seeking access to financial services (Allen et al., 2014; Fratzscher et al., 2016). Indeed, Allen et al. (2014) found a positive correlation between the institutional development index and the proportion of adults with an account at a formal financial institution. As for the variable “inflation”, its effect on financial inclusion depends on its level. A low level of this indicator positively influences financial inclusion (Allen et al., 2014). We therefore expect a negative or positive effect on financial inclusion. Similarly, Allen et al. (2014) argue that population density is a determinant of financial

inclusion, as they have empirically observed a positive relationship between these two concepts. Table A1 in the appendix summarises the variables, the calculation method, and the expected signs.

3.3. Data sources

The dependent variables measuring access to and use of financial services by men and women are drawn from the World Bank's Global Findex Database (2022). These data are derived from a survey of 1,000 people in each of the 123 countries covered. This Global Findex database contains only triennial data covering the period 2011–2021.

With regard to digital transformation indicators, we use two separate measures to ensure the robustness of the results. The first is drawn from the Global Findex Database, which provides data every three years. In this database, digital transformation is measured by the percentage of users of digital payment tools (mobile money, payment cards, mobile phones, or the internet) to purchase goods or items in shops or online. The second measure comes from the International Monetary Fund's (IMF, 2022) Financial Access Survey (FAS) database. This database provides data on the volume of mobile and online banking services, as well as on the number of debit and credit cards.

As for the control variables, these are drawn from the World Bank's development indicators (WDI, 2022) and institutional governance indicators (WGI, 2022). The variable relating to the average number of years of schooling is taken from the "Penn World Table 10" database. However, due to the nature of the data relating to the model's dependent variable (three-yearly data), the explanatory variables are adjusted in line with this database. In other words, these variables are converted into triennial data by calculating the simple arithmetic mean over three years during the study period.

This study covers 28 countries in sub-Saharan Africa over the period 2011–2021. The absence of observations relating to the variables of interest in certain sub-Saharan countries explains the size of the sample. The scope of the study period is determined by the fact that the dependent variables (access to and use of financial services by gender) only cover the period 2011–2021.

3.4. Descriptive statistics and stylised facts

3.4.1. Descriptive statistics for the variables

Table 1 below presents a descriptive analysis of some of the model's variables. About financial inclusion indicators, the average percentage of women (and men, respectively) with access to formal financial services is approximately 25.09 per cent (32.03 per cent, respectively), with variation across the countries in the sample ranging from 1.45 per cent in Niger to 89.27 per cent in Mauritius. The gender gap in access to financial services is reflected in an average difference of 6.62, with a standard deviation of approximately 4.88. This gender inequality is therefore quite evident, both within and between countries. Indeed, the extreme values of this gap range from -3.94 to 19.08 (Global Findex, 2022). Concerning mobile and online banking services, considerable variation is observed within the sample. The volume of financial transactions ranges from 0.62 to 175,000 transactions per 1,000 adults, averaging at 15,223 transactions. Although

remarkable progress has been made in terms of financial inclusion in sub-Saharan Africa, gender inequalities persist and require targeted interventions.

Table 1: Descriptive statistics

VARIABLES	Mean	Standard deviation	Min	Max
Women's access to formal financial services	25.09	19.89	1.45	89.27
Men's access to formal financial services	32.03	20.06	1.59	92.49
Gender gap in access to financial services	6.62	4.88	-3.94	19.08
Number of users of digital payment methods (%)	33.815	23.064	3.429	98.217
Credit and debit cards (per 1,000 adults)	221.93	307.23	06	1615
Mobile and online banking transactions (per 1,000 adults)	22981	35927	0.625	175000
Political stability and absence of terrorism index	-0.40	0.92	-2.61	1.09
Rule of law index	-0.52	0.66	-1.48	0.97
Population density (% of total area)	90.76	126.6	2.57	621.0
Per capita income (% of GDP)	7.19	0.876	5.82	9.19
Net foreign direct investment (% of GDP)	5.23	8.94	-3.13	65.85
Human capital (level of education)	0.47	0.12	0.18	0.73
Inflation rate	7.45	27.21	-1.03	303.7
Unemployment rate	8.29	7.90	0	30.42
Remittances (% of GDP)	3.67	5.11	0	27.98

Source: Authors based on data from GFD (2022), FAS (2022), and WDI (2022)

3.4.2. Stylised facts

This section sets out the trends in the digital transformation (DT) indicator. It also highlights trends in gender-based disparities in access to formal financial services, as well as their potential correlation with DT in sub-Saharan Africa.

▪ Developments in mobile and online banking services

Figure 1 below shows the average evolution of mobile financial services in sub-Saharan Africa between 2011 and 2021. We see a significant increase in these services, which rose from 742 mobile financial transactions per 1,000 adults in 2011 to 47,406 in 2021. This reflects the commitment and enthusiasm of the various stakeholders (households, individuals, businesses, etc.) to carry out financial transactions remotely, without having to travel, thanks to the proximity of these mobile services to the population.

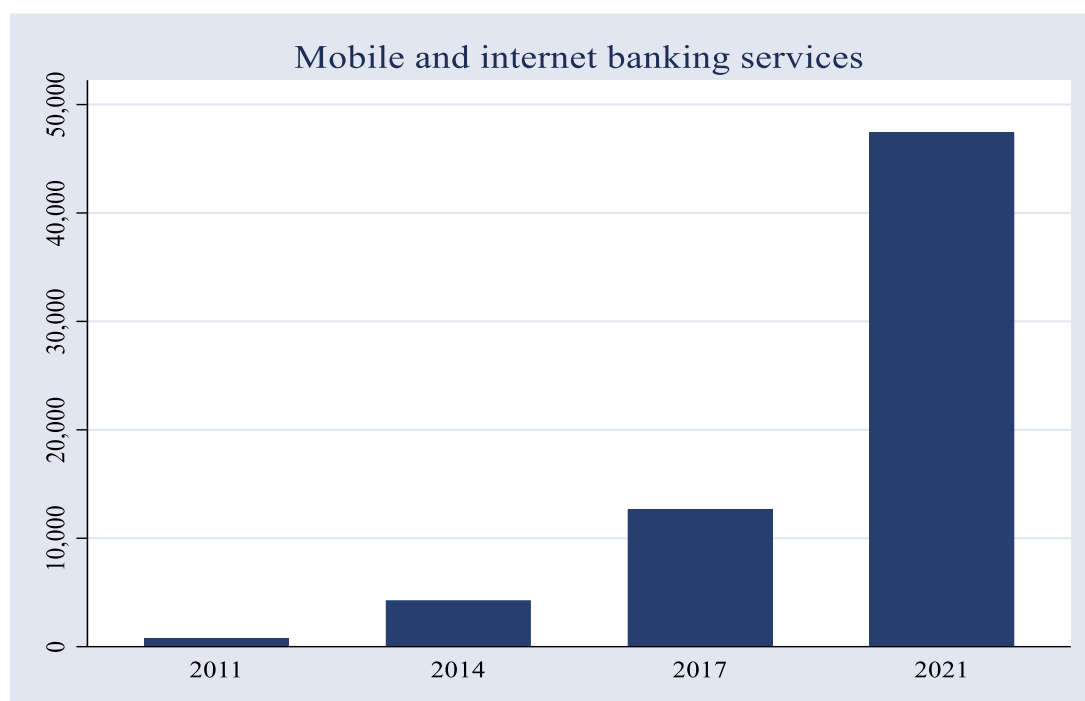


Figure 1: Average three-year growth in mobile and internet banking services across 28 SSA countries over the period 2011–2021.

Source: Authors based on data (FAS, 2022)

▪ **Evolution of indicators of access to financial services**

Figure 2 illustrates the evolution of the proportions of men and women with access to financial services, as well as the resulting inequalities in access. It shows an increase in the proportion of both sexes with access to financial services (FS), rising from 26.70% and 22.18%, respectively, in 2011 to 38.61% and 29.84% in 2017, respectively. However, we observe a slight decrease in both proportions between 2017 and 2021. Despite a marked improvement in these two indicators over the period, inequalities in access to formal financial services between men and women persist. This raises questions about the impact of digital services on gender-based disparities in access to financial services in SSA.

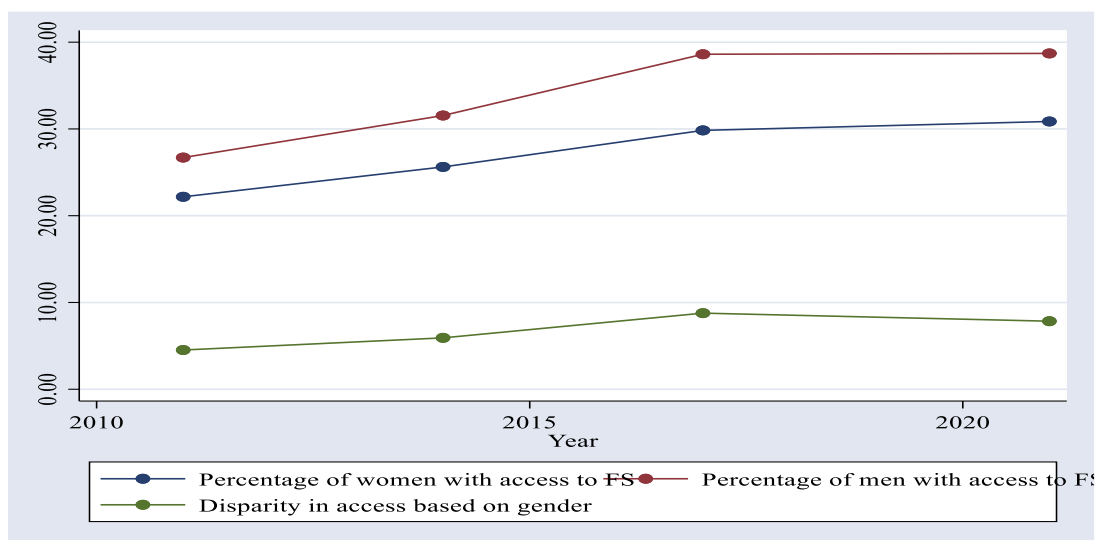


Figure 2: Trends in the proportion of men and women with access to financial services in 28 SSA countries, and disparities in access to financial services
Source: Authors based on Global Findex Database (2022)

At the same time, this improvement in access to financial services is also reflected in the use of these services by these two groups (see Figure 3 below). However, we observe a fluctuating trend in the proportion of men and women who manage to build up savings with formal financial institutions between 2011 and 2021. The increased use of financial services in sub-Saharan Africa can be attributed to the emergence of digital financial services.

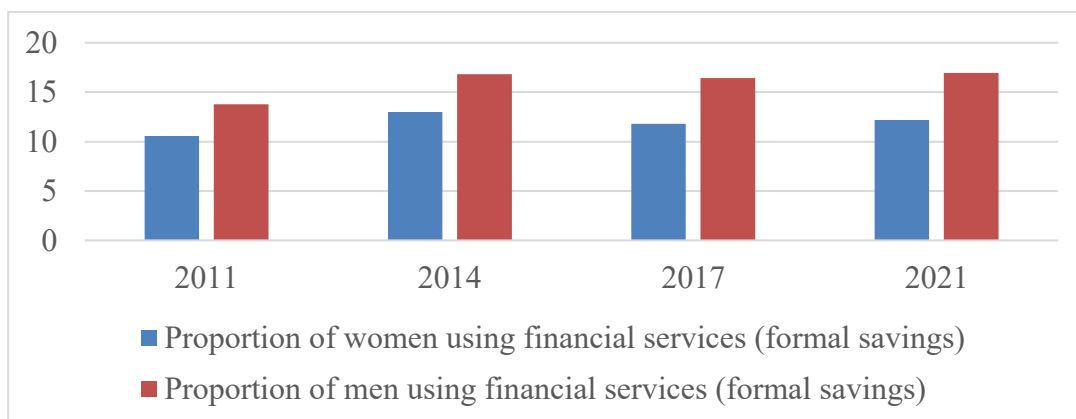


Figure 3: Average percentage of people using financial services by gender in 28 SSA countries over the period 2011–2021.
Source: Authors based on Global Findex Database (2022)

- **Correlation between the DT indicator and disparity in the use of financial services**

Figure 4 uses a scatter plot to illustrate a negative correlation between mobile and online banking services and gender-based disparities in the use of financial

services. This downward trend leads us to predict a strong correlation between these two variables. An empirical analysis could therefore confirm this prediction.

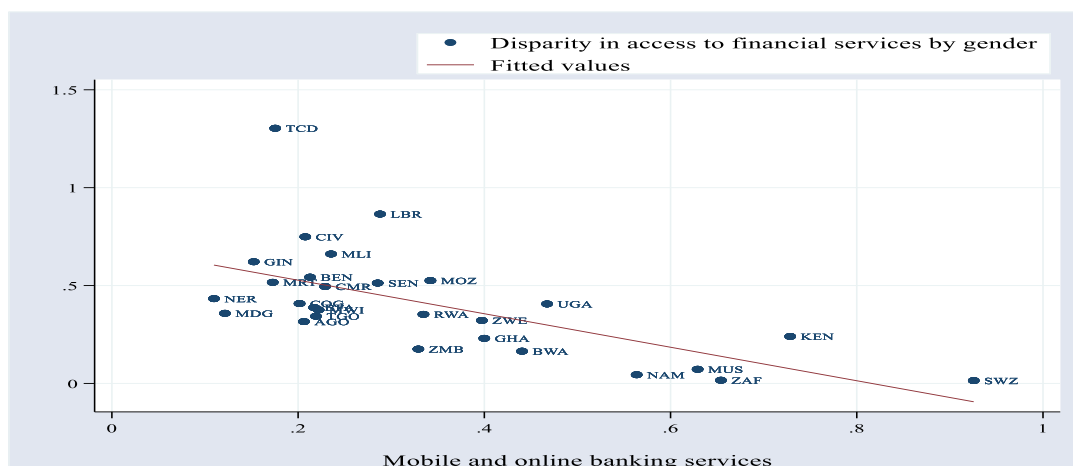


Figure 4: Scatter plot showing the relationship between a digital variable and gender-based disparities in access to financial services
Source: Authors based on data

3. Regression results

3.1. Preliminary test results

This section involves carrying out a series of preliminary tests in order to select an estimator appropriate to the data and to ensure higher-quality regression analyses. These tests essentially cover model specification, multicollinearity, endogeneity, heteroscedasticity and autocorrelation of errors.

▪ Model specification test

These are the Ramsey test and the Hausman test. The former is used to check for the omission of relevant explanatory variables. It assumes, under the null hypothesis, that the model is correctly specified, and under the alternative hypothesis, that the model is incorrectly specified. Applying this test, we obtain a p-value of 0.2696, which is greater than the 5 per cent threshold. The null hypothesis is therefore not rejected. The model is thus well-specified (no important explanatory variables have been omitted). As for the Hausman test, it allows us to choose between a fixed-effects model and a random-effects model (Hausman, 1983). Under the null hypothesis, it posits that the random-effects model is appropriate, whilst under the alternative hypothesis, it suggests that the fixed-effects model is preferable. Applying this test, the results indicate that the probability (p-value = 0.0006) is less than the critical value of 5%. The null hypothesis is therefore rejected, indicating that the fixed-effects model is preferable.

▪ Multicollinearity test

This is the VIF (Variance Inflation Factor) test, which is used to detect any multicollinearity between the explanatory variables (James et al., 2022). Unlike the other variables in the model, the results in Table 2 below indicate potential

multicollinearity between the TD indicators, as the VIF associated with each of these numerical variables is high and exceeds 5 (James et al., 2022). According to these authors, the simultaneous inclusion of these categorical variables in a single model could therefore lead to unreliable results. Consequently, it is advisable to include them in separate equations in order to avoid any bias in the regressions.

Table 2: Results of the multicollinearity test

Variables	Vif
Credit and debit cards	9.48
Mobile and internet banking services	9.31
Number of users of digital payment tools	5.88
Population density	3.39
Index of political stability and absence of violence or terrorism	2.84
Rule of Law Index	2.68
Unemployment rate	1.92
Human Capital	1.90
Foreign Direct Investment	1.44
Per capita income	1.25
Inflation rate	1.08
Average	3.92

Source: Authors, based on regression analysis

▪ **Endogeneity test**

This test is relevant because it helps to identify endogenous variables in the model, the omission of which could lead to biased results. More specifically, it allows us to check whether one or more explanatory variables are correlated with the error term (Hausman, 1978). According to the author, this correlation may stem from several sources (measurement errors, omitted variables, reverse causality, and selection bias). This test starts from the null hypothesis that the variable under suspicion is not correlated with the error term (or is exogenous), against the alternative hypothesis that it is endogenous. The test results indicate that the p-values associated with the residuals of variables such as digital transformation, per capita income, and foreign direct investment are all below 0.05 (see Table A2 in the appendix), which shows that these variables are endogenous. The other explanatory variables are exogenous (their p-values are greater than 0.05).

▪ **Tests for heteroscedasticity, cross-sectional correlation, and error autocorrelation**

These tests are equally important and are essential tools for ensuring the validity of econometric results. They guide the researcher in choosing appropriate regression methods. Thus, the results of the Breusch–Pagan test indicate a probability below the 5 per cent threshold (see Table A.3 in the appendix). This suggests that the errors are heteroscedastic, i.e., that the variance is not constant (Breusch & Pagan, 1979). The Pesaran test (cross-sectional dependence), meanwhile, yields a probability of less than 5 per cent, which confirms that the null hypothesis of no cross-sectional correlation is not rejected. Finally, Wooldridge's (2010) autocorrelation test rejects, at the 5 per cent significance

level, the null hypothesis of no autocorrelation in the residuals (see Table A.3 in the appendix).

▪ **Choice of estimation method**

Diagnostic tests revealed several data-related issues, including endogeneity, heteroscedasticity and autocorrelation. In view of these issues and given the structure of our data ($N = 28$ is greater than $T = 4$), the method of instrumental variables or double least squares proposed by Arthur Lewbel in 2012 (Lewbel IV/2SLS) has been adopted. This choice is justified by the fact that this method produces reliable results for panel data that exhibits problems of endogeneity, heteroscedasticity, and autocorrelation (Lewbel, 2012). According to the author, this instrumental variable method can address endogeneity when there are no credible external instruments available. The idea is to create instruments using the data itself by exploiting the heteroscedasticity of the errors. To ensure the robustness of the analysis, we use the fixed-effects estimator with clustered standard errors and instrumental variables (FE-IV+Clustered SE) as an alternative regression method. This method is an extension of the fixed-effects model. It combines three elements: the fixed-effects model, instrumental variables, and clustered standard errors. It is effective and robust in correcting for heteroscedasticity, serial correlation (autocorrelation of errors), and endogeneity (Apostoaie & Bilan, 2026).

3.2. Basic regression results

This section first presents the findings on the effect of digital transformation (DT) on gender disparities in access to financial services. It then examines its effects on the “disparity in usage” of financial services between men and women in sub-Saharan African countries. For the baseline estimates, we use the first measure of DT (the percentage of the population using digital payment tools) from the Global Findex database. Other measures of DT from a different database (FAS, 2022) are used for robustness purposes.

3.2.1. Dimension: “Gender disparities in access to formal financial services”

Applying the Lewbel-IV/2SLS method to the data, Table 3 below presents the results showing the effect of DT on gender disparities in access to financial services. Fisher’s test statistics and associated probabilities, shown at the bottom of the table, indicate that the model is significant overall. In other words, the explanatory variables provide a more effective explanation of the model. Furthermore, Hansen’s test, which yields a probability greater than the 5 per cent threshold across all specifications, clearly indicates that the instruments used to correct for endogeneity are valid and robust.

The results thus show that the coefficients associated with DT are positive for men’s and women’s access to financial services, and negative for gender inequality in access. These coefficients are statistically significant at the 1 per cent level. These results show that a one percentage point increase in the use of digital and mobile payment tools leads to an improvement in financial access for both men and women, as well as a reduction in gender inequality in access of 0.77, 0.82, and 0.31 percentage points, respectively.

These findings suggest that DT plays an important role in reducing gender disparities in access to formal financial services in the region. This trend can be explained by the ability of digital financial services to reduce access costs (both monetary and non-monetary), to overcome certain geographical and socio-cultural constraints, and to improve financial inclusion for women. By making remote financial services more accessible, affordable, and tailored to customers' needs, as well as by reducing certain discriminatory barriers associated with the traditional banking system, digital transformation promotes more equitable financial inclusion between women and men (Ozili, 2024a, 2024b; Demirgüç-Kunt et al., 2022). These mobile banking services also offer certain benefits for women, notably the ability to manage their e-wallet independently, without it being linked to their husband's. This makes them more likely to adopt these services.

Table 3: Results of the effect of the DT on gender-based disparities in access to financial services (FS)

Explanatory variables	Men's access to FS	Women's access to FS	Gender-based inequality in access to FS
	(1)	(2)	(3)
Digital transformation (% of the adult population)	0.767*** (0.028)	0.816*** (0.027)	-0.309*** (0.0919)
Per capita income (% of GDP)	0.0446*** (0.0131)	0.0249 (0.0158)	-0.0004 (0.0036)
Net foreign investment (% of GDP)	0.002 (0.0014)	-0.0006 (0.0013)	0.0232 (0.0388)
Human capital	0.096 (0.086)	0.187** (0.0782)	-0.8387 (0.6068)
Unemployment rate	-0.0007 (0.0010)	0.0037*** (0.0012)	-0.015*** (0.005)
Inflation rate	0.00001 (0.00005)	-0.00008 (0.00005)	0.00017 (0.0003)
Political stability and absence of terrorism index	-0.0127* (0.0067)	-0.0025 (0.0053)	0.0072 (0.0325)
Population density (% of total area)	0.00022*** (0.00004)	0.0003*** (0.00004)	-0.0004*** (0.0001)
Constant	-0.152** (0.074)	-0.197** (0.089)	0.934*** (0.252)
Number of observations	84	84	84
Fisher's test (p-value)	0.0000	0.0000	0.0000
R ²	0.9552	0.9660	0.7608
Hansen J test (p-value)	0.1080	0.3632	0.5385

Notes: Standard errors in parentheses; *p-value<0,10, **p-value<0,05, ***p-value<0,01

Source: Authors based on regression analyses

3.2.2. Dimension: “Gender disparities in the use of formal financial services”

When the dependent variable “disparity in access to financial services” is replaced by its dimension “use of financial services by gender”, the estimates remain conclusive. Indeed, Table 4 below (columns 1 and 2) shows that DT is positively and significantly correlated with the use of formal financial services, among both men and women. In column 3, the negative and significant coefficient indicates that inequalities in the use of financial services between men and women decrease with DT. This is achieved by reducing the socio-cultural constraints and the costs of using formal financial services for vulnerable and low-income groups, particularly women (Beck, 2020; Fletschner and Kenney, 2014). Indeed, due to the high costs of traditional financial services (transaction and travel costs, etc.) and the constraints limiting their mobility, some women tend to hoard their wealth or keep it on their person as a precautionary measure, in the hope of being able to spend it at any time. This situation limits their participation in the financial market. Consequently, the introduction of mobile financial platforms enables them to build up formal savings or take out loans from credit institutions. These resources enable them to invest in improving their small income-generating activities, to set up small businesses or to undertake training to help them enter the labour market (Alom et al., 2025; Demirgüç-Kunt et al., 2022). This inevitably contributes to their financial empowerment and, in turn, to more inclusive economic growth (Levine, 1997; Loaba, 2025).

Table 4: Results of the effect of DT on gender disparities in the use of financial services (FS)

Explanatory variables	Men's use of FS	Women's use of FS	Gender disparities in the use of FS
	(1)	(2)	(3)
Digital transformation (% of adult population)	0.386*** (0.065)	0.327*** (0.057)	-0.3305*** (0.0763)
Per capita income (% of GDP)	1.5498 (2.4308)	1.7855 (1.925)	0.0429 (0.0311)
Net foreign investment (% of GDP)	-0.3721 (0.284)	-0.2727 (0.2310)	-0.0158*** (0.0036)
Human capital	0.349** (0.160)	0.4198*** (0.1400)	0.0431 (1.390)
Unemployment rate	0.088*** (0.023)	0.0103*** (0.0019)	-0.0168 (0.0164)
Inflation rate	-0.0331*** (0.0105)	-0.017** (0.0073)	0.0004 (0.0007)
Political stability and terrorism-free index	-0.4459 (1.168)	-0.2468 (0.754)	-0.173*** (0.0464)
Population density (% of total area)	0.0241*** (0.0092)	0.291*** (0.006)	-0.0009*** (0.0003)
Constant	-0.438** (0.137)	-0.339 (0.1056)	0.5536 (0.6858)
Number of observations	84	84	84
Fisher's test (p-value)	0.0000	0.0000	0.0050
R ²	0.7473	0.8118	0.913

Explanatory variables	Men's use of FS	Women's use of FS	Gender disparities in the use of FS
	(1)	(2)	(3)
Hansen J test (p-value)	0.2927	0.1503	0.7064

Notes: Standard errors in parentheses; *p-value<0,10, **p-value<0,05, ***p-value<0,01

Source: Authors based on regression analyses

Furthermore, control variables such as population density, per capita income, and the political stability index show the expected signs in the specifications where the corresponding coefficients are significant. The coefficients for the other variables are not significant. However, the unemployment rate is associated with a counter-intuitive coefficient (see columns 2 and 3 of Table 4). This positive sign can be explained by several factors. On the one hand, unemployed people can open an account with a financial institution to receive government, social, or family transfers (for example, remittances from migrants) (Demirgüç-Kunt et al., 2022). According to these authors, in developing countries, social protection schemes or programmes and remittances from the diaspora (a significant source of family income) are key factors in the opening of bank accounts (Demirgüç-Kunt et al., 2022).

3.3. Robustness test of the results

The robustness analysis is carried out in three stages. The first involves repeating the baseline estimates using the Lewbel-IV estimator, whilst adding additional variables to test the robustness of the results. The second stage involves repeating the exercise using other indicators of DT. Finally, the third stage involves using an alternative regression method to compare the results with those of the baseline estimation.

3.3.1. Robustness test with the addition of further control variables

The literature identifies other factors that may limit or improve women's access to financial services. These include women's limited bargaining power, socio-cultural norms, discriminatory laws (Mariscal et al., 2019; Molinier & Quan, 2019; Demirgüç-Kunt et al., 2013), and remittances from migrants (Ajefu and Ogebe, 2019). Indeed, in countries where women face legal discrimination (legal restrictions), they are less likely than men to hold a bank account, as well as to save and borrow (Demirgüç-Kunt et al., 2013). This implies that strengthening legislation (women's rights) would help to eliminate these socio-cultural and institutional constraints and improve women's participation in financial markets. Concerning the variable "Migrant remittances", Ajefu and Ogebe (2019) found, in their study conducted in Nigeria, that remittances were a key determinant of access to and use of formal financial services. Consequently, we use these variables (rule of law index, remittances) as additional control variables in our regressions to test the robustness of the baseline estimates.

Using the Lewbel-IV/2SLS method, the results of the estimation of the effect of DT on the use of financial services by gender remain conclusive after the inclusion of additional variables (see Table A4 in the appendix). They show that DT contributes significantly to improving the use of financial services among both

men and women. Furthermore, it reduces inequalities in access to and use of financial services between men and women in sub-Saharan Africa. These results, therefore, confirm the robustness of the baseline estimate.

3.3.2. Robustness test involving a change in the DT measurement

This stage involves presenting the results obtained from other DT indicators. The indicators used are as follows: the volume of mobile and online banking transactions, and credit and debit cards.

Tables A5 and A6 (in the appendix) show that all parameters associated with the DT indicators are positive and statistically significant at the 1 per cent level, for both women and men. These results also indicate that DT is significantly and negatively associated with inequalities in access to and use of formal financial services in low-income countries. These results are similar to those of the baseline estimates. Consequently, these results indicate that digital financial services are a powerful and appropriate tool that enables people who were previously excluded from the financial market to now benefit from formal financial services. They thus demonstrate that the transformative role of digital financial services is not limited to improving access to these services for both women and men, but also enables them to use these services to increase their financial independence and well-being.

3.3.3. Robustness test using an alternative estimation method

In order to assess the robustness of the results, this article proposes an alternative estimator to the basic method for estimating the effect of DT on gender-based disparities in the use of financial services. This is the FE-IV+ Clustered SE estimator, which is suitable for addressing autocorrelation, heteroscedasticity (Stock et al., 2008), and endogeneity (Wooldridge, 2010).

Applying this method, Table 5 below shows that the negative association between the DT and gender inequalities in the use of financial services in sub-Saharan Africa remains significant. This means that the digitalisation of banking activities represents an opportunity for financial inclusion and a strategic lever for reducing disparities in access to and use of financial services between men and women in developing economies. This finding demonstrates that the core results are stable and robust.

Table 5: Results of the impact of DT on disparities in the use of formal financial services, using the FE-IV + Clustered SE estimator

Explanatory variables	Men's use of FS	Women's use of FS	Gender disparities in the use of FS
	(1)	(2)	(3)
Digital transformation (% of adult population)	0.9402*** (0.1798)	0.7769*** (0.163)	-0.285** (0.1306)
Income per household (% of GDP)	0.2674 (0.595)	0.8511 (0.604)	-0.0199 (0.0181)
Foreign direct investment (% of GDP)	-0.6145*	0.2069	-0.8327

Explanatory variables	Men's use of FS	Women's use of FS	Gender disparities in the use of FS
	(1)	(2)	(3)
	(0.00177)	(0.3429)	(0.4928)
Human capital	1.9039*	2.1989***	-0.764
	(1.0217)	(0.7303)	(0.639)
Unemployment rate	-0.2945**	-1.716	-0.0156*
	(0.1492)	(1.419)	(0.0085)
Inflation rate	0.0057	-0.0203**	0.0431
	(0.0009)	(0.0086)	(0.0452)
Political stability and terrorism-free index	-2.801	-8.897***	0.4410
	(4.817)	(3.374)	(0.337)
Population density (% of total area)	-0.0748	-0.0911	-0.0406*
	(0.149)	(0.0895)	(0.0002)
Number of observations	84	84	84
Wald chi-squared (8)	32.48	108.36	32.21
Prob > chi-squared	0.0001	0.0000	0.0001
Hansen J-test (p-value)	0.7675	0.8596	0.1469

Notes: Standard errors in parentheses; *p-value<0,10, **p-value<0,05, ***p-value<0,01

Source: Authors based on regression analyses

3.4. Discussion of results

An empirical analysis of the impact of digital transformation on gender disparities in access to and use of financial services across 28 sub-Saharan African countries has yielded interesting findings that contribute to the existing literature. Indeed, our findings suggest that the shift from traditional bank branches to mobile banking brings unbanked populations, particularly women, closer to banking institutions and encourages them to use these services. These initial findings further support the conclusions of certain small-scale studies (Avom et al., 2023; Loaba, 2022; Kim, 2022; Nzilano & Magoti, 2025; Ong et al., 2023), which found a positive relationship between mobile money and financial inclusion. Indeed, the mobile banking services on offer are convenient, affordable, and give women the autonomy to manage their own finances, thereby driving widespread uptake of financial services. However, these findings contrast with certain empirical studies (Demombynes and Thegeya, 2012; Ky et al., 2018; Saeed and Donkoh, 2024), which have shown that mobile services have a negative or no effect on people's access to financial services.

Furthermore, the significant negative effect of DT on gender-based inequality in access to and use of financial services provides empirical evidence for theories of financial inclusion through digital banking and inclusive finance (Beck, 2020; Beck and Cull, 2014; Beck & De La Torre, 2007; Demirgüç-Kunt & Klapper, 2018; Ozili, 2024). These theories argue that the introduction of mobile banking would help to overcome the structural barriers that create inequalities in access to and use of traditional financial services across different social strata. Finally, our

findings support the theory of technological innovation adoption (Venkatesh et al., 2003), which suggests that the adoption of technology, particularly by women, can improve their financial inclusion and reduce inequalities between social groups (men and women). However, our findings contradict the research by Chavan (2008) conducted in India, which revealed that gender inequalities in access to financial services increased as the availability of such services grew.

4. Conclusion and economic policy implications

This article aimed to examine the effect of digital transformation on gender disparities in access to and use of formal financial services in this region. Using three-yearly data from 28 sub-Saharan African countries for the period 2011–2021, this study applied an estimation method guided by preliminary tests. These methods were the Lewbel-IV (2SLS) estimator and the FE-IV+ Clustered SE method. The regressions derived from applying these methods, together with the associated robustness tests, reveal significant findings. The results indicate that digital transformation considerably reduces gender inequalities in access to and use of these formal financial services in this region.

Consequently, this article highlights the need for banks to invest more in the development of mobile banking platforms and digital payment instruments. This translates, on the one hand, into an expansion of mobile and online banking services, as well as electronic payment cards, in order to encourage greater uptake of formal financial services by urban and rural households. Furthermore, these policies not only simplify the procedures for opening mobile accounts, but also strengthen cybersecurity and improve existing services, with a view to offering customers a better quality of service and strengthening the relationship between customers and the institution. Finally, this article highlights the need for public authorities to support banks in promoting digital financial services and to implement targeted initiatives aimed at women, in order to reduce financial exclusion in the 28 countries concerned. Such initiatives may, for example, involve facilitating women's access to digital devices (such as mobile phones and the internet) at an affordable cost, in order to increase the uptake and effective use of digital financial services.

However, this research has some limitations. These relate to the exclusion of certain countries. Indeed, the lack of data on our variables of interest in some countries forced us to reduce the sample to 28 sub-Saharan African countries. Furthermore, the digitalisation of financial products and services is still in full swing in sub-Saharan African countries. As a result, little information is available to assess the impact of digital financial services beyond access and usage, i.e., the quality of these services. Therefore, one way to advance research in this area for the sub-Saharan African banking sector is to conduct additional surveys on service quality.

Declaration of competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

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Data availability

The data that support the findings of the study are available from the corresponding author upon reasonable request

Author contributions:

Yaya Hié (corresponding author): Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing

Relwendé Sawadogo: Conceptualization, Formal analysis, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing

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APPENDIX:**Table A1:** Summary of variables

Variable names	Calculation method	Expected sign	Sources
Dependent variables			
Proportion of men with access to financial services (FS)	(Number of men with access to financial services divided by the total number of men aged 15 and over) × 100		The Global Findex (2022); Demirgüç-Kunt et al. (2022)
Proportion of women with access to financial services (FS)	(Number of women with access to financial services divided by the total number of women aged 15 and over) × 100		
Proportion of men or women using formal financial services	The number of women or men using financial services compared to the total number of women or men aged over 15.		
Disparity or Inequality in access to financial services	Differences between the proportion of men and the proportion of women with access to formal financial services.		
Variables of interest			
Users of digital payment methods	(Number of users of mobile and digital payment tools divided by the total adult population)*100.	(+) Accessibility /	(Ahmed & Wamugo, 2018)
Mobile and online banking services	(Volume of mobile and online money transactions divided by Gross Domestic Product)*100	(-) Disparity	
Electronic payment cards	Natural logarithm of the total number of debit and credit cards		
Control variables			
Inflation	Consumer price index	+ / -	(Allen et al., 2014))
Gross domestic product (GDP) growth rate	((PIB_t - PIB_{t-1})/ PIB_{t-1})× 100	(+) Accessibility / (-) Disparity	(Akileng et al., 2018). Triki and Faye (2013)
Institutional	The index ranges from -	(+)	Allen et al.

Quality Index	2.5 to 2.5.	Accessibility / (-) Disparity	(2014); Fratzscher et al. (2016)
Human capital (level of education)	Average number of years of education completed by adults	(+) Accessibility / (-) Disparity	Akileng (2018) and Loaba (2021)
Foreign direct investment	(Foreign direct investment / GDP) × 100	+	Akileng (2018)
Population density	Population density per square kilometre	(+) Accessibility / (-) Disparity	(Allen et al., 2014))

Source: Authors

Table A2: Results of the endogeneity test

Variables	Probability	Decision
Digital transformation	P-value= 0.000	Endogenous
Unemployment rate	P-value= 0.751	Exogenous
Population density	P-value= 0.473	Exogenous
Political stability and the absence of violence or terrorism	P-value= 0.213	Exogenous
Per capita income	P-value= 0.000	Endogenous
Human capital	P-value= 0.532	Exogenous
Foreign direct investment	P-value= 0.000	Endogenous
Rule of law	P-value= 0.145	Exogenous
Inflation rate	P-value= 0.641	Exogenous
Remittances	P-value= 0.645	Exogenous

Source: Authors, based on regression analysis

Table A.3: Results of the various tests

Type de test	Probability	Decision
Heteroscedasticity test	P-value=0.027	Presence of heteroscedasticity
Cross-dependence test	P-value=0.600	Absence of cross-correlation
Autocorrelation test for errors	P-value= 0.005	Presence of autocorrelation in the errors

Source: Authors, based on regression analysis

Table A4: Results of the effect of DT on gender disparities in the use of FS
(Adding additional variables)

Explanatory variables	Men's use of financial services	Women's use of financial services	Gender disparities in the use of financial services
	(1)	(2)	(3)
Digital transformation (% of adult population)	0.3246*** (0.0024)	0.3241*** (0.0554)	-0.428*** (0.0918)
Per capita income (% of GDP)	1.8024 (2.2457)	1.8949 (1.880)	-0.0871** (0.0358)
Net foreign investment (% of GDP)	-0.3084 (0.2509)	-0.2936 (0.2332)	-0.0195*** (0.006)
Human capital	0.2043* (0.1221)	0.3947*** (0.1384)	-0.0431 (1.638)
Unemployment rate	0.075*** (0.024)	0.0101*** (0.0022)	-0.0102 (0.0214)
Inflation rate	-0.0382*** (0.0134)	-0.016* (0.0088)	-0.000005 (0.00043)
Political stability and terrorism-free index	-0.125 (1.025)	-0.2718 (0.7928)	-0.1392*** (0.0415)
Population density (% of total land area)	0.0203*** (0.0107)	0.0306*** (0.0082)	-0.00071*** (0.0007)
Rule of Law Index	0.2234 (2.961)	-1.257 (2.524)	-0.0067 (0.1333)
Remittances (% of GDP)	0.1151 (0.288)	0.2366 (0.229)	0.0405** (0.0191)
Constant	-0.548 (0.146)	-0.522 (0.107)	0.2788 (0.3089)
Number of observations	84	84	84
Fisher's test (p-value)	0.0000	0.0000	0.0010
R ²	0.9249	0.8153	0.9870
Hansen J test (p-value)	0.2430	0.2349	0.5448

Notes: Standard errors in parentheses; *p-value<0,10, **p-value<0,05, ***p-value<0,01

Source: *Authors, based on regression analysis*

Table A5: Results of the effect of mobile and online banking services on gender-based disparities in the use of financial services

Explanatory variables	Men's use of financial services	Women's use of financial services	Gender disparities in the use of financial services
	(1)	(2)	(3)
Mobile and Online Banking Services (% of GDP)	0.1213*** (0.0378)	0.051*** (0.015)	-0.1817*** (0.0334)
Per capita income (% of GDP)	0.0507*** (0.0053)	0.0423*** (0.0030)	-0.0279*** (0.0081)
Net foreign investment (% of GDP)	0.0001 (0.0010)	0.00016 (0.0009)	-0.0158*** (0.0036)
Human capital	0.130*** (0.0175)	0.1209* (0.0634)	-1.0504*** (0.363)
Unemployment rate	0.0104*** (0.0003)	0.0096*** (0.0007)	-0.0203*** (0.0034)
Inflation rate	-0.0002*** (0.0000)	-0.00011** (0.00004)	0.00012 (0.00024)
Political stability and terrorism-free index	0.0013 (0.0023)	0.0046 (0.0038)	-0.0185 (0.0180)
Population density (% of total land area)	0.0003*** (0.00004)	0.00033*** (0.00002)	-0.00056*** (0.0001)
Constant	-0.2678** (0.0464)	-0.2364** (0.0455)	0.9736 (0.2064)
Number of observations	84	84	84
Fisher's test (p-value)	0.0000	0.0088	0.0000
R ²	0.8377	0.8249	0.9280
Hansen J test (p-value)	0.1081	0.2107	0.8856

Notes: Standard errors in parentheses; *p-value<0,10, **p-value<0,05, ***p-value<0,01

Source: *Authors, based on regression analysis*

Table A6: Results of the effect of payment cards on gender-based disparities in the use of financial services

Explanatory variables	Men's use of financial services	Women's use of financial services	Gender disparities in the use of financial services
	(1)	(2)	(3)
Credit and debit cards (ln)	0.5314*** (0.0696)	0.4853*** (0.0544)	-0.5183*** (0.0759)
Per capita income (% of GDP)	0.0466** (0.0191)	0.0441*** (0.0145)	-0.0813*** (0.0468)
Net foreign investment (% of GDP)	0.00569*** (0.00177)	0.00467*** (0.00127)	-0.0150*** (0.0042)
Human capital	0.0937 (0.102)	-0.01628 (0.0641)	-0.1690 (1.392)
Unemployment rate	0.0029 (0.0024)	0.00468*** (0.0015)	-0.0119 (0.017)
Inflation rate	-0.0003*** (0.0001)	-0.0002*** (0.0000)	0.0004 (0.0006)
Political stability and terrorism-free index	-0.0156* (0.0089)	-0.0111* (0.0060)	-0.1621** (0.0795)
Population density (% of total area)	-0.00003 (0.00015)	0.00004 (0.00001)	-0.00078*** (0.0003)
Constant	0.3383** (0.1266)	0.3138*** (0.0969)	0.2997 (0.7372)
Number of observations	84	84	84
Fisher's test (p-value)	0.0000	0.0000	0.0000
R ²	0.9242	0.8832	0.9056
Hansen J test (p-value)	0.2093	0.5370	0.2548

Notes: Standard errors in parentheses; *p-value<0,10, **p-value<0,05, ***p-value<0,01

Source: *Authors, based on regression analysis*