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Article

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Upstarts vs incumbents: the interaction between fintech credit and bank lending in Sub-Saharan Africa

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ABSTRACT

This study analyzes how fintech credit affects bank lending in Sub-Saharan Africa (SSA) and how this relationship is influenced by financial inclusion measured by bank branch networks. We utilized the system GMM to examine data spanning 19 SSA economies from 2013 to 2019. This study finds that fintech credit has a mixed effect on bank lending in SSA, depending on how it is measured. When fintech is measured by total alternative credit (fintech and Bigtech credit), there is a negative and significant relationship between Fintech and bank lending in SSA economies, suggesting that some borrowers are shifting towards fintech options. However, we observe a positive and significant relationship when we focus solely on fintech credit, suggesting that fintech can complement traditional bank lending, potentially by expanding access to financial services. Furthermore, this study underscores the importance of the presence of physical banks. Fintech lending growth has a negative net effect on bank lending when traditional banks reduce their branch network. This suggests that physical branches remain crucial for financial inclusion, particularly in areas with a limited digital infrastructure. These insights offer valuable guidance for policymakers and industry leaders seeking to promote financial inclusion and stability in SSA's evolving financial landscape.

IMPACT STATEMENT

This study investigates the impact of credit provided by fintech players on lending activities of traditional banks and the moderating effect of financial inclusion proxied by bank branch density on this nexus. Using data from 19 sub-Saharan African economies and GMM for estimation, the study identified a mixed effect of fintech on bank lending. When fintech is measured by total alternative credit (fintech and Bigtech) the results show that fintech tends to reduce bank lending, suggesting that some borrowers are shifting towards fintech products potentially competing with traditional banks. However, fintech credit alone show a positive effect, suggesting a complementary effect of fintech activities to enhance financial access. The study also shows that fintech lending negatively affects bank lending when banks reduce branch networks, emphasizing the importance of continued physical bank branches. Overall, this research highlights the complex interplay between fintech and traditional banking in Sub-Saharan Africa, providing valuable insights for policymakers and industry leaders seeking to promote financial inclusion and stability in the region.

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1. Introduction

The financial landscape of Sub-Saharan Africa (SSA) is undergoing a profound transformation driven by the rapid rise in financial technology (fintech). Fintech, characterized by the use of digital platforms, software, and applications to deliver financial services directly to consumers (Financial Stability Board, 2017), is reshaping the way financial transactions occur, particularly in regions with limited access to traditional banking services. With its unique challenges and opportunities, SSA is at the forefront of this fintech

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revolution. Fintech has the potential to revolutionize financial inclusion, efficiency, and innovation across SSA, a region where access to formal credit has historically been constrained, especially for small businesses and households (Dolson & Jagtiani, 2021; Erel & Liebersohn, 2020). Despite these challenges, these segments play a pivotal role in driving macroeconomic growth, creating employment opportunities, and alleviating poverty (Sahay et al., 2020). However, they often face formidable obstacles when seeking credit from conventional banks, including high interest rates, stringent collateral requirements, administrative complexities, and absence of an established credit history (Demirguc-Kunt et al., 2018). Fintech, however, offers a promising alternative for these underserved populations. It introduces diverse sources of financing such as peer-to-peer lending, crowdfunding, mobile money, and e-commerce platforms. These digital platforms leverage technology to efficiently streamline credit assessments and disburse loans (Bazarbash, 2019). As a result, fintech credit provides a lifeline for those previously excluded from the formal financial sector and catalyzes economic development. This study explores the relationship between fintech-driven credit and traditional bank lending in SSA.

Fintech credit, in the context of this study, encompasses loans extended through electronic platforms that operate independently of traditional commercial banks (Claessens et al., 2018). These platforms encompass specialized financial technology firms (fintechs) and large telecommunications companies expanding into financial services (Bigtechs), such as Vodafone's M-PESA and Alibaba's Ant Financial. They employ advanced machine learning algorithms and harness big data analytics to automate the credit evaluation process and expedite loan distribution (Bazarbash, 2019). The appeal of fintech credit lies in its speed, convenience, cost-efficiency, and effectiveness in catering to a broad spectrum of borrowers. Moreover, fintech credit can enhance financial access by utilizing alternative data sources for credit evaluation, reaching previously marginalized borrowers who lack traditional documentation and credit history (Erel & Liebersohn, 2020).

The growth of fintech credit in SSA is remarkable. Both the number of accounts and volume of loans disbursed through fintech platforms have witnessed exponential expansion in recent years (Cornelli et al., 2023; Jhariya et al., 2023). Cornelli et al. (2023) note that fintech and Bigtech credit have reached a level of economic significance in emerging markets, such as China and Kenya, which approach systemic importance. However, this spectacular rise in fintech credit prompts a fundamental question: what is the impact of fintech credit on the lending activities of conventional banks? Do fintech credit providers compete with or complement bank lending? Understanding the nature of this relationship is critical, as fintech's ascendancy could either erode the market share and profitability of traditional banks or fill a critical credit gap between unserved and underserved segments, thereby fostering synergy between the two. The answer to this question has significant implications for financial regulations, supervision, and policy development.

While a growing body of literature has examined this issue using data from developed economies (e.g. Hodula, 2022; Kowalewski & Pisany, 2022; Tang, 2019; Jagtiani & Lemieux, 2018), empirical evidence specific to SSA remains conspicuously absent. SSA has a unique financial landscape, in which banks have traditionally served as the primary source of credit (European Investment Bank, 2016). However, despite their critical role, banks have struggled to adequately meet the credit demands of marginalized populations, including small businesses and low-income households (Demirgüç-Kunt & Klapper, 2012). In this context, fintech solutions have emerged as potential remedies for the challenge of financial exclusion in SSA (Ashenafi & Yan, 2023). These innovative digital platforms offer alternative avenues for credit provision, signaling a transformative shift in the region's financial ecosystem. Moreover, one of the key differentiators of fintech activity in SSA, compared to its counterparts in developed economies, lies in the diverse array of fintech services that predominate the region. While developed economies often exhibit a dominance of peer-to-peer lending or marketplace lending platforms, SSA's fintech landscape is characterized by the prominence of mobile money services (Demirguc-Kunt et al., 2018). This unique feature arises from SSA's distinct financial landscape, characterized by limited banking penetration and underdeveloped capital markets (Sy et al., 2019). This contrast underscores the need for region-specific investigations, as the dynamics of fintech and its interaction with traditional banking can vary significantly based on a region's economic and financial characteristics. It is imperative to scrutinize how the role of traditional banks is evolving in response to the burgeoning fintech credit sector and, critically, to what extent fintech companies are filling the voids left by banks in the credit market. In response to this

research gap, our study seeks to provide empirical insights into the dynamics between fintech credit and bank lending in the context of SSA. Through this analysis, we aim to shed light on a critical aspect of the regional fintech revolution.

This study extends the existing literature on the fintech credit bank lending nexus by examining the role of financial inclusion, specifically bank branch networks. Recently, banks have been reducing their physical branch networks due to various factors, such as fintech innovations within the banking sector, competition from new fintech entrants, and low profitability of branches (Yan & Jia, 2022; Coetzee, 2018). Coetzee (2018) documents that the leading banks in South Africa decreased their branches between 2015 and 2017 as follows: ABSA (6%), FNB (5%), Nedbank (22%), and Standard Bank (0.2%). This shift is attributed to digitalization efforts aimed at creating smaller and more efficient branches. When bank branches become scarce or inaccessible due to various factors such as high costs, low profits, internal fintech innovations, or regulatory hurdles, many people, especially in rural areas, face limited and costly access to financial services. Fintech credit providers can bridge this gap by offering alternative and convenient ways to obtain credit, such as mobile money, peer-to-peer lending, or crowdfunding. This leads to a substitution effect between fintech credit and bank lending, as some segments of the market switch from banks to fintech to meet their credit needs (Bazarbash & Beaton, 2020). Alternatively, as more individuals gain access to traditional banking services, there may be a shift away from fintech credit providers. This is because fintechs typically cater to underserved or marginalized segments of the population (Kowalewski & Pisany, 2022; Erel & Liebersohn, 2020). Consequently, when mainstream financial institutions become more inclusive, people are more likely to turn to banks for their borrowing needs, potentially affecting the fintech credit industry.

The findings of this study have important implications for bank regulation and supervision in Sub-Saharan countries. One of the key findings is that fintech has a mixed impact on bank lending, depending on how it is measured and context. This implies that policymakers and regulators must consider the trade-offs and synergies between fintech and traditional banks when designing policies and regulations for the financial sector. Another finding is that fintech lending is not a complete replacement for bank lending, as physical branches still play a role in financial access and intermediation in Sub-Saharan Africa. This means that financial inclusion and intermediation still require a combination of digital and physical channels to reach different customer segments and meet their diverse needs. By contrast, physical branches may not be as relevant in other regions where digital channels are more prevalent and accessible.

The remainder of this paper is organized as follows. Section two reviews the literature on the relationship between fintech credit and bank lending and identifies the research gaps that this study aims to fill. Section three describes the data sources, variables, and analysis methods. Section four reports the preliminary estimates while section five presents and discusses the main results. Section six concludes the study and provides policy implications.

2. Literature review

2.1. Theoretical framework

The emergence of fintech credit in Sub-Saharan Africa (SSA) creates a complex landscape where its relationship with traditional bank lending can have both synergistic and competitive consequences. Building on existing research, this study explores the underlying mechanisms that drive these effects, providing valuable insights into the forces that shape financial markets in the region.

2.1.1. Potential mechanisms of competition

Fintech platforms often have lower operating costs, owing to technology-driven models and less stringent regulatory requirements. This allows them to offer competitive interest rates and more flexible lending criteria, attracting customers away from traditional banks (Berg et al., 2022). By capitalizing on their lean structures and digital-first approaches, fintech players can disrupt the conventional banking landscape and challenge the market dominance of established banks. Fintech lenders leverage alternative data sources and employ advanced algorithms to assess customer creditworthiness. Unlike

traditional banks that rely heavily on formal credit histories, fintech firms scrutinize unconventional data, such as transaction history and social media behavior (Cong et al., 2021). This innovative approach allows fintech platforms to extend credit to underbanked individuals who lack traditional credit profiles, thereby posing a significant competitive threat to banks (Erel & Liebersohn, 2020). By tapping into previously untapped segments of the population, fintech lenders expand their customer base and may 'eat' the market share of traditional banks. Additionally, the rise of mobile-based fintech lenders has revolutionized access to credit, particularly in regions with limited physical banking infrastructure, such as rural areas in SSA. Leveraging the widespread use of mobile devices, fintech platforms provide convenient and accessible financial services anytime, anywhere, effectively bypassing the need for physical bank branches. (Ben-David et al., 2021). This accessibility advantage allows fintech firms to penetrate underserved markets and capture customer segments that are overlooked by traditional banks. Consequently, traditional banks may face intensified competitive pressure, as fintech platforms gain traction among previously neglected demographics (Naceur et al., 2023).

2.1.2. Possible mechanisms of complementarity

As fintech platforms penetrate previously untapped segments of the population, traditional banks stand to benefit from an expanded customer base and an increased demand for complementary financial products and services. Fintech companies often collaborate with traditional banks, offering expertise in customer acquisition, underwriting technologies, and distribution channels (Hornuf et al., 2021). By leveraging these partnerships, banks can extend their reach and improve their operational efficiency, enhancing their competitiveness in the evolving financial landscape (Berg et al., 2022). This collaborative approach allows banks to leverage fintech innovations while leveraging their existing infrastructure and regulatory frameworks and creating synergies that drive mutual growth and innovation. Moreover, increased competition from fintech firms can act as a catalyst for innovation in traditional banks. Faced with the threat of market disruption, banks are incentivized to innovate their services, improve customer experiences, and adopt new technologies to remain competitive (Bao & Huang, 2021). This competitive pressure stimulates a culture of innovation within traditional banking institutions, leading to the development of new products, services, and operational efficiencies that benefit customers and broader financial ecosystems.

2.1.3. The context of Sub-Saharan Africa

Understanding the specific context of Sub-Saharan Africa (SSA) is crucial when examining the interplay between fintech credit and traditional bank lending. Several characteristics unique to a region shape these dynamics. SSA has one of the world's highest rates of financial exclusion (Nyimbiri, 2021; Achugamonu et al., 2020), with a significant portion of the population lacking access to formal banking services. Thus, they are underserved by traditional financial institutions. Such high levels of financial exclusion create a vast potential market for fintech lenders who are willing to cater to these excluded segments. Additionally, many areas within SSA have a sparse network of bank branches (Ajide et al., 2022), particularly in rural areas. This limitation creates geographical barriers to accessing financial services, exacerbating financial exclusion. However, fintech platforms with their technology-driven models have the potential to bridge this gap by offering much-needed credit access to populations beyond the reach of traditional banks. Through innovative approaches and digital solutions, fintech firms can extend their services to remote areas, thereby addressing the issue of a limited physical banking infrastructure.

Moreover, SSA has been a pioneer in the adoption of mobile money, which has facilitated payments and basic financial transactions, even for the unbanked (Nyimbiri, 2021; Siano et al. 2020). The widespread reliance on mobile money and informal financial mechanisms (Ky et al., 2021) such as savings groups and rotating credit associations highlights the limitations of the formal banking sector in meeting the needs of the population. Although fintech credit could potentially compete with some of these informal channels, it may also introduce more streamlined and regulated alternatives, providing consumers with safer and more accessible financial services. The regulatory environment for fintech is also evolving across SSA but at varying paces and with different levels of stringency. A proactive and balanced regulatory approach can foster innovation and healthy competition, ultimately benefiting the consumers. However, uncertainty or overly restrictive regulations can hinder fintech growth, potentially

limiting its positive impact on the financial landscape. Therefore, it is essential to consider a regulatory framework within which fintech operates when assessing its potential impact on traditional bank lending.

The mechanisms outlined above illustrate how the impact of fintech credit on bank lending in SSA is likely complex. For instance, mobile-based fintech lenders offering microcredit might primarily serve the unbanked population, thereby increasing overall financial inclusion in the region. However, a peer-to-peer lending platform catering to SMEs could pose a more competitive threat to banks, particularly to those that have been slow to digitize or provide tailored products for small businesses. A critical question arising from this analysis is how does fintech credit impact traditional bank lending in the SSA region? While some believe that fintech might replace banks altogether, reality is likely to be more complex. This study explores the interaction between fintech credit and bank lending in SSA and how financial inclusion, measured by bank branch density, influences this interaction. Insights into this complex nexus are important for policymakers and industry leaders seeking to promote financial stability and inclusion in the rapidly evolving financial landscape.

2.2. Empirical literature

The literature examining the relationship between emerging fintechs and established incumbent banks has grown significantly in recent years, offering various perspectives, but yielding inconsistent results. One perspective suggests that fintechs primarily engage in ‘skimming the cream’ – serving customers who already have access to bank services but offering them lower-cost products and better service quality (Dolson & Jagtiani, 2021). This perspective is supported by Eca et al. (2021), who find that fintech companies tend to target high-quality and creditworthy small businesses that already utilize traditional bank credit, as evidenced by data from a peer-to-business lending platform. However, the ‘skimming the cream’ hypothesis has been contested by several scholars, including Balyuk et al. (2022), De Roure et al. (2016), Fu and Mishra (2022) and Jagtiani and Lemieux (2019), who advocate for the ‘bottom-fishing’ hypothesis. These studies argue that fintech credit enhances financial inclusion by lending to lower-quality borrowers, who banks typically overlook. In support of this, Jagtiani and Lemieux (2018, 2017) demonstrate that fintech firms’ use of alternative data for credit scoring allows subprime borrowers to access not only better loan grades but also lower interest rates.

The literature underscores the transformative potential of fintech in expanding access to financial services, particularly for individuals and segments that are traditionally marginalized by conventional banks. These groups often face significant barriers in obtaining credit from traditional banking institutions, such as high-risk profiles, insufficient documentation, and low profitability. However, some scholars have argued that fintech credit is more inclusive. For instance, Hau et al. (2021) demonstrates how fintech platforms provide credit to individuals with low credit scores, often excluded from traditional bank lending, based on a comprehensive data analysis from Ant Financial. Similarly, Bazarbash and Beaton (2020) conducted a comprehensive study of 109 countries from 2015 to 2017, revealing an increase in peer-to-peer lending platforms, particularly in regions with limited financial infrastructure. This growth suggests that marketplace lending has the potential to fill credit gaps left by traditional banks, particularly in low-income countries. However, it is important to acknowledge that the long-term impact and overall volumes of peer-to-peer lending are debatable. Several platforms have faced challenges, including failures that highlight the risks associated with this lending model and the need for evolving regulations to ensure its sustainable contribution to financial inclusion. Despite these limitations, the potential of diverse fintech models to address financial inclusion gaps remains an important research area.

Nonetheless, the impact of fintech on bank lending is not uniform, as evidenced by Wolfe and Yoo’s (2017) study, which indicates that bank size affects how fintech influences lending activities. Smaller banks face more pressure from fintech competition than larger banks. Moreover, Cornaggia et al. (2018) provide insights into borrower behavior, suggesting that higher-risk borrowers switch from traditional bank credit to fintech loans possibly attracted by lower interest rates. Supporting this view, Jagtiani and Lemieux (2017) also report that loans from Lending Club, a fintech lender, are cheaper than traditional bank loans for similar borrowers, implying that fintech offers lower-cost loans than banks. Furthermore, Kowalewski and Pisany (2022) note that domestic and privately owned banks are more affected by

digital lending platforms, especially Bigtech, than foreign banks. These dynamics reveal the complex relationship between fintech and traditional banks, in which various factors shape the changing landscape of credit provision.

There is a close relationship between financial inclusion and bank lending. Bank lending serves as a key avenue for individuals and businesses to access finance, whereas financial inclusion helps expand the pool of potential borrowers and lenders. Financial inclusion can improve individuals' financial well-being by providing access to savings and credit products (Sahay et al., 2020), whereas bank lending can finance growth and investment for businesses (Munangi & Sibindi, 2022). Financial inclusion is the process by which individuals and businesses gain access to appropriate, affordable, and timely financial products and services that meet their needs, including transactions, payments, savings, credit, and insurance (Pesqué-Cela et al., 2021). Small and medium-sized enterprises (SMEs) in Sub-Saharan Africa (SSA) face significant barriers to accessing traditional bank financing due to various challenges. These challenges include a lack of credit history, high risk premiums, insufficient collateral, high transaction costs for small loan sizes (Demirguc-Kunt et al., 2018; World Bank, 2018), along with the reluctance of banks to lend to high-risk individuals and businesses (Cortés et al., 2020). As a result, many SMEs are credit-constrained in Sub-Saharan Africa, East Asia and the Pacific and South Asia, with 25% of them unable to access credit and 19% unlikely to access external financing despite their active efforts (World Bank, 2018). This financing gap disproportionately affects underserved segments, such as rural, informal, and women-owned businesses (de Haan, 2016). This difficulty faced by SMEs in SSA can be attributed to the concept of asymmetric information, where banks have less information about potential borrowers than the borrowers themselves (Stiglitz, 2002; Akerlof, 1970). This information asymmetry is particularly problematic during times of crisis, as seen during the COVID-19 pandemic, where access to formal financing significantly impacted SMEs' ability to respond (Alekseev et al., 2023). This limited access to credit not only hinders SMEs' growth and development but also exacerbates their vulnerability during economic shocks, perpetuating a cycle of disadvantage.

However, fintech can address these challenges by providing alternative lending channels and innovative financial solutions that bridge the information gap between banks and SMEs. Fintech can improve financial access by using alternative data sources and automated credit assessments to evaluate credit-worthiness for borrowers lacking formal financial histories. Through digitalization, fintechs can serve remote and hard-to-reach groups more cost-effectively than traditional banks. Moreover, fintech's flexibility in loan sizes and repayment terms is well-suited to the needs of small businesses. Overall, fintech has the potential to address the financing gaps faced by SMEs in SSA, promoting financial inclusion and stability in the region. Additionally, fintech can provide financial support to SMEs during times of crisis, helping them respond to economic shocks and maintain their operations (Fu & Mishra, 2022). This is contrary to the 'cream skimming' doctrine suggested by some scholars (for example, Jagtiani & Lemieux, 2018; De Roure et al., 2016).

The remarkable growth and success of fintech companies in Sub-Saharan Africa (SSA) and beyond can be attributed to significant investments from private equity funds, corporate ventures, and development finance institutions (Yermack, 2018). This influx of financing has empowered fintechs to scale innovative solutions, challenge traditional banks, and tackle the long-standing issue of financial inclusion. By leveraging alternative credit-scoring models and data sources, fintechs can assess the creditworthiness of underserved populations, including thin-file borrowers and small businesses with limited financial histories (Cornaggia et al., 2018). While fintechs have made significant strides in expanding financial access, the sector also presents unique challenges. These include the risk of over-indebtedness for consumers, concerns about customer data protection, and the strain on regulators to adapt to innovative financial technologies (Boeddu and Chien, 2022; World Bank, 2020). Despite these challenges, fintechs have the potential to bridge the financial inclusion gap by providing alternative credit scoring models and data sources. This enables them to serve underserved populations, including thin-file borrowers and small businesses, which have been historically excluded from traditional banking services (Cornaggia et al., 2018). However, the extent to which fintechs are displacing traditional banks in SSA, and the impact of financial inclusion on this trend, remains an important research question that warrants further investigation. As the fintech landscape continues to evolve, it is crucial to explore the dynamics between

fintechs, traditional banks, and financial inclusion to ensure that the benefits of financial innovation are shared equitably among all stakeholders.

3. Methodology

3.1. Data and sample

This study employs country-level data from various sources including the World Bank Financial Development Database, S&P Capital Pro, and World Bank Economic Indicators. Bank-specific characteristic data were obtained from the World Bank Financial Development Database, while macroeconomic fundamental data were sourced from the World Bank Economic Indicators and supplemented by S&P Capital Pro for variables that had significant missing data. More specifically, Cornelli et al. (2023) developed the fintech and Bigtech credit databases that are available from the World Bank Financial Development Database. To mitigate the impact of outliers, the data underwent log transformation. The initial study covered 48 Sub-Saharan African countries, but due to data limitations, the sample was reduced to 19 countries. These countries were selected based on data availability, and included Burkina Faso, Burundi, Cameroon, the Democratic Republic of Congo, Ghana, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Togo, Uganda, and Zambia. It is worth noting that this study focuses on the period from 2013 to 2019, aligning with the data availability based on the fintech database of Cornelli et al.'s (2023) fintech database.

3.2. Variables

3.2.1. Dependent variable

This study employs private credit by deposit money banks to GDP as a proxy for bank lending, with domestic credit to the private sector to GDP used for robustness analysis.

3.2.2. Independent variable

The central variable of interest in this study is fintech, characterized by the provision of direct financial services to consumers through digital platforms, software, and applications. To investigate the impact of fintech on bank lending activities in Sub-Saharan Africa, this study uses fintech credit proxies provided by Cornelli et al. (2023), including total alternative credit (fintech + Bigtech credit) and fintech credit per capita.

3.2.3. Control variables

In line with the existing literature (Vinh, 2017; Pham, 2015; Gambacorta & Mistrulli, 2004), this study considers several control variables that could influence bank lending volumes. These variables include bank liquidity (measured by the liquid asset ratio), asset quality (proxied by non-performing loans), bank concentration (proxied by the C3 ratio), regulatory capital (estimated by the ratio of capital to risk-weighted assets), bank funding (proxied by retail deposits), and macroeconomic factors, such as inflation and GDP growth.

3.3. Empirical specification and estimation

The empirical model used in this study is as follows:

$$BL_{it} = \alpha + \delta BL_{it-1} + \phi fintech_{it} + \varphi Z'_{it} + \eta_i + \mu_t \quad (1)$$

where BL represents bank lending; fintech represents credit provided by fintech players; Z is a vector of control variables; and α , δ , ϕ , φ , η , and μ denote the coefficients for the constant term, lagged dependent variable, fintech variables, vector of controls, country fixed effects, and the error term, respectively.

The above model was estimated using the system Generalized Method of Moments (SGMM) estimator, a statistical technique developed by Arellano and Bover (1995) and further refined by Blundell and Bond (1998). The GMM estimator's strength lies in its capacity to accommodate diverse characteristics and variations across different entities or groups (heterogeneity), enabling a more thorough analysis of the data (Newey, 2007). Moreover, it is adept at mitigating the impact of endogeneity, which may arise when an

independent variable is correlated with the error term, ensuring that the estimated results are more reliable and unbiased (Blundell & Bond, 1998). System GMM combines two equations: one that uses first differences to eliminate unobserved heterogeneity and one that uses levels to exploit the additional information in the initial observations (Arellano & Bover, 1995). By incorporating lagged values as instruments, the GMM method accounts for the dynamic nature of the data, effectively addressing potential endogeneity issues and ensuring a more robust estimation of the relationships between the variables. In addition to handling the complexities of heterogeneity and endogeneity, the study also utilized Roodman's (2009) xtabond syntax to manage the issue of instrument proliferation. This syntax serves as a valuable tool for controlling an excessive number of instrumental variables, ensuring that only relevant and valid instruments are included in the estimation process. By employing this approach, the instrumental variables used in the analysis were refined to enhance the overall reliability and validity of the estimated model.

3.4. Pre-estimation and post-estimation tests

Before conducting regression analysis, the data were subjected to various tests. Initially, stationarity was assessed through unit root tests and multicollinearity was checked using the correlation matrix. Subsequently, instrument validity was tested using the Sargan test and second-order correlation was examined using the Arellano and Bond (1991) AR 2 test.

4. Preliminary analysis

4.1. Stationarity test

To avoid spurious regression results, the stationarity of the data was checked using a Fisher-type unit root test. The results of the unit root tests are presented in Table 1.

As shown above, all the variables used in this study are stationary in levels. Thus, the estimates can be relied upon as the data exhibit a constant mean and variance over time, which means that there is no change in the distribution or behavior of the data over time, and that the estimates are consistent and efficient.

4.2. Correlation analysis

The correlation matrix was used to detect multicollinearity and explore possible associations between the variables. Table 2 displays the results of the correlation analysis.

The presented correlation matrix shows that there were no independent variables with correlations above 0.70, thus confirming the absence of multicollinearity within the dataset. Furthermore, the correlation matrix highlights several noteworthy tentative relationships worth exploring. The notable 0.90 correlation between bank lending and inflation suggests a positive correlation between inflation and bank lending in Sub-Saharan Africa. This could be attributed to the increased demand for loans amid rising inflation, as households and businesses seek to bridge the financing gaps. Additionally, the correlation might reflect how inflation reduces the real value of debt, thereby making borrowing more affordable.

Table 1. Unit root results.

| Variable | Test statistic | Order of integration |
|----------------|----------------|----------------------|
| lnbank_lending | 98.95*** | Level |
| lnfintech | 78.14*** | Level |
| lnlar | 61.77*** | Level |
| lnnpl | 96.70*** | Level |
| lnconc | 162.55*** | Level |
| lnreg_cap | 47.04** | Level |
| lndeposits | 60.95*** | Level |
| lninf | 77.29** | Level |
| lngdp | 165.14*** | Level |

Source: Authors' construction.

***, **, * indicates statistical significance at 1%, 5% and 10% respectively.

lnbank_lending = bank lending; lnfintech = fintech; lnlar = liquid asset ratio; lnnpl = non-performing loans; lnconc = bank concentration; lnreg_cap = regulatory capital; lndeposits = bank deposits; lninf = inflation; lngdp = gdp growth.

Table 2. Correlation matrix.

| Variable | Inbank_lending | Infintech | Inlar | Innpl | Inconc | Inreg_cap | Indep | Ininf | Ingdp |
|----------------|----------------|-----------|--------|-------|--------|-----------|--------|-------|-------|
| Inbank_lending | 1.00 | | | | | | | | |
| Infintech | 0.03 | 1.00 | | | | | | | |
| Inlar | -0.60* | -0.09 | 1.00 | | | | | | |
| Innpl | 0.18 | 0.02 | 0.08 | 1.00 | | | | | |
| Inconc | 0.14 | -0.55* | 0.08 | 0.24* | 1.00 | | | | |
| Inreg_cap | 0.03 | 0.26* | -0.07 | -0.18 | -0.15 | 1.00 | | | |
| Indep | -0.48* | -0.13 | 0.50* | 0.29* | 0.26* | 0.06 | 1.00 | | |
| Ininf | 0.90* | 0.03 | -0.55* | 0.20* | 0.09 | 0.07 | -0.47* | 1.00 | |
| Ingdp | -0.04 | -0.23 | -0.09 | -0.14 | 0.05 | 0.05 | 0.10 | -0.07 | 1.00 |

Source: Authors' construction.

*indicate statistical significance at 5%.

Inbank_lending = bank lending; Infintech = fintech; Inlar = liquid asset ratio; Innpl = non-performing loans; Inconc = bank concentration; Inreg_cap = regulatory capital; Indeposits = bank deposits; Ininf = inflation; Ingdp = gdp growth.

Table 3. Descriptive statistics.

| Variable | Obs | Mean | Std. Dev | Minimum | Maximum |
|----------------|-----|------|----------|---------|---------|
| Inbank_lending | 130 | 2.88 | 0.65 | 1.65 | 4.86 |
| Infintech | 76 | 1.85 | 2.47 | -3.91 | 7.63 |
| Inlar | 123 | 3.38 | 0.41 | 2.46 | 4.26 |
| Innpl | 97 | 2.45 | 0.53 | 0.20 | 3.16 |
| Inconc | 123 | 4.08 | 0.30 | 3.37 | 4.61 |
| Inreg_cap | 87 | 2.87 | 0.26 | 2.06 | 3.29 |
| Indeposits | 130 | 3.07 | 0.43 | 2.21 | 4.04 |
| Ininf | 133 | 4.82 | 0.40 | 3.93 | 6.04 |
| Ingdp | 110 | 2.41 | 2.17 | -0.58 | 8.65 |

Source: Authors' construction.

Inbank_lending = bank lending; Infintech = fintech; Inlar = liquid asset ratio; Innpl = non-performing loans; Inconc = bank concentration; Inreg_cap = regulatory capital; Indeposits = bank deposits; Ininf = inflation; Ingdp = gdp growth.

Furthermore, the significant negative correlation (-0.60) between bank lending and liquidity aligns with the intuitive understanding that banks tend to curtail credit supply, as they allocate more resources to liquid assets. This behavior resonates with the asset allocation intuition, which highlights how banks manage their resource allocation between riskier and less risky assets based on their respective risk-return tradeoffs. Additionally, the substantial negative correlation (-0.55) between the variables *fintech* and *bank concentration* suggests that the emergence of fintech solutions may reduce bank concentration. This phenomenon can be attributed to the comparatively lower entry barriers and innovative edge enjoyed by fintech firms, resulting in the diminishing concentration of traditional banking institutions. The negative and statistically significant correlation of (-0.47) between bank deposits and inflation suggests that bank deposits tend to decline in inflationary environments. This trend might be attributed to the erosion of purchasing power and diminished returns on bank deposits, potentially leading to a reduced incentive to save and encouraging individuals to seek alternative avenues to preserve the value of their money.

4.3. Descriptive statistics

The study presents the descriptive statistics for the variables in Table 3 and analyzes them in this section.

The summary statistics indicate a moderate standard deviation of (0.65) for bank lending, suggesting relatively consistent private credit provided by deposit money banks across the sampled countries in Sub-Saharan Africa. This finding suggests that similar factors may influence bank lending behavior across regions. By contrast, the fintech variable exhibits a higher standard deviation of 2.47, along with a substantial range between the minimum (-3.91) and maximum (7.63) values. These findings underscore significant variations in fintech lending activities among economies, likely driven by varying levels of fintech penetration and adoption within the Sub-Saharan African region. Similar evidence was reported by Mashamba and Gani (2023) in their paper on fintech, bank funding, and economic growth in Sub-Saharan Africa.

Meanwhile, the liquid asset ratio shows a narrow spread with a low standard deviation of 0.41 and a relatively minor range between the minimum (2.46) and maximum (4.26) values. Consistent with Tamini and Petey (2021) this finding suggests a consistent distribution of high bank liquid asset holdings in Sub-Saharan Africa, possibly influenced by the region's financial underdevelopment and limited access to additional funding sources during liquidity shocks.

The non-performing loans variable shows a moderate spread, with varying levels of loan performance within the region. While some areas exhibit more consistent repayment behavior, others face higher volatility and risk in loan repayment. The results also show that, in the context of Sub-Saharan Africa (SSA), bank concentration exhibits a relatively low degree of variability. The narrow spread is indicated by the low standard deviation (Std. Dev = 0.30) suggesting that the values of the concentration variable were clustered closely around the mean (4.08). This suggests a certain level of equilibrium or similarity in the distribution of market concentration within the banking sectors in Sub-Saharan Africa, suggesting a fairly homogenous market structure within the region.

The mean regulatory capital for the sampled economies in its non-log-transformed form is 18.17% (not reported for brevity), indicating a robust capitalized banking sector across Sub-Saharan Africa. The notably low standard deviation (0.26) associated with the regulatory capital variable underscores the stable and uniform distribution of capital ratios within the region's banking sector. Exhibiting a modest range between the minimum (2.21) and maximum (4.04) values, the deposit variable suggested a relatively limited degree of variability within the dataset. This finding indicates a relatively consistent deposits-to-GDP ratio among the sampled economies within Sub-Saharan Africa, pointing to a certain degree of stability in deposit trends across the region.

The unreported non-log-transformed data for the inflation variable indicate an average inflation rate of 135.05% among the sampled economies. Meanwhile, the log-transformed inflation variable demonstrated a moderate standard deviation (0.40), implying a notable degree of variability within the dataset. These findings collectively suggest that inflation levels remain considerably elevated across the Sub-Saharan African region. Lastly, the log-transformed GDP variable displays substantial variation, as indicated by the high standard deviation of 2.17 and the considerable difference between the minimum (-0.58) and maximum (8.6) values. These disparities in economic output reflect the diverse nature of Sub-Saharan African economies, influenced by factors such as political stability, natural resource wealth, technology access, and human capital development (Achuo et al., 2021; Rjoub et al., 2021; Izvorski et al., 2018). These findings emphasize the need for tailored policies and interventions to address the various challenges and opportunities present within the region.

5. Main results

5.1. Empirical findings

The results of estimating Equation (1) using the system GMM estimator are provided in Table 4. Columns 2 and 3 present the results for Model 1, where Total Alternative Credit (combining fintech and Bigtech) is used as a proxy for fintech. By contrast, Columns 4 and 5 display the results for Model 2, employing Fintech Credit per Capita (measured in USD) as the Fintech indicator. The results show that the p-values for both the AR(2) and Sargan tests are above 0.05, indicating that the models do not suffer

Table 4. Empirical findings.

| Variable | Model 1 (Total Alternative Credit) | | Model 2 (Fintech Credit per Capita) | |
|-------------------------|------------------------------------|----------|-------------------------------------|----------|
| | Coeff | Std. Err | Coeff | Std. Err |
| Inbank_lending(1) | 0.5894*** | 0.0564 | 0.4379** | 0.1747 |
| Ln fintech | -0.0209*** | 0.0060 | 0.0473** | 0.0219 |
| Lnlar | -0.1388** | 0.0696 | -0.1506** | 0.0745 |
| Lnnpl | 0.0049 | 0.0483 | 0.0240 | 0.0572 |
| Lnconc | 0.2182*** | 0.0672 | 0.3326*** | 0.1192 |
| Inreg_cap | -0.0472 | 0.0569 | -0.1087* | 0.0597 |
| Ln deposits | 0.5246*** | 0.0642 | 0.6630*** | 0.1715 |
| Lninf | -0.1215** | 0.0478 | -0.1716* | 0.0927 |
| Lngdp | -0.0074 | 0.0063 | -0.0023 | 0.0064 |
| <i>Diagnostic Tests</i> | | | | |
| AR (2) | 0.420 | | 0.571 | |
| Sargan | 0.242 | | 0.728 | |

Source: Authors' construction.

***, **, * indicates statistical significance at 1%, 5% and 10% respectively.

Inbank_lending = bank lending; Ln fintech = fintech; Lnlar = liquid asset ratio; Lnnpl = non-performing loans; Lnconc = bank concentration; Inreg_cap = regulatory capital; Ln deposits = bank deposits; Lninf = inflation; Lngdp = gdp growth.

from significant residual autocorrelation and that the instrumental variables employed in the estimation process are valid and do not introduce systematic bias into the results. This enhances the reliability of the models and the validity of the inferences drawn from them.

First, the coefficient for the lagged dependent variable, which proxies bank lending using private credit by deposit money banks to GDP, is statistically significant in both Models 1 and 2. Notably, these coefficients fall within the boundary $[0, 1]$. This statistical significance and adherence to the range $[0, 1]$ implies a significant level of persistence in bank lending over time, justifying the use of a dynamic estimation approach like GMM.

The results in column 2 of the models yield interesting findings. When fintech is measured by total fintech credit (comprising fintech and Bigtech credit), there is a negative and statistically significant association between fintech and bank lending in Sub-Saharan Africa. A one percent increase in fintech credit is associated with a 2% decline in credit provided by deposit-taking banks, *ceteris paribus*. In other words, as fintech (including Bigtech) credit availability expands, it has a negative impact on traditional bank lending. This finding indicates a substitution effect, where some customers are switching to fintech options. However, this does not necessarily mean that fintech companies are exclusively serving the previously unbanked population. The observed trend may be influenced by various factors beyond the direct expansion of financial services to previously unbanked individuals, such as customer switching behavior, wherein existing bank customers are enticed by convenience, lower fees, or broader service offerings provided by fintech platforms.

Additionally, heightened competition from fintech firms may prompt traditional banks to enhance their efficiency and lower their fees to retain their customer base. Consequently, while the overall number of banked customers may remain stable, the competitive landscape and market dynamics are evolving, potentially impacting the market share of traditional banks in the financial services sector. This evidence is consistent with studies that identify a negative and significant relationship between fintech and bank lending in other regions or countries. For instance, Jagtiani and Lemieux (2018) use loan-level data from the Lending Club and Y-14M bank stress test data to show that fintech is substituting traditional bank loans by providing credit to borrowers who are otherwise excluded or underserved by banks. Similarly, Buchak et al. (2021), using loan-level data from HMDA and LPS, find that shadow banks, which include online fintech lenders, increased their market share of U.S. mortgage lending from 25% in 2007 to 38% in 2015. They also show that shadow banks have a comparative advantage in refinancing and FHA lending, which are standardized and technology-intensive segments of the market. This suggests that fintech reduces demand for bank loans by offering convenience or faster processing times. On the other hand, the adverse effect of fintech on traditional bank lending in SSA is concerning, as SMEs, which traditionally depend on traditional bank lending for their financial needs, may be disproportionately affected. This is particularly worrisome in light of Alekseev et al. (2023) findings, which revealed that access to formal financing played a crucial role in SMEs' ability to respond to the COVID-19 pandemic. As such, the decline of traditional bank lending due to fintech growth may exacerbate the existing challenges faced by SMEs in accessing financial services, potentially hindering their resilience and recovery in times of crisis.

However, this evidence is also in contrast with some studies that find a positive and significant relationship between fintech and bank lending in different regions or countries. For example, Fuster et al. (2019), using loan-level data from HMDA and LPS, show that technology-based lenders increased their market share of U.S. mortgage lending from 2% to 8% from 2010 to 2016. They also find that technology-based lenders process mortgage applications 20% faster than other lenders do, without increasing default rates. They argue that technology-based lenders create positive spillovers or synergies in bank lending by fostering financial inclusion, innovation, competition, or efficiency in the financial sector. Similarly, Cornaggia et al. (2018) used loan-level data from Prosper and FDIC to show that peer-to-peer lending platforms increase the supply of credit to small businesses in areas where banks face more regulatory constraints or higher capital requirements. They also find that peer-to-peer lending platforms complement rather than substitute bank lending by serving different types of borrowers or offering different types of loans. Therefore, evidence from Sub-Saharan Africa may reflect the specific characteristics or challenges of this region, such as low financial inclusion, weak institutional quality, high market concentration, or limited access to finance. This evidence could have various implications for the financial landscape of the region, such as changes in lending practices, competition between fintech firms and traditional banks, and the overall accessibility of credit to consumers and businesses.

In contrast, when fintech is measured by fintech credit per capita, the empirical findings reveal a positive association between fintech and bank lending in Sub-Saharan Africa, suggesting a complementary relationship. The estimated coefficient of 0.0473 indicates that for every one percent increase in fintech credit per capita, there is an associated growth of approximately 4.7% in bank lending activities. It seems that the growing accessibility of fintech credit leads to a heightened demand for financial services. These findings align with Cornaggia et al.'s (2018) study, which shows that peer-to-peer lending platforms enhance the availability of credit to small businesses, particularly in regions where banks contend with greater regulatory constraints or elevated capital requirements. This finding suggests that fintech may augment the capacity of traditional banks to extend credit to a broader range of customers or serve as a catalyst for increased economic activity, leading to expanded lending opportunities. Such a complementary effect could signify that fintech and traditional banking institutions coexist and collaborate in ways that enhance overall access to financial services and economic development in the region. This finding may have implications for financial institutions, policymakers, and regulators, highlighting the potential benefits of fostering synergistic relationships between fintech firms and traditional banks to further drive financial inclusion and economic growth in Sub-Saharan Africa.

Turning our attention to the control variables, the results shed light on their influence on bank lending in Sub-Saharan Africa, revealing noteworthy insights. As indicated by the liquid asset ratio, bank liquidity has a statistically significant negative impact on bank lending in Models 1 and 2. The coefficients for Models 1 and 2, which stand at (-0.1388) and (-0.1506), respectively, imply that a one percent increase in bank liquidity corresponds to 14% and 15% decreases in bank lending, respectively. This finding is consistent with intuitive expectations and supports existing literature. For instance, Dahir et al. (2019) observe that funding liquidity undermines bank lending in BRICS economies. Likewise, in Europe, Naceur et al. (2017) reported that holdings of liquid assets exert a pervasive influence on bank lending. A plausible explanation for this is that when banks allocate a substantial portion of their resources to highly liquid securities, such as money market instruments, they naturally diminish their capacity to extend loans, which represents riskier assets. Therefore, the negative relationship observed here underscores the trade-off that banks face between maintaining ample liquidity for short-term obligations and deploying capital for lending activities that generate interest income in the long term.

In both models, the non-performing loans (NPLs) variable demonstrates a positive but insignificant effect on bank lending. This suggests that the presence or level of non-performing loans has an insignificant impact on the lending practices of banks in the Sub-Saharan African region. This evidence contrasts with the findings of Mpofu and Nikolaidou (2019), who identified a positive and statistically significant relationship between non-performing loans and domestic credit provided by banks to the private sector in eight Sub-Saharan economies. One plausible explanation for this is that banks in the region might have developed strategies to manage and mitigate the impact of NPLs effectively, such as prudent risk management practices, collateral requirements, or loan provisioning.

The study proxied bank competition by the concentration ratio, specifically the C3 ratio, which measures the assets of the three largest banks as a percentage of the total banking system assets. This variable has a significant positive effect on bank lending in both models. The coefficient of (0.3326) in column 4 indicates that a one percent increase in bank concentration is associated with a 33% increase in bank lending in Sub-Saharan Africa. This evidence implies that banks in Sub-Saharan Africa may benefit from economies of scale, market power, or lower information asymmetry when they operate in a less competitive environment. This may enable them to offer more credit to customers at lower costs or higher margins.

While both models exhibit a negative coefficient for the regulatory capital variable, it is only in Model 2 that the study observes a significant result. The point estimate of (-0.1087) in model 2 is statistically significant at the 10% level. Our findings corroborate and extend the empirical evidence provided by Naceur et al. (2018), emphasizing the importance of this regulatory capital lending nexus in shaping the dynamics of banking systems across diverse geographic domains. This evidence is not only reasonable but also aligns with the prevailing wisdom within the financial industry. The rationale is clear: higher regulatory capital levels incentivize banks to extend more loans (Louhichi & Boujelbene, 2017). This is primarily because elevated capital levels bolster banks' capacity to absorb potential credit losses. Consequently, banks tend to be more confident in lending when they have a stronger capital buffer to cushion potential setbacks, thereby stimulating economic activities.

Furthermore, it is important to recognize the significance of deposits as the lifeblood of banks, particularly in emerging economies, where financial development is still in its nascent stages. In Sub-Saharan Africa, deposits represent the primary source of funding for banks because of the relatively low levels of financial development across many of these economies (Mashamba & Magweva, 2019). In line with these expectations, our analysis reveals a statistically significant relationship between deposits and bank lending with consistent results in both models. The coefficient of (0.52) in Model 1 is particularly striking, indicating that a mere one percent increase in bank deposits corresponds to a substantial 52% surge in bank lending. This outcome underscores the critical role that deposits play in fueling lending activities within Sub-Saharan Africa. As banks accumulate more deposits, they simultaneously expand their capacity to provide loans, fostering economic growth and financial stability. This finding resonates with the broader economic landscape, emphasizing the pivotal function of deposits in stimulating lending (Berlin & Mester, 1999) and, by extension, economic development in emerging economies.

The study employed the Consumer Price Index (CPI) as a control variable to account for the potential impact of inflation on our analysis. The CPI variable exhibited statistical significance in both models, but intriguingly, it exerted a negative influence on bank lending. This finding aligns with (Vo, 2018) who reports that high levels of inflation tend to stifle bank lending. The negative effect of inflation on bank lending can be explained as follows. When inflation rates soar, the real value of money diminishes (Bernanke, 2006). In response, individuals and businesses become increasingly cautious about borrowing and lending. Borrowers anticipate higher repayment costs in an inflationary environment, whereas lenders grapple with the eroding value of the funds they extend as loans (Mosk & Welz, 2022). This mutual apprehension translates into a reduced appetite for credit, ultimately resulting in a contraction in bank lending. This evidence underscores the importance of inflation control measures for fostering a conducive environment.

Shifting our focus to the Gross Domestic Product (GDP) growth rate, the results reveal an expected negative coefficient sign for this variable in both models but is statistically insignificant at conventional levels. Consequently, the study did not find evidence supporting the notion that bank lending in Sub-Saharan Africa exhibits procyclical behavior. This evidence contradicts the findings of Amidu (2014), who reported a positive and significant effect of GDP growth on bank lending in a sample of 24 Sub-Saharan African economies from 2000 to 2007. While the anticipated negative relationship between GDP growth and bank lending was present in our models, the absence of statistical significance suggests that other factors and complexities may overshadow this relationship in Sub-Saharan Africa.

5.1.1. Interaction effect of financial inclusion

This study extends the analysis to examine the effect of financial inclusion, measured by bank branch density, on the relationship between fintech and bank lending in SSA. The results are displayed in Table 5.

Table 5. Interaction analysis.

| Variable | Model 1 | | Model 2 | |
|-------------------------|------------|----------|------------|----------|
| | Coeff | Std. Err | Coeff | Std. Err |
| Inbank_lending(1) | 0.5886*** | 0.0789 | 0.5356*** | 0.1363 |
| Infintech | 9.9700** | 4.5609 | 10.5226** | 5.1779 |
| Infininc | 10.094** | 4.5609 | 10.5225** | 5.2015 |
| Infintech*fininc | −9.9609** | 4.5534 | −10.5174** | 5.1765 |
| lnlar | −0.1448*** | 0.0535 | −0.1520*** | 0.0506 |
| lnnpl | −0.070* | 0.0361 | −0.0889* | 0.0475 |
| lnconc | 0.2245*** | 0.0561 | 0.2545*** | 0.0668 |
| lnreg_cap | −0.1373** | 0.0550 | −0.1280** | 0.0545 |
| lndeposits | 0.3679*** | 0.0677 | 0.4025*** | 0.1205 |
| lnunempl | −0.0244 | 0.0256 | −0.0606*** | 0.0194 |
| lninf | 0.0241 | 0.0243 | 0.0301** | 0.0147 |
| lnrgdpg | 0.0234 | 0.0359 | — | — |
| lngdp_pc_g | — | — | 0.0299** | 0.0129 |
| <i>Diagnostic Tests</i> | | | | |
| AR (2) | 0.512 | | 0.546 | |
| Sargan | 0.685 | | 0.978 | |

Source: Authors' construction.

***, **, * indicates statistical significance at 1%, 5% and 10% level.

To conserve space, this study focuses on the critical variable of interest, namely the interaction effect of financial inclusion on fintech and bank lending. The results for *fintech*financial inclusion* in columns 2 and 4 show statistically significant negative coefficients. With coefficients measuring -9.96 and -10.52 for Models 1 and 2, respectively, it becomes evident that the interaction between financial inclusion and the bank lending-fintech relationship is profound. This negative and significant coefficient implies that as fintech lending expands and, concurrently, banks reduce their physical branch networks, the resultant effect is adverse, leading to a decrease in bank lending. In other words, the negative coefficient sign indicates that when fintech lending grows in SSA, and at the same time, traditional banks reduce their physical branch networks (a possible consequence of fintech competition), the net effect on bank lending is negative. This means that the combined influence of fintech and reduced physical bank branches leads to a decrease in bank lending. One possible explanation for this finding is that fintech and financial inclusion have different effects on the supply and demand for bank lending. Fintech may increase the supply of bank lending by reducing information asymmetry, transaction costs, and credit risk (Jagtiani & Lemieux, 2018).

However, fintech may also reduce demand for bank lending by offering alternative sources of financing, such as peer-to-peer lending, crowdfunding, and mobile money. Financial inclusion may increase demand for bank lending by expanding the pool of potential borrowers, especially among unbanked and underbanked segments (Barajas et al., 2020). However, financial inclusion may also reduce the supply of bank lending by increasing competition and diversity in the financial sector, which may erode the market share and profitability of traditional banks (Erel & Liebersohn, 2020). Therefore, when fintech and financial inclusion are both low, fintech may have a positive effect on bank lending by increasing its supply more than demand. However, when fintech and financial inclusion are both high, fintech may dampen bank lending by reducing demand more than supply. This may explain why this study finds a negative coefficient for the interaction term *fintech*financial inclusion*.

5.2. Robustness tests

To ensure that the results are robust to alternative specifications, the study estimates three different robustness tests. The baseline results (columns 1 and 2) employ Total Alternative Credit and Fintech Credit per capita as the fintech measures. To ensure robustness, several alternative specifications were tested: (i) using domestic credit as a measure of bank lending, (ii) using GDP per capita to capture economic development, and (iii) controlling for GDP per capita growth and the unemployment rate. The results are presented in Table 6 columns 3, 4, and 5.

The robustness tests (columns 3-5) largely confirm the original findings, especially for Total Alternative Credit as the fintech measure. This indicates that the empirical results are robust to alternative specifications. The addition of GDP per capita growth and the unemployment rate (column 5) suggests that GDP per capita growth promotes bank lending (coefficient = 0.0445). Conversely, unemployment has a weak but expected negative association (coefficient = -0.04), aligning with the idea that higher unemployment increases default risk and may suppress lending.

Table 6. Robustness test results.

| Variable | Model 1 (1) | Model 2 (2) | Model 3 (3) | Model 4 (4) | Model 5 (5) |
|-------------------------|-------------|-------------|-------------|-------------|-------------|
| Inbank_lending(1) | 0.5894*** | 0.4379** | 0.6293*** | 0.5929*** | 0.7671*** |
| Infintech | -0.0209*** | 0.0473** | -0.0184*** | -0.0215*** | -0.0137*** |
| Inlar | -0.1388** | -0.1506** | -0.1125* | -0.1524** | -0.1299*** |
| Innpl | 0.0049 | 0.0240 | -0.0178 | 0.0047 | 0.0012 |
| Inconc | 0.2182*** | 0.3326*** | 0.2060*** | 0.2099*** | 0.0693** |
| Inreg_cap | -0.0472 | -0.1087* | -0.0261 | -0.0476 | -0.0482 |
| Indeposits | 0.5246*** | 0.6630*** | 0.4606** | 0.5198*** | 0.3286*** |
| Ininf | -0.1215** | -0.1716* | -0.1168*** | -0.1030** | -0.0012 |
| Ingdp | -0.0074 | -0.0023 | -0.0018 | -0.0073 | 0.0445** |
| Inunemp | - | - | - | - | -0.0406* |
| <i>Diagnostic Tests</i> | | | | | |
| AR (2) | 0.420 | 0.571 | 0.218 | 0.326 | 0.449 |
| Sargan | 0.242 | 0.728 | 0.136 | 0.459 | 0.806 |

Source: Authors' construction.

***, **, * indicates statistical significance at 1%, 5% and 10% level.

6. Conclusion

In this study, we analyzed the relationship between fintech and bank lending in 19 Sub-Saharan Africa from 2013 to 2019, and how this relationship is affected by the level of financial inclusion. The key findings are summarized as follows. Fintech has a mixed effect on bank lending in Sub-Saharan Africa, depending on how it is measured. When fintech is measured by total fintech credit (comprising both fintech and Bigtech credit), there is a negative and statistically significant association between fintech and bank lending—a substitution effect. This finding suggests that fintech competes with traditional banks and reduces their market share. Policymakers and practitioners must recognize the shifting dynamics within the financial landscape of SSA. The rise of fintech and Bigtech credit may signal a changing preference among consumers and businesses, potentially eroding traditional banks' market share. Consequently, for traditional banks, the rise of fintech and Bigtech credit necessitates adaptation and innovation to remain competitive. Embracing digital transformation, exploring partnerships with fintech firms, and tailoring products to meet the evolving needs of consumers and businesses are crucial strategies for banks to thrive in this new era. Policymakers may need to reassess regulatory frameworks to ensure that they facilitate healthy competition while safeguarding financial stability.

Conversely, when fintech is measured by fintech credit per capita, the empirical findings reveal a positive and statistically significant impact on bank lending. This indicates that fintech credit, excluding Bigtech credit, is augmenting rather than replacing traditional bank lending. This finding underscores the potential for collaboration and partnership between fintech and traditional banking. Traditional banks can leverage fintech innovations to enhance their service offerings and reach previously underserved population segments. Policymakers should encourage and support such collaborations through regulatory frameworks that foster innovation and mitigate risk, while supporting fintech solutions that provide financial services to underserved segments, such as SMEs, rural, informal and women entrepreneurs. One notable partnership between banks and fintechs in SSA is M-Shwari, a savings and loan product offered through the collaboration between the Commercial Bank of Africa (CBA) and Safaricom in Kenya. CBA provides bank accounts linked to M-Pesa mobile money accounts, offering savings and loan services. Surveys have shown significant benefits to consumers of this partnership, allowing them to smooth out consumption (FSD, 2016). Thus, besides benefiting both parties, fintech-bank collaborations promise to drive financial access in SSA. Policymakers should encourage and support such collaborations through regulatory frameworks that foster innovation and mitigate risk. Policymakers should support fintech solutions that extend financial services to underserved segments, such as rural, informal, and women-owned businesses.

On the contrary, the moderation results show that as fintech lending grows, it exerts a negative net effect on traditional bank lending. This effect is particularly pronounced when traditional banks reduce their physical branch network. The rise of fintech lending may lead to a shift in borrower preferences, favoring digital channels over brick-and-mortar branches. As banks downsize their physical presence, fintech platforms gain prominence. Therefore, traditional banks are likely to face the challenge of adapting to changing landscapes. Thus, they must find innovative ways to remain relevant and competitive in the wake of fintech growth.

Future research should examine the mechanisms behind fintech's varying competitive and complementary effects, explore consumer preferences and adoption patterns, and examine how banks can successfully leverage fintech partnerships for greater financial inclusion. Additionally, other studies can explore the role of fintech in alleviating credit constraints for SMEs. These insights will be crucial for guiding policy and practice in shaping a sustainable and equitable financial landscape in Sub-Saharan Africa.

7. Limitations of the study

The main limitation of this study is the data availability, particularly for fintech credit lending. This resulted in a sample of 19 Sub-Saharan African economies with a population of 48. However, the sample was considered adequate to provide a broad overview of the intricate relationship between fintech credit and bank lending in Sub-Saharan Africa. The sample size and period of data availability (2013–

2018) also limited the heterogeneous analysis that the study intended to conduct. Future research can use alternative fintech credit data to investigate how fintech influences the various blocs within Sub-Saharan Africa, such as the SADC and ECOWAS. This would be insightful given the diverse levels of fintech adoption and financial development across blocs.

Authors' contribution

Tafirei Mashamba: Conceptualization and Design, Writing (Original Draft), Methodology, Data Analysis and Interpretation. Shenaaz Gani: Writing (Review & Editing), Project Administration, Resources (data), and final approval of the version to be published.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data supporting the findings of this study were sourced from the World Bank Financial Development Database (<https://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database>), World Bank Economic Indicators (<https://data.worldbank.org/>), and the S&P Capital Pro. However, S&P Capital Pro is only available through subscriptions. Fintech and Bigtech data are publicly available from Cornelli et al. (2023) upon request.

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