Chinoda & Mashamba, *Cogent Economics & Finance* (2021), 9: 1986926
https://doi.org/10.1080/23322039.2021.1986926

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DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

Fintech, financial inclusion and income inequality nexus in Africa

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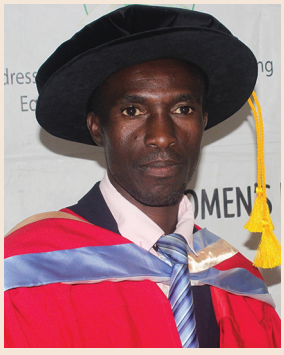
Received: 24 March 2021
Accepted: 23 September 2021

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Reviewing editor:
Andrew Vivian, Loughborough University, UNITED KINGDOM

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Abstract: Financial institutions play a pivotal role in the efficient allocation of capital resources. However, some households and firms may be excluded from formal financial markets due to asymmetric information and market imperfections, thereby adversely affecting equitable income distribution. On the other hand, among other things, access to finance is viewed as one of the key tools to fight poverty. This study develops a novel double FFI Model and applies the structural equation modelling to simultaneously analyze the interaction between financial technology, financial inclusion, and income inequality in a panel of 25 African countries over the periods 2011, 2014, and 2017. The results show that financial inclusion mediates the financial technology-income inequality relationship thus playing a fundamental role in reducing income inequality in Africa. On the policy front, the study urges African policymakers and regulators to craft policies that enhance Fintech developments and financial inclusion.



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ABOUT THE AUTHOR

Tough Chinoda is a senior lecturer and a renowned researcher at Women's University in Africa. He has published several research articles in the area of financial inclusion including the current manuscript. Tafirei Mashamba is a postdoctoral research fellow at the University of South Africa, and a senior lecturer at Great Zimbabwe University. He is passionate about Fintech (a 4th IR facet) and financial markets and supports the development of Fintech products and services that increase financial inclusion and reduce poverty in emerging economies.
Tough Chinoda has an academic experience that spans more than eight years in Finance whilst Tafirei Mashamba's academic career spans twelve years in the same area. Together, we are exploring a bigger picture of financial technology, financial inclusion, and economic growth in the African region.

PUBLIC INTEREST STATEMENT

This article investigates the mediating effects of financial inclusion on the interplay between financial technology and income inequality in Africa. Data from 25 countries for the periods 2011, 2014, and 2017 were collected and analysed using an eight-variable panel structural equation model. There was evidence to show that financial inclusion mediates the financial technology-income inequality relationship thus playing a fundamental role in reducing income inequality in Africa. Hence, the conclusion is that financial inclusion plays a mediating role in the interaction between financial technology and income inequalities in Africa. On the policy front, the study urges African policymakers and regulators to craft policies that enhance Fintech developments and financial inclusion.

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Subjects: Economics; Development Economics; Finance

Keywords: Fintech; financial inclusion; income inequality; structural equation modelling; Africa

1. Introduction

Financial institutions play a pivotal role in the efficient allocation of capital resources as underpinned by finance theory. However, some households and firms may be excluded from formal financial markets due to asymmetric information and market imperfections, thereby adversely affecting equitable income distribution. There are global concerns about the nexus between finance and development, particularly where income inequality and financial exclusion are persistent. The pivotal role of financial inclusion in reducing inequality is recognised by the UN 2030 Agenda for Sustainable Development (Klapper et al., 2016). The 2017 Global Findex database indicates that about 1.7 billion adults worldwide still do not have access to formal financial services. Demirgüç-Kunt et al. (2018) cite documentation requirements, high transaction costs, and distance as some of the reasons for financial exclusion.

However, recent and ongoing financial technology, herein FinTech, developments are promising unparalleled opportunities to overcome financial inclusion barriers by taking advantage of the increasing penetration of mobile technology (Salampasis & Mention, 2018). FinTech is seen as a key enabler of financial inclusion, which can lead to more equitable income growth (Demirgüç-Kunt et al., 2018; GPFI, 2016). Surprisingly, there is a dearth of empirical studies which draw on the finance-growth theory to investigate the nexus between FinTech, financial inclusion, and income inequality. A few studies have examined the nexus between financial inclusion and inequality at the country level (see for example, Demirgüç-Kunt et al., 2017) and none, as far as could be ascertained, has examined the mediating effect of financial inclusion on FinTech and income inequality.

Most researchers approve that financial development boosts economic growth in the long run since a well-developed financial system encourages savings, investments, risk diversification, and daunts moral hazard (Junior et al., 2021; Puatwoe & Piabuo, 2017; Song et al., 2021). However, the nexus between financial development and income inequality remains ambiguous. The study proposes a financial technology-financial inclusion-income inequality and financial technology-financial development-income inequality model termed the "double FFI Model" using structural equation modelling (SEM). To the best of our knowledge, studies that investigate the mediating effects of financial development on financial technology and income inequality nexus have been relatively overlooked. The study addresses the extent to which financial technology and financial development can impact income inequality through financial inclusion. Overall, the model affirms that financial technology can be simultaneously managed in Africa to optimise financial inclusion and thus eradicate income inequality in line with the FFI model. The rest of the paper is organised as follows. The detailed empirical literature is discussed in Section 2. Section 3 covers the research methodology. Section 4 discusses the findings while Section 5 concludes and offers policy implications.

2. Literature review

2.1. Financial inclusion and income inequality

Theory suggests that financial market imperfections inhibit poor people from evading poverty by limiting their access to formal financial services (Galor & Zeira, 1993; Kim, 2016). Galor and Zeira's model (Galor & Zeira, 1993) demonstrates that imperfect credit markets limit poor people's access to finance. Broader access to finance has been taunted as one of the effective tools of fighting poverty since higher levels of financial inclusion are associated with lower levels of income inequality (Aslan et al., 2017; Park & Mercado, 2018; Turégano & Herrero, 2018). Although an inverse relationship between financial inclusion and income inequality is generally confirmed in

the literature, this association might differ across countries and is contingent upon factors such as the regulatory environment and institutional quality, level of economic development, the nature of financial markets as well the type of financial inclusion policies followed.

Empirical studies conducted on individual countries on the interplay between inequality and financial inclusion are equally inconclusive and mixed. Kochar (2011) investigated the interplay between financial inclusion and income inequalities for households in the Indian state of Uttar Pradesh and concluded that increased access to formal financial services through local bank branches did not translate into increased actual usage of these financial services by poor households. On the other hand, Zhang and Posso (2019) found that financial inclusion has a positive effect on income for households in China and that this effect is larger for households at the lower quantiles of the income distribution, indicating that it reduces inequality. Omar and Inabar (2020) investigated the impact of financial inclusion on reducing poverty and income inequality in 116 developing countries using unbalanced panel data from 2004 to 2016. The results provide robust evidence that financial inclusion significantly reduces poverty rates and income inequality in developing countries. Other studies, like Huang and Zhang (2020) and Salazar-Cantú et al. (2015) concluded that the possibility of the impact of financial inclusion varies over time. Six randomised controlled trials conducted in Mexico, Mongolia, Bosnia, India, Ethiopia, and Morocco, found no robust evidence of a positive impact of household participation in microcredit programs on household income (Angelucci et al., 2015; Augsburg et al., 2015; Banerjee & Newman, 1993). Employing the generalised method of moments to explore the interplay between financial inclusion, remittances, and income inequalities in Africa, Bkwayep and Tsafack (2020) confirmed that financial inclusion reduces income inequalities. To conclude, empirical evidence from single-country studies suggests varying effects of financial inclusion on inequality over time. This study seeks to add new knowledge using structural equation modelling which has a strength in examining the mediating effect amongst variables.

2.2. FinTech and income inequality

In developing countries, information and communication technologies (ICTs) (incorporating FinTech) can play a pivotal role in alleviating income inequality. ICTs can generate opportunities for the poor through job creation. They can also lead to improved government services and tax collection while reducing corruption. Asongu and Le Roux (2017) investigated the interplay between ICTs (i.e. mobile, internet, and broadband penetration) and inclusive growth in Sub-Sahara Africa over the period 2000–2012. They found a positive relationship between ICTs and inclusive growth, as measured by the inequality-adjusted human development index. Asongu (2015) found an inverse relationship between income inequality and mobile penetration in Africa. Likewise, Asongu and Odhiambo (2019) identified an inverse relationship between mobile, internet, and broadband penetration and inequality using a panel of 48 African countries. A study by Abor et al. (2018) also found an inverse relationship between mobile ownership and poverty in Ghana.

Asongu and Nwachukwu (2018) examined the link between mobile banking and inclusive development (inequality, quality of growth, and poverty) in a cross-section of 93 countries. They found a significant negative effect of Fintech measured by the use of mobile phones to pay bills or to send/receive money on income inequality in upper-middle-income countries. Likewise, Asongu and Odhiambo (2019) found an inverse relationship between mobile banking and income inequality in middle-income countries, contingent on a country's level of economic development, as measured by the human development index. These studies had a limitation in that they all failed to address endogeneity concerns. As a way of addressing this weakness, our study adopted the structural equation modelling which addresses endogeneity in line with Hult et al. (2018).

2.3. FinTech and financial inclusion

Most studies have found that FinTech and ICT are key drivers of financial inclusion (Ghosh, 2018; Gosavi, 2018; Tchamyou et al., 2019). However, the FinTech-financial inclusion nexus might differ depending on the financial inclusion dimensions (access versus use), in addition to the type of

financial service (payments, savings, credit, and insurance). Surviving studies investigated the link between financial inclusion and inequality or that between FinTech and inequality but fail to look at the trivariate relationship among the three. Demir et al. (2020) attended to the above gap by investigating the nexus between FinTech, financial inclusion, and income inequality using the Global Findex data for 2011, 2014, and 2017. Invoking quantile regression analysis for a panel of 140 countries, the study revealed new evidence that financial inclusion is a key channel through which FinTech reduces income inequality. Our study used a different methodology, structural equation modelling, which is superior when determining the mediating effects amongst variables to determine if the same results with Demir et al. (2020) are obtained.

3. Methodology

To structurally examine the variables of concern, two alternatives were considered; structural equation modelling or a stepwise regression model (Li, 2011). Stepwise regression offers a simpler and easy estimation alternative, but it lacks the ability to control for measurement error; hence, it cannot represent multiple mediators in a model. This makes the structural equation modelling (SEM) superior and justifies why it was used in this study. In addition, SEM implements hypothesis testing of several factors and their link with observed variables using maximum likelihood estimates (Kline, 2015). This makes it a more appropriate model for this study which contains four observed variables with two of them standing in as mediating variables. The strength of the SEM is in the capacity to measure both indirect and direct causal effects amongst structure variables thus the mediation analysis. As such it permits one to fit conditional relationships chains through the path analysis. Given the above-mentioned literature, Figure 1 hypothesizes the projected relationship between the variables.

The key relationship of interest is FinTech and income inequality. Financial inclusion and financial development are the mediating variables whereas trade and GDP per capita are control variables that are expected to directly affect income inequality. This study hypothesizes that FinTech will tempt the unbanked population to open bank accounts and access funds which reduces income inequalities. The diagram above hypothesizes that financial technology directly affects income inequality (Φ_1), and indirectly impacts income inequality through financial inclusion (Φ_2), and financial development (Φ_3). Following Akande et al. (2019) the relationships can be summarized in a reduced form of the SEM as follows:

$$Y = \alpha + B \quad + \emptyset Z + \varepsilon \tag{1}$$

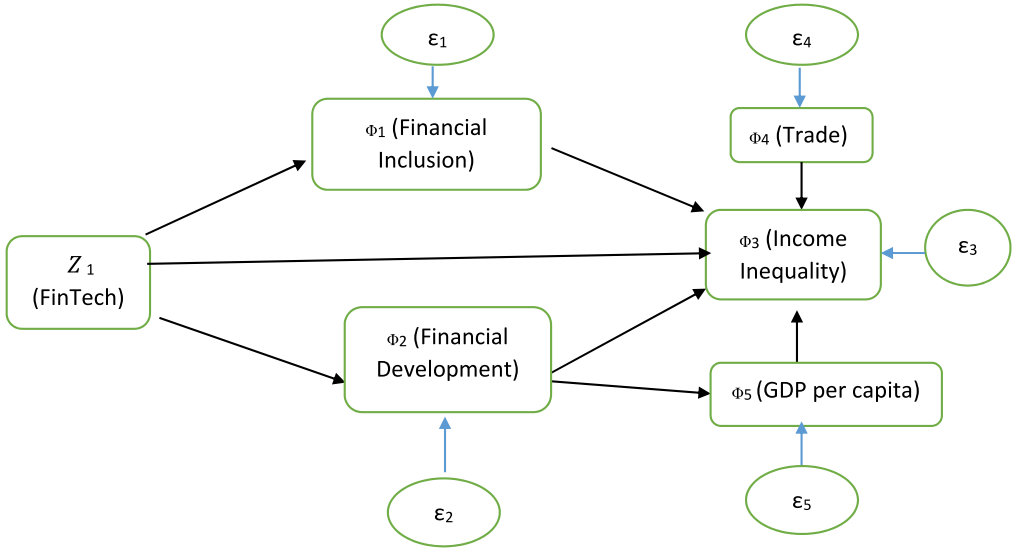


Figure 1. Possible recursive path model for FFI.

Where: represents (N x1) matrix of endogenous variables, financial development, FinTech, and income inequality; Z represents (NZx1) matrix of exogenous variables; B stand for a vector of coefficients of endogenous variables, FinTech; ∅ is a vector of point estimates of exogenous variables; α is a column vector of intercept of endogenous variables; ε is the error terms of response variables matrix; N represents the number of endogenous variables, ; NZ is the number of exogenous variables, Z. The point estimates of B matrix estimate the direct impact of one endogenous variable on another endogenous variable, the ∅ matrix coefficients examine the direct impact of exogenous on endogenous variables. This SEM model allows analysis of the direct and indirect effects of financial inclusion, FinTech, and financial development on income inequality.

3.1. Variables description and data

The SEM used in this study comprises six variables, namely, fintech which was proxied by the use of mobile phones to pay bills in line with Asongu and Nwachukwu (2018) and Asongu and Odhiambo (2019); income inequality measured by the Gini-Coefficient following De Haan and Sturm (2017); trade openness to capture the integration degree to the world economy since extant literature shows that the trade liberalization results in a decrease in income inequality (Bensidoun et al., 2005; Shahbaz, 2008; Shahbaz et al., 2007, 2007). Moreover, in line with the financial development history in Africa, the establishment of the African Continental Free Trade Area agreement is likely to bring the greatest changes to Africa's trade and financial system. Hence, this study also investigates the impact of trade openness on income inequalities in Africa. This can act as a parameter for evaluating the effectiveness of the African Continental Free Trade Agreement that is already effective in Africa. The financial development index (FDI) was also included in the study to measure financial development. It was computed using the principal component analysis on seven variables, namely net interest margin, the overhead cost to total assets, broad money (M2) to GDP, bank assets to bank and central bank assets, bank assets to GDP, domestic credit to private sector as a percentage of GDP and liquid liabilities to GDP. The study used four extensively used financial inclusion indicators namely ATMs per 100,000 adults, commercial bank branches per 100,000 adults, bank accounts per 1000 adults and outstanding loans to GDP to proxy financial inclusion. These variables comprehensively represented financial inclusion which involves accessibility, availability/penetration and usage of formal financial services to the vulnerable populations. The study proxied FinTech using mobile phones to pay bills following Demir et al. (2020) and Asongu and Nwachukwu (2018). The data on financial inclusion, Fintech and financial development and trade openness was obtained from the Global Development Indicators Database (World Bank). Data on income inequality was sourced from the Standardised World Income Inequality Database. The study used a panel of 25 African countries sourced based on data availability over the period 2011, 2014, and 2017 (see Table A in the Appendix for a list of countries). Data on income inequality was available for the given period. Table 1 contains the description of variables employed in the study and their measurement.

4. Results and discussion

4.1. Descriptive statistics

Table B, in the Appendix, shows the descriptive statistics of the data used in this study for the period 2011, 2014, and 2017. Income inequality, as measured by the Gini coefficient, was found to be lowest in Seychelles in 2014 and was highest in South Africa in 2014 and 2017. Also, financial development in Africa is still low at 37 percent with less standard deviation and disparities compared to financial inclusion. Trade openness was lowest in Nigeria in 2017 and highest in Seychelles in 2011. Kenya has become one of the fastest-growing mobile money markets in Africa in terms of FinTech, as it was highest in terms of using a mobile phone to pay bills both in 2014 and 2017. Madagascar was the lowest in 2014 in terms of using a mobile phone to pay bills. These results are in line with Demir et al. (2020) who concluded that financial systems in Africa are less inclusive. ATMs per 1000 adults, bank branches per 1000 adults, outstanding loans to deposits and bank accounts per 1000 adults justify that financial inclusion is still low in Africa. GDP

Table 1. Variables description and measurements

Variable	Measurement/ Definition	Reference
Financial technology (FinTech)	Use of mobile phones to pay bills	Asongu and Nwachukwu (2018); Asongu and Odhiambo (2019); Demir et al. (2020)
Income Inequality	Gini-Coefficient	De Haan and Sturm (2017); Demir et al. (2020)
Control Variables		
Economic development	GDP per capita	Evans (2015)
Trade	Trade openness	Shahbaz et al. (2007), Shahbaz (2008)
Financial Development Index	net interest margin, overhead cost to total assets, broad money (M2) to GDP, bank assets to bank and central bank assets, bank assets to GDP, domestic credit to private sector as a percentage of GDP and liquid liabilities to GDP	Qamruzzaman and Wei (2018)
Financial Inclusion		
Usage	Outstanding loans to GDP	Sarma (2008, 2012)
Bank penetration	Bank accounts per 1000 adults	Evans (2015); Adeola and Evans (2017)
Access	Commercial bank branches per 100,000 adults	Adeola and Evans (2017)
	ATMs per 100,000 adults	Sarma (2008)

Source: Researchers' construction

per capita was highest in Seychelles in 2014 and lowest in Malawi in 2017. Overall, the Jarque-Bera statistics in Table B confirm that the data are normally distributed validating the use of SEM.

4.2. Correlation results

SEM provides an opportunity to model the region as a structural unit. To the best of our knowledge, no study has used the SEM to determine the direct and mediating effect of financial inclusion on the Fintech-income inequality relationship bringing in a major contribution to literature. Table C in the Appendix shows that trade openness, financial development, GDP per capita and financial inclusion (ATMs, accounts and branches) are negatively correlated with income inequality though the relationship is insignificant at a 5% level except for branches. The study also shows a significant positive association between financial development, trade and financial inclusion. The association between FinTech and financial inclusion variables is positive though not significant.

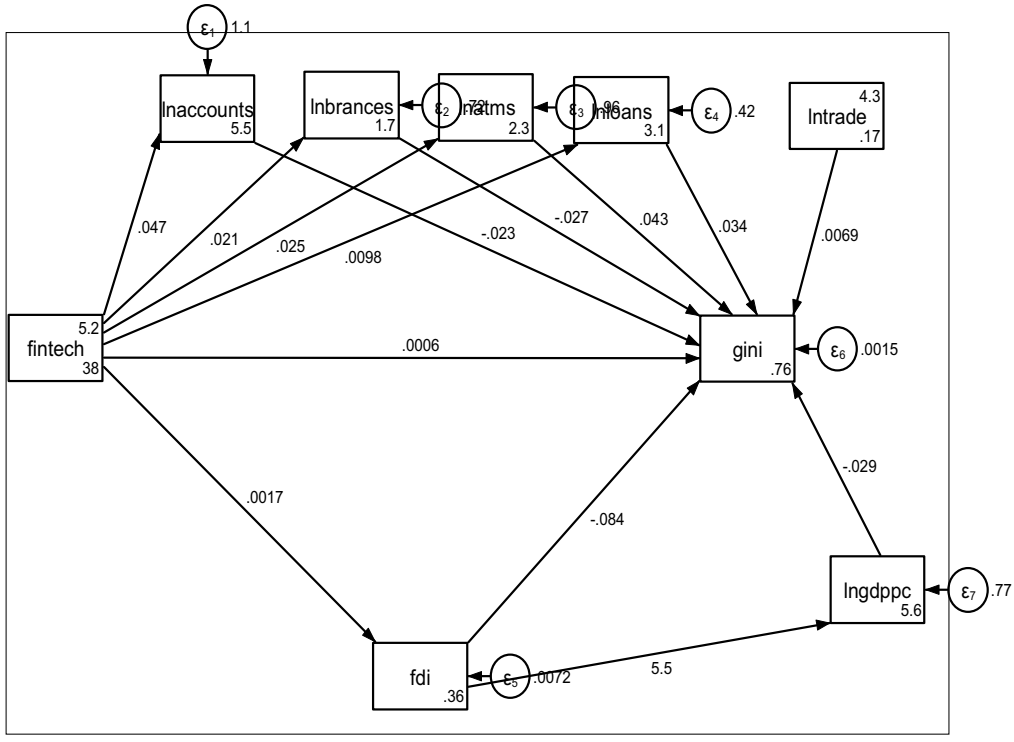
4.3. SEM results

Mediation analysis is suitable where there is no establishment of a direct relationship between two variables, and it can be confirmed that the influence of one of these variables on the other variable is conveyed through the third variable known as the mediator (Obagbuwa et al., 2021). In such a case, the third variable could either fully or partially mediate the relationship where the direct path of the main two variables became statistically significant (Obagbuwa et al., 2021). The model in SEM analysis must pass global fitness indices. Germane indices extracted for this model are tagged in Figure 2 and they reflect that all the indices are within acceptable global range for the acceptance of the SEM model. Since the model passed the model fitness test, Figure 2 presents the result of the SEM model estimated to explore the structural relationship amongst the observed variables; financial inclusion, financial technology, financial development, trade openness, and income inequality. Based on the literature discussed before, financial

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Figure 2. Model result.

Source: Authors' SEM estimation output



inclusion and financial development are expected to mediate the relationship between financial technology and income inequality in Africa.

The first objective of the study was to investigate the direct effect of FinTech on income inequality in Africa. The results of the estimated SEM model revealed that there is no statistically significant direct path running from FinTech to income inequality, as the direct relationship is not statistically significant (see Table 3 and Figure 2). This result does not support the proposition that FinTech reduces income inequality. Although the relationship is positive, it is also not statistically significant and contrary to expectations indicating that FinTech does not in itself translate to income inequality reduction in Africa. The failure by financial technology to directly reduce income inequalities in Africa implies that financial systems in Africa may be benefiting the rich and worsen income disparities because "the reputable or rich" are allowed into banking at the expense of the poor.

Global model fitness indices: LR Prob>Chi2→ 0.721, SRMR → 0.004, TLI → 0.982, CFI → 0.879, RMSEA → 0.002, PCLOSE → 0.85.

The second objective of this study was to explore the mediating effect of financial inclusion variables (loans, accounts, branches and ATMs) on the FinTech-income inequality nexus. Thus, from the mediation (path) analysis (Figure 2, Table 2 and Table 3), FinTech has a direct relationship with all financial inclusion variables, and branches and accounts have an inverse relationship with income inequality. However, the study could not establish a direct connection between financial inclusion (loans, branches and ATMs) and FinTech as the path is not statistically significant. The mediation analysis further shows that FinTech has an indirect relationship with income inequality through financial inclusion (branches and accounts), because financial inclusion (branches and accounts) are related to both FinTech and income inequality; hence, performing a mediation role between the

Table 2. Recursive model estimates

Variables	Direct Effects			Total Effects		
	fintech	Gini	fdi	fintech	gini	fdi
Lnaccounts	0.047**	−0.022***		0.047**	−0.022***	
	(0.016)	(0.004)		(0.016)	(0.004)	
Lnbranches	0.021	−0.031***		0.021	−0.031***	
	(0.179)	(0.004)		(0.179)	(0.004)	
Lnatms	0.025	0.023**		0.025	0.023**	
	(0.169)	(0.017)		(0.169)	(0.017)	
Lnloans	0.0098	0.026**		0.0098	0.026**	
	(0.417)	(0.036)		(0.417)	(0.036)	
Lntrade		0.0069 (0.643)			0.0069 (0.643)	
Fintech		−0.0003 (0.81)	0.0017 (0.273)		0.0006 (0.487)	0.0017 (0.273)
Fdi		−0.084*** (0.002)			−0.084*** (0.002)	
Lngdppc		−0.016*** (0.008)	5.451*** (0.000)		−0.029*** (0.008)	5.451*** (0.000)
Observations.	68	75	75	68	75	75

*Note: Standard errors in parentheses; * p < 0.1, *** p < 0.01, ** p < 0.05.*

Source: Authors' estimation

two variables. The coefficient of this indirect relationship is 0.027 and 0.023 for bank branches and bank accounts and is statistically significant at the 5% level (see Table 2). The significant negative impact of financial inclusion (branches and accounts) on income inequality obtained in our study means that infrastructural development (branches) and opening of bank accounts have significantly contributed to a reduction in income inequalities in the region for the periods 2011, 2014 and 2017. Combining all financial inclusion variables (access, availability and usage), Table 3 shows that financial inclusion mediates the Fintech-income inequality nexus though the overall contribution is not significant. This implies that FinTech in Africa is thus a key enabler of financial inclusion, which can lead to more equitable income growth in line with the finance-growth theory (Demirgüç-Kunt et al., 2018; GPFI, 2016). In line with Kochar (2011), it can be concluded that increased access to formal financial services through local bank branches in Africa did not translate into increased actual usage of these financial services by poor households thus the overall insignificant effect on income inequality.

We also examined the mediating effect of financial development on FinTech and income inequality relationship. We found no statistically significant direct path running from FinTech to financial development, as the direct relationship between the two variables is not statistically significant (see Table 2 and Figure 2). This result does not support our prior expectation, which suggests that FinTech positively influences financial development. While the relationship is positive as expected, it is not statistically significant, indicating that FinTech in Africa does not in itself translate to financial development. In addition, we find economic growth to be positive with a coefficient of 5.5 and significantly related to financial development and statistically significant at the 1% level, implying that higher levels of financial development influence economic growth which statistically reduces income inequality by 2.9%. This result is consistent with the literature since financial development is expected to increase the growth of economies which reduces inequality as the piece of the cake gets shared between the rich and the poor. We find no

Table 3. Indirect effects

Variable	Coefficient	Std. Error	z	P>|Z|
gini ←				
lnaccounts	0	(no path)		
lnbranches	0	(no path)		
lnatms	0	(no path)		
lnloans	0	(no path)		
fintech	−0.000855	.0008753	−0.98	0.329
gini ←				
Fdi	0	(no path)		
fintech	−0.000675	−0.0001257	−0.54	0.591

Source: Authors' estimation

statistically significant direct path running from FDI → Gini, as the direct relationship between the FDI and Gini is not statistically significant (see Table 2 and Figure 2). This result does not support our expectation that financial development reduces income inequality. While the relationship is positive as expected, it is not statistically significant, indicating that financial development in itself does not translate to a reduction in income inequality in Africa. An analysis of the mediating effect of financial development on the FinTech-income inequality nexus reveals that financial technology reduces income inequality through financial development though the effect is not significant (see Table 3).

To control the study, we also investigated the impact of trade on income inequality. The relationship between trade openness and income inequality is positive and significant. A 1% rise in trade openness insignificantly deepens income inequality by 0.7%. This finding is in line with Bensidoun et al. (2005), Shahbaz et al. (2007), and Jaumotte et al. (2013), who contend that trade openness deepens income inequality as most exporting firms use educated workers thus not benefiting the poorer workers who are likely to have low education. This, therefore, justifies that trade openness in Africa deepens not diminishes, accentuates not ameliorates, poverty in both the rich and the poor countries. This, however, contradicts Mookerjee and Kalipioni (2010) and Turégano and Herrero (2018) who argue that trade openness plays a significant role in reducing income inequality as the size of the pie increase. This, therefore, helps governments and policymakers to accelerate the African Continental Free Trade Agreement and make sure the poor also benefit from it thus reducing income inequalities in the region. Overall, our results indicate that financial inclusion and financial development mediates the nexus between FinTech and inequality.

4.4. Discussion

This study developed a novel double FFI Model and applies the structural equation modelling to simultaneously analyse the interaction between financial technology, financial inclusion, and income inequality in a panel of 25 African countries over the periods 2011, 2014, and 2017. While previous studies have examined the nexus between FinTech and inequality; FinTech and financial inclusion; financial development and income inequality, our research makes a unique contribution by examining the joint dynamics among the four constructs to provide a holistic view of how income inequalities in Africa can be reduced.

We found from the mediation analysis that FinTech positively influenced financial inclusion (bank accounts and branches). This is consistent with Gosavi (2018) and Mbiti and Weil (2011) who found this relationship within a broader-based sample. Thus, from our results, as shown in Figure 2, Table 2, and Table 3, financial inclusion (bank branches and accounts) fully mediates the relationship between FinTech and

income inequality in Africa consistent with Demir et al. (2020) and Zhang and Posso (2019). In other words, FinTech reduces income inequalities through the opening of bank accounts especially by those in remote areas who were previously involuntarily excluded due to factors such as distance, and bank charges amongst others. The bank accounts can later be used for receiving and making payments. Banks in Africa are encouraging the building of a highly adequate environment for pushing financial innovations through FinTech and modernizing the financial structure. The designed payment framework permits banks and other financial services suppliers to access the payment system in a transparent and equal manner. Although the governments and central banks in Africa have made certain improvements in financial access, they seem not to have been focused on individuals and the poorer classes. The inverse relationship between financial inclusion and income inequality can be elucidated by the fact that financial transactions between households in the countries officially pass through a financial structure (bank accounts and branches). The existence of a financial structure in an environment catalyzes financial literacy and makes it possible for populations to seize financial opportunities. Also when the poor visit bank branches and open bank accounts and make deposits, this money is put back into the financial system through the formal borrowing channel thus reducing inequalities as more people can access the funds. Generally, availability and accessibility of formal financial services and products alone are not enough, there is a need for African governments and policymakers to ensure usage. Several bank accounts in Africa could be dormant or several people may be owning multiple bank accounts thus the insignificant effect of the overall financial inclusion position on income inequality. The other reason for the insignificant contribution of ATMs and loans in Africa could be that these services are accessible to the rich compared to the poor.

We found no significant support for the second proposed model/path as there was no statistically significant relationship between FinTech to financial development to income inequality. The insignificant path from financial development to income inequality may be a result of financial development in Africa which is restricted to the rich who can easily access finance and cause income inequality attributable to the lack of financial accessibility to the poor. The rich may capitalize on the opportunities by embracing capital-intensive technologies which oftentimes require more skilled labour. Consequently, the poor who have a deficiency in such skills suffer. The absence of a developed financial sector also wound the poor because it gets costly for them to have access to financial resources. Where institutions are weak, the benefits of financial deepening may accrue excessively to the rich which have higher collateral and/or income, further aggravating initial inequality in access to finance consistent with Jauch and Watzka (2016) who found that financial development alone is insufficient to guarantee a reduction in income inequality. These findings are in line with Wahid et al. (2010) who concluded that financial development widens income inequality, but economic growth helped create a more uncensored society by redistributing income in Bangladesh.

On the policy front, policymakers and regulators should craft policies that enhance financial inclusion such as financial literacy programs which reduce income inequalities. Financial institutions should introduce innovative formal financial services that are apt to the financially excluded population since the demand for financial services varies with culture, beliefs, and income levels differences. Secondly, to increase financial literacy levels in remote areas, a solid time-action-bound targeted policy is necessary to elevate financial awareness and alter financial behavior among low-income people. Policymakers must strive to improve per capita income and craft economic growth-enhancing policies to minimize income inequalities.

5. Conclusion

Given the scarcity of studies surrounding this area, this study investigated the mediating effects of financial inclusion and financial development on FinTech-income inequality nexus using Structural Equation Modelling. Using panel data on 25 African countries the study found a significant relationship between financial inclusions (branches and accounts), in which case financial inclusion influenced income inequality in the paths lnaccounts → Gini and lnbranches → Gini. We also found that trade openness increases income

inequality in Africa given that the path lntrade → Gini is significant and positive. We also found an indirect mediating effect of financial inclusion (branches and accounts) on the FinTech-income inequality nexus with the significant paths; FinTech → lnaccounts → Gini and FinTech → lnbranches → Gini. Therefore, financial inclusion mediates the effects of financial technology on income inequality in the African economies justifying the FFI model instead of the hypothesized double FFI model. As an area for further studies, we recommend the inclusion of other control variables such as rural and urban concentration and institutional quality amongst others to test their effect on inequality using the same methodology. We also recommend further studies on the reverse effect of inequality on financial inclusion and financial technology examining whether a bidirectional relationship exists.

Funding
The authors received no direct funding for this research.

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Disclosure statement
We disclose that we have no competing interests.

Citation information
Cite this article as: Fintech, financial inclusion and income inequality nexus in Africa, Tough Chinoda & Tafirei Mashamba, *Cogent Economics & Finance* (2021), 9: 1986926.

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APPENDIX

Table A. List of Sampled Countries

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros Congo, Dem, Rep, Congo, Rep, Côte d'Ivoire, Djibouti, Egypt, Arab Rep, Ethiopia, Gabon, Gambia, The, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Principe, Senegal, Seychelles, Sierra Leone, South Africa Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia.

Table B. Descriptive statistics

	Fintech	Fdi	Trade	Gini	Gdppc	Atms	Loans	Branches	Accounts
Mean	5.671	0.371	78.652	0.574	3311.5	18.782	29.291	9.727	495.116
Std. Dev.	6.455	0.087	34.748	0.047	3288.5	19.042	20.865	11.166	456.534
Maximum	37.105	0.59	207.16	0.6624	15,571	71.802	83.572	53.205	1962.43
Minimum	0.031	0.23	30	0.441	300	1.563	6.506	1.043	20.39
Jarque-Bera	0.000	0.000	0.001	0.000	0.002	0.002	0.003	0.002	0.005
Obs.	68	75	75	75	75	75	75	75	75

Table C. Correlation results

	Gini	Fdi	Fintech	Trade	Atms	Loans	Branches	Accounts	Gdppc
Gini	1.0000								
Fdi	−0.075	1.0000							
Fintech	0.0049	0.2308	1.0000						
Trade	−0.2122	0.1875	0.0366	1.0000					
Atms	−0.0690	0.6313*	0.1032	0.5460*	1.0000				
Loans	0.0297	0.8268*	0.0303	0.1720	0.6086*	1.0000			
Branches	−0.3562*	0.5164*	0.1299	0.7108*	0.7161*	0.5289*	1.0000		
Accounts	−0.1616	0.7260*	0.3360	0.4084*	0.7615*	0.6346*	0.7711*	1.0000	
Gdppc	−0.3459*	0.2747*	0.1547	0.6053*	0.6806*	0.2789*	0.6851*	0.4953*	1.0000

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