Sustainable Development And Financial Inclusion In Sub-Saharan Africa: Empirical Evidence From Panel Vector Error Correction Model (Vecm)

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Abstract

Financial inclusion has been identified as an essential tool for sustainable development in Sub-Saharan Africa (SSA). The low level of financial inclusion in SSA has been attributed to various factors such as low income, high level of poverty, low literacy rate, and inadequate infrastructure. This research investigates the long-run and short-run relationships between financial inclusion and sustainable development in SSA using a panel vector error correction model (VECM) regression method. The study uses cross-sectional data from 48 countries in SSA, covering the period from 2000 to 2021. The model considers the number of Bank branches per 100,000 adults, automated teller machines (ATMs) (per 100,000 adults), and borrowers from commercial banks (per 100,000 adults) as proxies of financial inclusion, while the sustainable development is proxied by human development index (HDI). In addition, the model controls for the influence of GDP per capita and health expenditure. The regression results show that financial inclusion has a positive and statistically significant association with the level of sustainable development in the SSA region. In the long run, a 1% increase in financial inclusion is associated with a 0.62% increase in sustainable development, while the short-run Wald test indicates that each of lagged values of all independent variables jointly Granger causes changes in HDI, suggesting that financial inclusion variables help predict short-run deviation in HDI. This study's findings reveal significant statistical evidence of financial inclusion variables in promoting sustainable development. Policymakers can use this information to develop policies that aim to increase GDP per capita, improve access to healthcare services, and financial institutions to promote sustainable development.

Keywords: Sustainable Development, Financial Inclusion, Developing Economies, Sub-Saharan African Economies, Panel (VECM).

JEL Classifications: B55, D60, O23, I15, I30, J10

Introduction

A discussion as to whether financial inclusion is correlated with economic development has been debated by the scholarly community for a long time. Earlier research indicated that financial inclusion may be an important component in economic development (Goldsmith, 1959; King & Levin, 1993; McKinnon, 1973) but other economists such as Robinson (1952) found that financial development followed economic development.

Financial inclusion is an effort that aims at bringing the population that is out of the financial system (unbanked) into the formal financial system, giving them the opportunity to access financial services such as payments, savings, credit, and insurance (Hannig & Jansen, 2010). Hannig and Jansen (2010) indicated that financial inclusion is a policy intervention that ensures each member of society has access to quality, affordable institutional financial products. Kim (2016), in the paper 'A study on the effect of financial inclusion on the relationship between income inequality and economic growth' noted that the goal of financial inclusion is to allow financial services to be extended to the "unbanked" so that they can improve their living standards by efficiently participating in economic activities that foster economic development.

The unbanked are described by the Federal Deposit Insurance Corporation (FDIC) as those adults without an account at a bank or other financial institution and are considered to be outside the mainstream for one reason or another. The 2017 World Bank Global Findex report found that roughly 62 percent of sub-Saharan Africans still need a bank account. The main reasons cited for lack of bank accounts include high fees charged by banks, unemployment, distrust, lack of literacy, inconvenience, lack of services among many others (World Bank, n.d).

Financial inclusion efforts became the main agenda for the Millennium Development Goals (MDGs) in the year 2000 and have ever since become emphasized by worldwide policymakers and prominent international development organizations such the World Bank and International Monetary Fund (IMF). MDGs are a project developed by the United Nations (UN) and adopted by the member countries (McArthur, 2014). All 191 United Nations member states at that time were participants in the MDGs. The MDGs are the world's time-bound and quantified targets for addressing extreme poverty in its many dimensions including financial exclusion, poverty, poor health, illiteracy, inequality, and unemployment (Sahay et al., 2015; Ulfgard, 2017).

After the 2007 global financial crisis, financial inclusion efforts were re-emphasized and the relationship between financial inclusion and economic development drew more interest in the scholarly and business communities. Sahay et al. (2015) indicated that more than 60 governments across the world set financial inclusion as a main tool for promoting economic development. While Hannig and Jansen (2010) contended that greater financial inclusion presents opportunities to enhance financial stability, Sahay et al. (2015) described that financial inclusion is seen by policymakers to improve people's livelihoods, reduce poverty, and advance economic development.

The financial system in Africa remains underdeveloped. However, with the introduction of digital technology, e.g., mobile money, mobile banking and online banking, growth in the financial sector increased and the well-being of the people improved (Buku & Meredith, 2012). The World Bank Group enterprise surveys indicated variability of financial inclusion in several African countries. This variability in financial inclusion created a need to understand how this impacts economic development across the region. Research by Demirgüç-Kunt and Klapper (2012) created the data set of Global Findex, which can be used to track the effects of financial inclusion policies globally and develop a deeper understanding of how people make payments, save, borrow, and manage risk around the world.

This study examined the relationship between financial inclusion and sustainable economic development in 48 Sub-

Saharan Africa countries . The panel vector error correction model (VECM) methodology is employed to estimate the relationship between financial inclusion and sustainable development in SSA. VECM is a dynamic econometric model that is suitable for analyzing time series data with cointegrating properties. The model allows for the estimation of both short-term and long-term relationships between the variables of interest. The study applies cross country analysis technique to examine the relationship between sustainable development variable proxied by human development index (HDI) and financial inclusion variables proxied by a number of bank branches, number of ATMs , and number of borrowers at commercial banks. To account for macroeconomic influence, the model controls for the influence of GDP per capita and health expenditure.

This study will contribute to the existing literature on financial inclusion and sustainable development in SSA by revealing new statistically significant evidence from panel VECM in regard to the relationship between financial inclusion and sustainable development (proxied by the human development index). The study will provide robust and reliable results that can be compared with previous studies that have used different data and methodologies. The study will also highlight the importance of financial inclusion in promoting sustainable development in the region.

Literature Review

Historical Perspective

Financial inclusion became a discussion among economists in the 18th century (Goldsmith, 1959) and policymakers in different countries and regions since 2000 after the MDG's summit when global partnerships to eradicate poverty were adopted by United Nations (UN) member countries. The summit emphasized the importance of financial inclusion as a critical strategy for economic development through financial empowerment, especially to the poor.

While continuing the campaign for poverty eradication in 2003, former United Nations secretary-general, the late Kofi Annan, emphasized that “The stark reality is that most poor people in the world still lack access to sustainable financial services, whether it is savings, credit, or insurance. The great challenge before us is to address the constraints that exclude people from full participation in the financial sector.” Subsequently, Sahay et al. (2015) indicated that the aftermath of the 2007 world financial crisis and the relationship between financial inclusion and economic development drew more interest to the scholarly and business communities.

Currently, the world's poor live and work in what is known as the informal economy, often called the shadow economy. The world's poor are mostly found in developing countries in Africa and some parts of Asia (Demirguc-Kunt & Klapper, 2012). For example, the World Bank reported that at least two billion people worldwide lack a formal bank account, of which the most significant percentage is concentrated in the African region. According to the World Bank survey, only 24 percent of adults have a bank account, even though Africa's formal financial sector has multiplied in recent years.

Although the poor have little money, they still save, borrow, and manage day-to-day expenses, but it is difficult, therefore making a case for easier to use and appropriate financial services. However, without access to a bank, savings account, debit card, insurance, or line of credit, the vulnerable must rely on informal means of managing money, e.g., family and friends, cash-on-hand, pawnbrokers, moneylenders, or keeping it under the mattress. These practices are expensive, inconvenient, unpredictable, and risky. The benefits of financial inclusion are significant not only for individuals but for economies, too. Financial inclusion is linked to a country's economic and social development and plays a role in reducing extreme poverty, which forms the main Millennium Development Goal (Demirguc-Kunt & Klapper, 2012).

Achieving MDGs has been a subject of discussion by leaders across the globe. Studies concerning financial inclusion have been conducted in different countries and regions, but levels of economic well-being differ from region to region, depending on economic well-being standards in those regions. For example, in Kenya, owning a motor vehicle is a luxury and not a basic need, while in the USA a motor vehicle is considered a basic need. Therefore, studies for financial inclusion and economic development conducted for developed countries such as the USA may not represent developing countries such as Kenya.

Financial Development and the Economic Growth

The relationship between financial development and economic growth has received significant attention throughout the modern history of economics. Its roots can be traced to the work of Schumpeter (1911; 2017). In 1911, Joseph Schumpeter argued that the services provided by financial intermediaries - mobilizing savings, evaluating projects, managing risk, monitoring managers, and facilitating transactions - are essential for technological innovation and economic development. He defined development as a spontaneous and discontinuous change in the channels of flow, disturbance of equilibrium, which forever alters and displaces the equilibrium state previously existing. Schumpeter further argued that financial services are paramount in promoting economic growth. Since then, many other researchers and theorists have posited different ideologies.

A study by Goldsmith (1959) indicated that differences in a country's financial organization and its financial habits and attitudes influence the direction of its economic development. The availing of financial services (financial inclusion) to the unbanked is one of these financial habits. Financial institutions that are well organized can provide efficient services and products to individuals and organizations. When families receive efficient services, they can save and use the savings to improve their lifestyle, e.g., pay for education, buy property, or start new businesses, leading to economic development. Goldsmith (1959) found that the level of savings ratio and distribution of savings by firms is affected by the level of a country's financial organization. Goldsmith's study used data from 35 countries between 1860 and 1963 suggested that a correlation does not imply causality. While Goldsmith (1959) indicated that there is no possibility of establishing with confidence the direction of causality (p. 48), he did establish a correlation.

McKinnon (1973) noted that money and capital in economic development present a theory of economic development. McKinnon (1973) found that an economy with an efficient financial system can achieve growth and development. However, McKinnon argued that historically, many countries, especially developing ones, have restricted competition in the financial sector, creating challenges or barriers to financial inclusion. Both Goldsmith (1959) and McKinnon (1973) believed that financial systems play a crucial role in alleviating market frictions and hence influencing savings rates, investment decisions, technological innovation, and long-run growth rates.

King and Levin (1993), in their paper "Finance and Growth: Schumpeter Might be Right," assessed whether higher levels of financial development are significantly and robustly correlated with economic development using data for 80 unspecified countries for a period between 1960-1989. They found that various measures of financial development are strongly associated with GDP growth (p. 735). It is unknown which set of countries was used in that study, and the countries may not represent the situation for African countries.

Another study conducted by Yorulmaz (2012) for Turkey. Yorulmaz (2012) contended that financial development enhances human development, and access to financial services makes a positive impact on people's lives, particularly that of poor people. In addition, financial development reduces income inequality and boosts incomes. The study focused on various cities within Turkey, and the results represented Turkey, so the trends may not apply to other countries. Yorulmaz (2012) developed an Index of Financial Inclusion (IFI) using banking sectors outreach indicators such as branches per million and ATMs per million from the Banking Association of Turkey (BAT). The study then compared the index within eighty cities and across regions in Turkey. However, this was not possible for Africa because that data was not available. Therefore, the World Bank financial inclusion data or global Findex and UNDP human development data were used.

Determinants of Sustainable Development and Financial Inclusion

The United Nations has identified seven Sustainable Development Goals (SDGs) that are enabled by financial inclusion, which is known to have a positive impact on the human development index (HDI). Anand and Chhikara (2013) revealed from cross-country data that a one percent increase in financial inclusion leads to an average of 0.142 percent increase in the human capital index (HDI). Empirical evidence from previous studies, among others, Pande, Cole, Sivasankaran, Bastian, & Durlacher (2012), Dupas & Robinson (2013), and Klapper, EL-Zoghbi, & Hess (2016) have shown that financial inclusion is associated with increased income and equality, reduced poverty, and improved health and overall well-being of individuals. HDI is comprised of three dimensions, namely long and healthy life, knowledge, and a decent standard of living. Financial inclusion can contribute to achieving a decent standard of living by providing access to financial services that enable individuals and households to manage their finances, save money, and invest in education and health, thereby improving their overall well-being. Therefore, financial inclusion can improve the indicators of HDI, such as life expectancy, education, and income.

To examine the relationship between financial inclusion and sustainable development, this study uses bank branches per 100,000 adults, Automated teller machines (ATMs) (per 100,000 adults), and borrowers from commercial banks (per 100,000 adults) as proxies for financial inclusion as suggested by Sarma (2008) and Park and Mercado (2015, 2018). In addition, HDI is used as a proxy for sustainable development, while control variables such as GDP per capita and health expenditure (% of GDP) are included to account for their influence on HDI.

Table 1: Description and calculation of variables

Variable	Description	Calculation	Data Sources
DHI	Human Development Index	Human Development Index	Human Development Reports(UNDP)
GDP	GDP per capita	GDP per capita (current US$)	World Development Indicators (World Bank)
HE	Health Expenditure	Health Expenditure (% GDP)	World Development Indicators (World Bank)
BKB	Bank branches	Bank branches per 100,000 adults	World Development Indicators (World Bank)
ATM	Automated teller machines	Automated teller machines (ATMs) (per 100,000 adults)	World Development Indicators (World Bank)
BRR	Borrowers	borrowers from commercial banks (per 100,000 adults)	World Development Indicators (World Bank)

Econometric Models

This study employs the Vector Error Correction Model (VECM) to estimate the relationship between financial inclusion and sustainable development (proxied by the human development index) in SSA. The model allows for the estimation of both short-term and long-term dynamics between the interested variables. The application of VECM is viable with dynamic panel data when considered variables are nonstationary at level, I(0), but stationary at the first difference, I(1), with cointegrated properties (Papke & Wooldridge, 2008; Asteriou & Hall, 2011). Hence, the first step in conducting VECM model is to test for stationarity and cointegration of the variables using Augmented Dickey-Fuller (ADF) or Levin-Lin-Chu (LLC) unit root test and Johansen cointegration test or Pedroni cointegration test for panel data. If the conditions of this first step are met, then the estimation of the VECM should be conducted.

Unit Root Test

Unit root test is performed to verify the stationarity of the data modeled in the estimation. A variable is considered stationary when the mean, variance, and auto-covariance of its time-series are constant over time (Enders, 2004). The purpose here is to confirm the appropriate selection of the regression method to avoid a spurious regression whose t-statistics and overall fit are likely to be overstated and unreliable (Studenmund, 2011). One standard method of testing for data stationarity is using the Dickey-Fuller test, which examines the hypothesis that the variable in question has a unit root. Hypothetically speaking, if the time series has a unit root, it is said to be nonstationary. In this study, the unit root test is conducted using the Augmented Dickey-Fuller (ADF) test method, an extended version of the regular Dickey-Fuller unit root test, as it is more appropriate for the higher order autoregressive model. In addition, because the conventional unit root tests, even the ADF, are weak in detecting non-stationarity in macroeconomic data, the Levin-Lin-Chu (LLC) test for unit roots is applied to confirm the robustness of the test results.

To examine if a variable is stationary or nonstationary, consider the following first order autoregressive model, AR(1):

$$\mathrm{Y_t} = \gamma \mathrm{Y_{t-1}} + \mathrm{u_t} \qquad (1)$$

Where u_t is the classical error term.

The Dickey-Fuller test states that variable Y is stationary if $|\gamma|$ <1 and nonstationary if $|\gamma|$>1. However, if $|\gamma|$=1, then the Y variable is considered to be nonstationary due to a unit root. To estimate equation (1) and determine if $|\gamma|$ <1, subtracting $Y_{(t-1)}$ from both sides of equation (1), yielding:

$$(Y_t - Y_{t-1}) = (\gamma-1)\, Y_{t-1} + v_t \qquad (2)$$

If defining $(Y_t - Y_{t-1}) = \Delta Y_t$, rewrite equation (2) in the simplest form of the Dickey-Fuller

test as:

$$\Delta Y_t = \beta_1 Y_{t-1} + u_t \qquad (3.1)$$

If Y_t includes a constant, then:

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + u_t \qquad (3.2)$$

If Y_t contains a trend *"t" (t= 1, 2, 3,…,T),* then:

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 t + v_t \qquad (3.3)$$

Where β_1= γ-1.

The null hypothesis is that Y_t contains a unit root and the alternative hypothesis is that Y_t is stationary. This means that if Y_t contains a unit root, γ=1 and β_1=0. If Y_t is stationary, $|\gamma| < 1$ and $\beta_1 < 0$. Hence, I constructed a one-sided t-test on the hypothesis that $\beta_1 = 0$:

$$H_0: \beta_1 = 0$$
$$H_1: \beta_1 < 0$$

Noted that whichever of the three forms of Dickey-Fuller test, equation (3.1,2,3) is adopted, the decision rule is based on the estimate of β_1. This means that if $\widehat{\beta_1}$ is significantly less than 0, one could reject the null hypothesis of nonstationary.

Because the Dickey-Fuller test presented in the context of equation 3.1 applies only in the first order autoregression or AR(1), which only includes one lag of Y_t in the model and does not capture all serial correlation in Y_t, applying the Augmented Dickey-Fuller (ADF) which incorporates higher order of autoregression, AR(*p*), is more appropriate.

Similarly, the Augmented Dickey-Fuller (ADF) test for a unit autoregressive root tests the null hypothesis H_0: β_1= 0 against the one-sided alternative H_0: $\beta_1 < 0$ in the regression.

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \eta_1 \Delta Y_{t-1} + \eta_2 \Delta Y_{t-2} + \ldots + \eta_p \Delta Y_{t-p} + u_t \qquad (4)$$

Under the null hypothesis, Y_t has a stochastic trend; under the alternative hypothesis, Y_t is stationary. The ADF statistic is the Ordinary Least Squared (OLS) t-statistic testing β_1 = 0 in Equation (4).

If instead the alternative hypothesis is that Y_t is stationary around a deterministic linear time trend, then this trend, "t" (the observation number), must be added as an additional regressor, in which case the Dickey-Fuller regression becomes:

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 t + \eta_1 \Delta Y_{t-1} + \eta_2 \Delta Y_{t-2} + \ldots + \eta_p \Delta Y_{t-p} + u_t \qquad (5)$$

where β_2 is an unknown coefficient and the ADF statistic is the OLS t-statistic testing β_2 = 0 in Equation (5).

The lag length p can be estimated using the Schwarz's Information Criteria (SIC) or Akaike Information Criteria (AIC) suggested by Phillips-Peron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). Studies of the ADF statistic such as Stock (1994, 1999) and Haldrup and Jansson and Moreira (2006) suggest that it is better to have more lags than too few, hence, using the AIC can be more preferrable over SIC in estimating p for the ADF statistic. Also note that if the determining of p = 0, lags of ΔYt are not included as regressors in Equations (4) and (5), and the ADF test simplifies to the Dickey-Fuller test in the AR(1) model. According to Studenmun (2011), because the ADF statistic does not have a normal distribution, even in large samples, the critical values for the one-sided ADF test depend on whether the test is based on Equation (4) or (5).

Cointegration Test

There is the possibility that a unit root test could give a stationary result due to the linear combination of two nonstationary variables. In such case, one could convert nonstationary variables to stationary variables by performing the first differences by replacing $\Delta Y = Y_t - Y_{t-1}$ *and* $\Delta X = X_t - X_{t-1}$. However, in economic data analysis, performing the first differences would eliminate information that economic theory can provide in the form of equilibrium relationships between the variables when they are expressed in their original forms (Studenmund, 2011). Therefore, the first differences approach is not normally recommended as the first resource in avoiding the spurious regression, unless the nonstationary variables are found not cointegrated at the same order. According to Studenmund (2011), “cointegration consists of matching the degree of nonstationary of the variables in an equation in a way that makes the error term and residuals of the equation stationary and rids the equation of any spurious regression results” (p. 242). In other words, if variables are cointegrated, the spurious regression can then be avoided even though the dependent variable and at least one independent variable are nonstationary.

There are different techniques used for cointegration tests such as the Granger-Engel algorithm (1987), the approaches of Johansen (1988, 1991), the Stock-Watson test (1988), and the Phillips-Ouliaris test (1990). This study employs the Pedroni cointegration test as it is a panel data cointegration test version of the Johansen cointegration test and is appropriate for testing the cointegration of variables in panel data. of economic growth. The Pedroni test provides four test statistics: group mean (PMG), group maximum (PGM), augmented mean (ADF), and augmented maximum (ADF-GLS). The choice of test statistic depends on the characteristics of the panel data set. If the Pedroni test indicates that there is cointegration among the variables (reject the null hypothesis), then the variables are said to be cointegrated, and a vector error correction model (VECM) can be used to estimate the long-run relationship between the variables. The VECM estimates the long-run and short-run coefficients of the variables and the error correction term (ECT). If the Pedroni test indicates that there is no cointegration among the variables (fail to reject the null hypothesis), then the variables do not have a long-run relationship and a static model can be used to estimate the relationship between the variables.

The cointegration test is derived as follows:

$$Y_t = \alpha_0 + \beta_0 X_t + u_t \quad (6)$$

If Y_t *and* X_t are nonstationary, it is likely that equation (3.6) would generate a spurious regression.

To test for cointegration between Y_t *and* X_t, solve the equation (6) for u_t :

$$u_t = Y_t - \alpha_0 - \beta_0 X_t \quad (7)$$

Here, the behavior of u_t is the key to integration. Since u_t is a function of nonstationary variables, it can also be expected to be nonstationary; however, that is not necessarily the case.

For instance, *if* Y_t *and* X_t are related, then the error term u_t may well be stationary even though both variables Y_t *and* X_t are nonstationary. According to Kennedy (2008), if u_t is stationary, then the unit roots in Y_t *and* X_t will be canceled out and Y_t *and* X_t are said to be cointegrated.

To determine if Y_t *and* X_t are cointegrated, one needs to perform the Ordinary Least Square (OLS) estimation of equation (5) and calculate the OLS residuals as follows:

$$\varepsilon_t = Y_t - \hat{a}_0 - \beta_0 X_t \quad (8)$$

If the null hypothesis of a unit root in the residuals in the Dickey-Fuller test is rejected, then one could conclude that Y_t *and* X_t are cointegrated and OLS estimates are not spurious.

The purpose of the cointegration test was to verify the long-run and short-run relationship of the variables in the models. A set of variables are said to be cointegrated if the long-run equilibrium relationship exists between them. For models where the ADF test showed that the variables of interest in the equation were nonstationary at their level units, the cointegration test result was used to decide whether to apply VAR or VECM as the most appropriate regression approach. Following the approach of Nantharath and Kang (2019), the data analysis of this study considered the following steps: (a) if all variables were stationary at level, the vector autoregressive (VAR) model is applied to estimate the equation in its original units; (2) if the model consisted of nonstationary and stationary variables at level or variables were not cointegrated in the same order, the equation is estimated using either the autoregressive (VAR) model or error correction model (ECM); (3) if all variables were stationary at first difference and cointegrated in the same order, the equation is estimated using the error correction model (ECM) for one endogenous variable or vector error correction model (VECM) for multiple endogenous variables.

Panel Vector Error Correction Model

Engle & Granger (1987) propose two steps of modelling the dynamic relationship of cointegrated I(1) variables leading to the formulating of VECM. The first step is estimating the long-run relationship through the cointegration estimation, which produces the estimated residual as the error correction term, ε_(i,t),sfor the panel vector error correction model. In step 2, the error correction from step 1 is incorporated into the panel vector autoregressive model (VAR) and forms the VECM (Jiang & Liu, 2014).

Recall from the long-run cointegrating regression model with time (t) and observed individual (i):

$$Y_{i,t} = \beta_{01} + \beta_{1i} X_{i,t} + \varepsilon_{i,t} \qquad (9)$$

The estimated residual, $\varepsilon_{i,t}$, can be estimated as error correction term as:

$$\varepsilon_{i,t} = ETC_{i,t-1} = Y_{i,t-1} - \beta_{0i} - \beta_{1i} X_{i,t-1} \qquad (10)$$

Incorporating the error correction term, $\varepsilon_{i,t}$, into the panel vector autoregressive model (VAR), gives:

$$\Delta Y_{i,t} = \alpha_i + \lambda_i \, ETC_{i,t-1} + \sum_{k=1}^{p} \beta_1 \, \Delta Y_{i,t-k} + \sum_{k=0}^{p} \beta_2 \, \Delta X_{1,i,t-k} + \dots + \sum_{k=0}^{p} \beta_{n+1} \, \Delta X_{n,i,t-k} + \mu_{i,t}$$

(11)

Where time, t = 1, 2, 3, …,T and observed individual, i = 1, 2, 3, …, N. Δ denotes the first difference in the variable, while the optimal lag length h is determined by the Schwarz information criterion., $ETC_{i,t-1}$, is error correction term, β is the coefficient of the estimated parameters, n is the number of exogenous variables in the model, Y is the dependent variables and X is the independent variab

Model Specification

In this study, the model includes the following independent variables: number of bank branches (BKR), number of ATMs (ATM), number of borrows at commercial banks (BRR) as the proxies of financial inclusion variable and human development index (HDI) as the proxy of level of sustainable development. The model control for the influence of GDP per capita (GDP) and health expenditure (HE).

The general specification of the panel data model of this study can be written as:

HDI=F(GDP,HE,BKR,ATM,BRR) (12)

$$HDI = \beta_0 + \beta_1 \ln GDP + \beta_2 \ln HE + \beta_3 \mathrm{Ln} BKB + \beta_4 \ln ATM + \beta_5 \ln BRR + \varepsilon$$

(13)

Based on equation (11), the established VECM can be written with all variables in logarithmic value as:

$$\Delta lnHDI_{i,t} = \alpha_i + \lambda_i ETC_{i,t-1} + \sum_{k=1}^{p} \beta_{1,i,k} \Delta lnGDP_{i,t-k} + + \sum_{k=0}^{p} \beta_{2,i,k} \Delta lnHE_{i,t-k} + \sum_{k=0}^{p} \beta_{3,i,k} \Delta lnBKB_{i,t-k} + \sum_{k=0}^{p} \beta_{4,i,k} \Delta AlnTM_{i,t-k} + \sum_{k=0}^{p} \beta_{5,i,k} \Delta lnBRR_{i,t-k} + \mu_{i,t} \quad (14)$$

Where time, t = 1, 2, 3, …,T and observed individual, i = 1, 2, 3, …, N.

Results

Panel Unit Root Test

Panel unit root test was conducted to verify the stationarity of the variables under the null hypothesis that there is presence of unit roots. The variable is stationary is the statistical p-value rejects the null hypothesis. The unit root test is important as it helps to ensure that an appropriate estimation technique is chosen to avoid a spurious regression. This study employed Levin-Lui-Chu unit root test and Augmented Dickey-Fuller unit root tests to confirm whether variables are I(0), I(I), or mixed of both.

The results presented in table 2 revealed that all some variables are stationary at level, and some are not. The unit root tests at first difference confirms that all variables are stationary, hence, possess I(1) properties. These results suggested that a panel cointegration test is appropriate to verify whether there exists a long-run relationship between variables.

Table 2: Panel Unit Root Test (t-statistics, p-value)

Fiscal Decentralization Indicators	**Augmented Dickey-Fuller test**		**Levin-Lin-Chu test**	
	Level	First Difference	Level	First Difference
lnHDI	3.32648	-3.40287	10.6107	-1.68171
	(0.9996)	(0.0003)***	(1.0000)	(0.0463)***
lnGDP	-2.33980	-11.8050	1.58376	-12.3498
	(0.0096)***	(0.0000)***	(0.9434)	(0.0000)***
lnHE	3.49867	-8.01070	3.50783	-8.03380
	(0.9998)	(0.0000)***	(0.9998)	(0.0000)**
lnBKB	-0.99909	-9.25742	0.57871	-8.14271
	(0.1589)	(0.0000)***	(0.7186)	(0.0000)***
lnATM	-1.34576	-13.1506	0.58738	-8.46830
	(0.0892)	(0.0000)***	(0.7215)	(0.0000)***
lnBRR	-1.93048	-8.74832	-0.10908	-7.74247
	(0.0268)**	(0.0000)***	(0.4566)	(0.0000)***

*, **, ***Indicating p-value rejected the Null Hypothesis at 10%, 5%, or 1% significant level respectively.

Panel Cointegration Test

Since variables are stationary at first difference or have I(1) properties, Pedroni (1999; 2004) and Kao (1999) cointegration tests were conducted to confirm the existence of long-run relationship between variables. Both methods are based on Engle-Granger (1987) two-step (residual-based) cointegration tests. The cointegration test results presented in table 3 and table 4 indicated that p-values rejected the null hypotheses of no cointegration between variables, hence, all variables are concluded to be cointegrated at the same order of I(1).

Table 3.: Pedroni Cointegration Test

Dimension	Test Statistics	Intercept	Intercept and Trend
Within-dimension	Panel v-Statistic	-2.322538 (0.9899)	11.19093 (0.0000)***
	Panel rho-Statistic	3.164238 (0.9992)	4.056436 (1.0000)
	Panel PP-Statistic	-2.216948 (0.0133)**	-3.439483 (0.0003)***
	Panel ADF-Statistic	-1.900296 (0.0287)**	-5.144908 (0.0000)***
Between-dimension	Group rho-Statistic	4.861241 (1.0000)	6.451351 (1.0000)
	Group PP-Statistic	-4.744671 (0.0000)***	-3.921604 (0.0000)***
	Group ADF-Statistic	-3.855426 (0.0001)***	-5.385386 (0.0001)***

*, **, ***Indicating p-value rejected the Null Hypothesis at 10%, 5%, or 1% significant level respectively.

Table 4: Kao Residual Cointegration Test

	t-Statistic	Prob.
ADF	-3.982300	0.0000***
Residual Variance	0.000387	
HAC variance	0.000583	

*, **, ***Indicating p-value rejected the Null Hypothesis at 10%, 5%, or 1% significant level respectively.

Panel Vector Error Correction Model (VECM)

The Panel Vector Error Correction Model (VECM) is used to estimate the short-run and long-run relationships between variables. The long-run estimation is based on the cointegrating coefficient, λ_(i), and the error correction term, ETC_(i,t-1), which reveal how variables are related over time. A negative λ_(i) coefficient indicates that variables converge over time, and the p-value should be statistically significant.

The short-run estimation considers the behavior of independent variables at different lags, for instance, lags 1 and 2. The short-run model is estimated with the error correction term, ETC_(i,t-1) and is used to determine if the independent variables jointly Granger cause the dependent variable. The results of the short-run estimation are presented in table 6, and the statistical significance of the short-run Granger cause is confirmed using the Wald coefficient diagnostic, as presented in table 7.

Long-Run Estimation

The cointegrating equation (13) represents the relationship between the variables in the long run. The error term coefficient, λ_i, is -0.006202 with a p-value of 0.0001, indicating that the long-run causality from independent variables to dependent variable is statistically significant at 1% level. The interpretation of the error term coefficient is that for a 1% increase in financial inclusion will increase the sustainable development by 0.62%, in the long run. Additionally, the cointegration equation reveals that lnBKR and lnATM have a positive causal effect on lnHDI, suggesting that an increase of 1% in BKR is associated with a 0.203% increase in HDI, while an increase of 1% in ATM is associated with a 0.135% increase in HDI. In contrast, lnBRR has a negative association with lnHDI, with an increase of 1% in BRR resulting in a 0.023% decrease in HDI.

Table 5: Long-run estimation (coefficient, t-statistics, p-value)

Cointegrating equation:

$$\mathbf{ETC_{i,t-1}} = \boldsymbol{lnHDI_{t-1}} + \mathbf{0.14329lnGDP_{t-1}} + \mathbf{0.37683lnHE_{t-1}} - \mathbf{0.20349lnBKB_{t-1}} - \mathbf{0.13571lnATM_{t-1}} + \mathbf{0.02325lnBRR_{t-1}} + \mathbf{0.4683} \quad \textbf{(13)}$$

Variable	$Coefficient$	$T-statistic$	$p-value$
$\mathbf{ETC_{i,t-1}}$	-0.006202	-4.021269	0.0001***
$\mathbf{lnHDI_{t-1}}$	1.000000		*Explained by p-value of cointegration coefficient*
$\mathbf{lnGDP_{t-1}}$	0.14329	5.82101	
$\mathbf{lnHE_{t-1}}$	0.37683	6.65980	
$\mathbf{lnBKB_{t-1}}$	-0.20349	-6.17657	
$\mathbf{lnATM_{t-1}}$	-0.13571	-5.07894	
$\mathbf{lnBRR_{t-1}}$	0.02325	0.94569	
constant	0.4683	-	-

*, **, ***Indicating p-value rejected the Null Hypothesis at 10%, 5%, or 1% significant level

Short-Run Estimation

The vector error correction equation (14) represents the short-run relationship between the dependent variable and the independent variables in the model. The coefficients of the lagged values of lnHDI suggest that past values of lnHDI have a positive effect on current changes in lnHDI. Holding other factors constant , the positive coefficient of lag 1 nGDP and lag 2 lnGDP indicates that an increase in GDP per capita in the previous period is associated with an increase in HDI in the current period. The short-run coefficients of lag 1 lnHE and lag 2 lnHE are positive, indicating that past healthcare expenses have a positive effect on current changes in HDI. Similarly, the short-run coefficients of lag 1 lnBKB and lag 1 lnATM suggest that an increase in the number of bank branches and ATM machines in the previous period is associated with an increase in HDI in the current period. In contrast, the negative short-run coefficients are associated with a decrease in HDI in the current period.

The short-run Granger causality Wald test indicates that lagged values (lag 1 and lag 2) of lnGDP, of lnHE, of lnBKB, and of lnATM each jointly Granger cause changes in HDI, suggesting that these variables are useful in predicting changes in HDI in the short run. In addition, p-values of all Wald test, except of lnBRR, are statistically significant at the 1% level, indicating a strong short-run causality between the variables. The Wald statistic of the lagged values of lnBRR do not jointly Granger cause changes in HDI, suggesting that the number of borrowers may not be a useful predictor of short-run changes in HDI.

Table 6: Short-run estimation (coefficient, t-statistics, p-value)

Vector Error Correction Equation:

$$\begin{aligned}\Delta \mathrm{lnHDI}_t = & -0.006202\ \mathrm{ETC}_{\mathrm{i,t-1}} + 0.1602\ lnHDI_{t-1} + 0.24477\ lnHDI_{t-2} \\ & + 0.010244\ lnGDP_{t-1} + 0.0005383\ lnGDP_{t-2} \\ & + 0.007198\ lnHE_{t-1} + 0.009345\ \mathrm{lnHE}_{t-2} + 0.006668\ \mathrm{lnBKB}_{t-1} \\ & - 0.00099\ \mathrm{lnBKB}_{t-2} - 0.002274\ \mathrm{lnATM}_{t-1} - 0.002341\ \mathrm{lnATM}_{t-2} \\ & - 0.001580\ \mathrm{lnBRR}_{t-1} - 0.000436\ \mathrm{lnBRR}_{t-2} - 0.004574\end{aligned} \quad (14)$$

Variable	$Coefficient$	$T - statistic$	$p - value$
$\mathrm{ETC}_{\mathrm{i,t-1}}$	-0.006202	-4.021269	0.0001***
$\mathrm{lnHDI}_{\mathrm{t-1}}$	0.160236	5.596214	0.0000***
$\mathrm{lnHDI}_{\mathrm{t-2}}$	0.244777	8.739233	0.0000***
$\mathrm{lnGDP}_{\mathrm{t-1}}$	0.010244	3.493538	0.0005***
$\mathrm{lnGDP}_{\mathrm{t-2}}$	0.005383	1.924876	0.0546***
$\mathrm{lnHE}_{\mathrm{t-1}}$	0.007198	2.377821	0.0176***

$\ln HE_{t-2}$	0.009345	2.58426	0.0099***
$\ln BKB_{t-1}$	0.006668	5.581482	0.0000***
$\ln BKB_{t-2}$	-0.00099	-0.805726	0.4206
$\ln ATM_{t-1}$	-0.002274	-3.039503	0.0024***
$\ln ATM_{t-2}$	-0.002341	-3.125639	0.0018***
$\ln BRR_{t-1}$	-0.00158	-2.122012	0.0341**
$\ln BRR_{t-2}$	-0.000436	-0.585993	0.5580
constant	0.004674	7.672222	0.0000

*, **, ***Indicating p-value rejected the Null Hypothesis at 10%, 5%, or 1% significant level respectively.

Short-Run Estimation Wald Statistic

Table 7: Short-run estimation (t-statistics, p-value)

Variable	Short-run Granger causality	$T - statistic$	$p - value$
lnGDP	$\ln GDP_{t-1}$ and $\ln GDP_{t-2}$ jointly Granger cause lnHDI	8.489351	0.0002***
lnHE	$\ln GDP_{t-1}$ and $\ln GDP_{t-2}$ jointly Granger cause lnHDI	5.813879	0.0031***
lnBKB	$\ln GDP_{t-1}$ and $\ln GDP_{t-2}$ jointly Granger cause lnHDI	16.10744	0.0000***
lnATM	$\ln GDP_{t-1}$ and $\ln GDP_{t-2}$ jointly Granger cause lnHDI -	8.475017	0.0002***
lnBRR	$\ln GDP_{t-1}$ and $\ln GDP_{t-2}$ jointly Granger cause lnHDI	2.261749	0.1048*

*, **, ***Indicating p-value rejected the Null Hypothesis at 10%, 5%, or 1% significant level respectively.

Discussion

The VECM results suggest that there are statistically significant long-run and short-run associations between sustainable development (proxied by human development index, HDI), and the financial inclusion (proxied by the number of bank branches, BKB, the number of ATM machines, ATM, and the number of borrowers BRR. The model considers GDP per capita, GDP, and healthcare expenses, HE, as the control variables. The empirical evidence from the error correction term of the cointegration equation infers that a 1% increase in financial inclusion is associated with 0.6202% of sustainable development. This number is higher in comparison with the finding of Anand and Chhikara (2013), which revealed from a cross country data that a 1% increase in financial inclusion leads to an average of 0.142% increase in human capital index (HDI).

The positive coefficient of lnGDP suggests that a 1% increase increase in GDP per capita in the long run is associated with a 0.143% increase in HDI, holding other factors constant. This implies that a higher GDP per capita can lead to an improvement in sustainable development, such as access to better healthcare, education, and infrastructure, which can enhance the quality of life of individuals in a society. This finding is consistent with (Demirgüç-Kunt et al., 2014, Kyophilavong, & Shahbaz, 2016) in terms of growth-led financial development.

Similarly, the positive coefficients of lnHE, lnBKB, and lnATM suggest that increased healthcare expenses, a higher number of bank branches, and ATM machines can improve HDI in the long run. This is because improved access to healthcare services and financial institutions can enable individuals to invest in their human capital and pursue economic activities, leading to better living standards and higher HDI. This finding is consistent with evidence of financial development-led growth from existing studies such as, among others, Robinson (1952), King & Levin (1993), and Levine, (2005). The effect of lnBRR is not statistically significant, suggesting that the number of borrowers may not be an important determinant of sustainable development in the long run.

The short-run estimation output of the VECM provides useful insights into the dynamic relationship between financial inclusion variables and sustainable development variable. The positive coefficients of lag 1 lnGDP and lag 2 lnGDP suggest that changes in GDP per capita in the current and previous periods have a positive effect on changes in HDI in the short run. This highlights the importance of economic growth in promoting sustainable development, such as improving access to healthcare, education, and infrastructure (Beck et. Al, 2009).

Similarly, the positive coefficients of lag 1 lnHE and lag 2 lnHE suggest that increases in healthcare expenses in the previous two periods have a positive effect on changes in HDI in the short run. This implies that investment in healthcare can have immediate benefits in promoting sustainable development. The positive coefficients of lag 1 lnBKB and lnATM suggest that an increase in the number of bank branches and ATM machines in the previous period is associated with an increase in HDI in the current period. This highlights the importance of financial development in promoting sustainable development, such as enabling individuals to invest in education, healthcare, and entrepreneurship (Banerjee & Newman, 1993).

The short-run Granger causality test indicates that lagged values of lnGDP, lnHE, lnBKB, and lnATM jointly Granger cause changes in HDI, suggesting that these variables are useful in predicting short-run changes in HDI. This highlights the importance of these variables in promoting sustainable development, and policymakers can use this information to develop short-term policies aimed at improving sustainable development. Overall, the VECM output highlights the importance of sustainable economic development for improving access to formal financial services, which are all important aspects of sustainable development. Improving financial inclusion may help reduce poverty through the achievement of Millennium Development Goals (MDGs) and improvement of people's well-being. Policymakers in SSA region may consider these findings to develop policies that aim to increase GDP per capita, improve access to healthcare services, and financial institutions to promote sustainable development.

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