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POPULATION HEALTH, INFRASTRUCTURE DEVELOPMENT AND FDI INFLOWS TO AFRICA: A REGIONAL COMPARATIVE ANALYSIS

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ABSTRACT

This study examined the effect of population health and infrastructure development on FDI inflows to Africa. Furthermore, a comparative study on the three biggest African regions, the ECOWAS, COMESA, and SADC regions, was conducted. A panel DOLS approach was adopted for 40 countries drawn from the regions from 1980 to 2017. Unlike empirical population health studies, the multidimensional effects of population health on FDI inflows were examined. The empirical findings from the study showed that population health significantly impacted FDI inflows to Africa, with strong effects in the ECOWAS, and weak effects in the COMESA and SADC regions. However, infrastructure development was found to be a major determinant of FDI flows to Africa and the three regions, thus suggesting that while foreign investors consider infrastructure development for investment in the three regions, population health is further considered on an aggregate level and by ECOWAS foreign investors.

Contribution/Originality: This study uniquely incorporates the five measures of population health, which is a major challenge in empirical health studies. Furthermore, the effect of infrastructure is made obvious in this study against what was obtained in prior studies, where its effect is usually reduced to a moderating role.

1. INTRODUCTION

Most African countries are usually tagged as "developing nations" due to the growing characteristic of their economies and their thirst for capital, especially foreign capital. Foreign capital can be transferred into an economy in many forms depending on the expected rate of return. However, if the population of a country is not healthy, and there is a huge deficit in infrastructure development, the expected foreign capital will remain a mirage. For instance, the 2001 World Health Organization's Report of the Commission on Macroeconomics and Health maintained that "a healthy workforce is important when attracting foreign direct investment (FDI)." To further buttress this position, international agencies such as the United Nations, World Bank, International Monetary Fund, and the European Union, unanimously agreed that population health as well as infrastructure development are key to attracting substantial inflows of FDI and reducing poverty in any nation. However, the health and the infrastructure challenges in Africa has perpetually made the continent lag behind in attracting huge flows of FDI from the rest of the world. Consequently, issues of population health and infrastructure development are increasingly gaining consideration, particularly in the formulation of global development agendas. One particular example is the United Nations'

Sustainable Development Goals (SDGs), which echoes the need for sustained population health and infrastructure development, especially in developing countries, by 2030.

There has been more emphasis in recent times on the need to maintain population well-being and wellness, which has further broadened or given a multidimensional meaning to the definition of population health. For example, trade relations, which is very different from health services, is now being regarded as a part measure of population health. Hence, regardless of how population health outcomes are defined or evaluated, they must reflect the product of the multidimensional health determinants, which have been grouped into five classes (health care, individual behavior, social and economic environment, physical environment, and genetic determinants) by the University of Wisconsin Population Health Institute and the Robert Wood Johnson Foundation (Remington, Catlin, & Gennuso, 2015).

The health determinants were adopted in this paper to verify their significance in attracting FDI to Africa. Since most African countries have poor income and limited savings to meet investment demands, the reliance of policymakers on FDI inflows as an essential source of generating capital for investment in infrastructure and implementing developmental initiatives in their economies may suffer. It is a known fact that the bulk of Africa's FDI inflows are from developed economies. Hence, the health and economic policy responses in these countries to pandemics such as the coronavirus, especially stemming from the prolonged lockdown, could slow down their recovery process, particularly as it relates to the FDI decisions of firms.

To further exacerbate the African situation, unlike their developed counterparts, many years of neglect have left their health system and public infrastructures overstretched (Aladejare, 2022a; Aladejare, 2022b). Hence, most African governments are temporarily more concerned with curtailing the pandemic, providing palliative measures to curtail civil disobedience and keeping their fragile economies afloat, while new health and business inducing infrastructures are relegated to the future. Developments such as these in African countries seem like a daunting task to attract future FDI inflows. Thus, this study is justified as it evaluates the significance of population health and infrastructure development for future FDI flows to Africa. Furthermore, a comparative analysis of Africa's three biggest regions or trade blocs, which are the Economic Community of West African States (ECOWAS), the Common Market for Eastern and Southern Africa (COMESA), and the South African Development Community (SADC) was conducted. The essence of the regional comparative study was to verify which of the three regions is most favored, as well as least preferred by foreign investors and why.

It is important to note that there is a dearth of studies, especially on Africa, that incorporates the five measures of population health as in this study. A major challenge in empirical population health studies has been the narrow definition of the concept, which tends to limit the understanding of its robust effect. Furthermore, the effect of infrastructure is made clear in this study because its effect was usually reduced to a moderating role in the population health–FDI inflow nexus in prior studies, thus obscuring their actual individual role in FDI determination. Methodologically, a panel dynamic ordinary least squares (PDOLS) approach was applied to panel data spanning from 1980 to 2017 for 40 African countries belonging to the three regions.

The remainder of this paper is structured as follows: Sections 2 is an overview of FDI inflows in Africa, Section 3 contains literature reviews related to the topic of interest, Section 4 describes the data and methodology, Section 5 presents the study findings, and Section 6 contains the concluding remarks.

2. OVERVIEW OF FDI INFLOWS TO AFRICA

By definition, FDI represents an investment often with medium- to long-term expected interest yields managed by one or more foreign interests (individual or corporate enterprises) in an economy (IMF, 1993; OECD, 1990). FDI can take the form of long-term equity capital supply, considered preferable to portfolio investments which are usually short-termed and easily susceptible to capital flight during financial crises. It can also take the form of a merger or joint venture with a foreign company, or the establishment of a subsidiary in another country. The benefits of FDI are enormous, such as transfer of efficient technologies and managerial skills, supply of capital inputs to the host

country, human capital development via training of local employees, expanding access of firms in the host country to global markets, and increasing the corporate tax base of the host country (Feldstein, 2000).

FDI can also help in the recovery of an economy besieged by health pandemics. Experience from past crises have revealed that foreign-owned companies, alongside small and medium enterprises, are more likely to exhibit greater recovery in times of crises due to their access to financial resources from their mother companies (OECD, 2019). Thus, for African countries, the importance of FDI cannot be understated, particularly given the fact that portfolio investments may likely flee the continent in large amounts in the event of a health crisis.

However, benefits from FDI inflows have been less felt in the African region due to their uneven distribution. Most foreign investors still favor developed countries and some developing countries over Africa in FDI distribution. For instance, evidence shows that there has been a rapid growth in the world's FDI inflows for close to three decades. Global FDI inflows rose from over $397 trillion between 1990 and 1999 to $1,579 trillion in the 2010–2017 period (see Table 1). Although, FDI flows to developed regions declined for close to three decades, they are still ahead of the share flowing to developing regions (see Table 1). FDI flows to developing countries rose from 28.86% of the world's share between 1990 and 1999 to 42.39% during the 2010–2017 period. As a share of total FDI inflows, Africa at its peak (i.e., between 2010 and 2017) received a share of 3.15% and 7.43% of the world's and developing nations' shares, respectively (see Table 1), thus lagging behind its Asian, Latin American and Caribbean counterparts, and affirming the lower interest of foreign investors in the region in the distribution of world's FDI inflows. Poor health among the population the poor state of economic infrastructure has been a major cause coupled with the fact that most FDI flows to the region are resource-seeking and not knowledge-seeking as in developed and Asian countries. Nevertheless, Africa's largest FDI inflows in 2016 came mainly from the United States of America and was valued at $57 billion, the United Kingdom valued at $55 billion, France at $49 billion, China at $40 billion, and South Africa at $24 billion (UNCTAD World Investment Report, 2018).

Table 1. Comparative average FDI inflows by region from 1990 to 2017 (in millions of US$).

Region	1990–1999	2000–2009	2010–2017
World	397,497	1,085,732	1,579,381
Developed economies	278,767	706,259	847,640
% of World	70	65	54
Developing economies	114,703	336,737	669,575
% of World	29	31	42
Africa	6,641	31,008	49,729
% of World	2	3	3
% of Developing economies	6	9	7
Asia	70,166	223,255	448,958
% of World	18	21	28
% of Developing economies	61	66	67
Latin America and the Caribbean	37,636	81,571	168,864
% of World	9	8	11
% of Developing economies	33	24	25
Africa	6,641	31,008	49,729
ECOWAS	2,122	6,286	12,932
% of Africa	32	20	26
COMESA	1,901	12,073	18,420
% of Africa	29	39	37
SADC	554	8,904	14,171
% of Africa	8	29	29

Further disaggregation of Africa's total FDI inflows between its three key regions, ECOWAS, SADC, and COMESA, shows that the ECOWAS, which used to be the highest recipient of FDI inflows in the 1990s, had become the lowest recipient in the later periods (see Table 1). The huge population of the region, compared to other regions, makes it more vulnerable in the event of a health crisis. It is also likely that multinational firms in the ECOWAS

region have been diversifying their supplier channels for the purpose of speeding up their recovery from location-specific vulnerabilities. Such an approach may involve divestments from countries considered highly susceptible to health crises to expansion in other less vulnerable countries.

In a neoclassical premise where capital and labor inputs are required for output production, it is expected that the flow of capital will be from developed countries to poor or developing countries until convergence of capital–labor ratios across both developed and developing countries is achieved. Therefore, the increased flow of FDI between developed countries, as shown in Table 1, is an apparent contradiction. One plausible explanation for this could be the obvious differences in human capital (Lucas, 1990). Empirical studies have shown growing interest in the notion that human capital could significantly induce FDI inflows to African countries (Alsan, Bloom, & Canning, 2006; Anyanwu, 2012; Asiedu, 2002; Cleeve, Debrah, & Yiheyis, 2015). Good health and educational infrastructures can actually spur growth in FDI inflows since there is a positive correlation between capital productivity, a healthy society, and a highly educated workforce. This is partly motivated by change in economic activity from natural resource production to manufacturing sectors and later toward services production, which are highly knowledge-driven (Zubair & Aladejare, 2017). For instance, FDI flows to Africa, and particularly to the major commodity exporters, have continued to decline in recent times due to declining resource prices (UNCTAD World Investment Report, 2018). Nevertheless, the fall in natural resource-related manufacturing was partially compensated for by an increase in FDI flows to other manufacturing sectors. Evidence shows that greenfield FDI flows to Africa in textiles, clothing and leather have continued to grow over time, reaching $4 billion in 2017, thus doubling its 2014 value and rising 20 times higher than its 2008 value (UNCTAD World Investment Report, 2018).

3. LITERATURE REVIEW

3.1. Theoretical Review

In the works of Dunning (1977) and Dunning and Lundan (2010), a theoretical framework that categorizes micro and macro level FDI determinants was provided to aid the understanding of why and where multinational companies (MNCs) invest their resources abroad. Three factors were highlighted, which are: ownership (O), location (L), and internalization (I), known as the OLI parameters. The ownership-specific factor relates to the opportunity to own property rights or patents, expertise, and other intangible assets. This enables a firm to compete with other existing firms in the market, irrespective of its foreign status due to its access to, and ability to exploit and export, natural resources and resource-based goods at its disposal. A foreign firm's edge in this regard could be due to its ability to coordinate complementary functions of manufacturing and distribution, as well as the ability to take advantage of heterogeneity between countries.

Factors that make a country an attractive destination for investment are known as the location advantages. These factors include the availability of cheap or highly skilled labor, heterogeneity in the country's natural wealth, and favorable trade policies, transport costs, macroeconomic stability, and cultural factors. Thus, FDI is required by the host country to supply the domestic market via an affiliate (horizontal FDI). Internalization factors include the ability to exploit existing imperfections in foreign markets, lower the uncertainty and cost of transactions to allow for an efficient knowledge yield, as well as reduce foreign exchange tariffs and subsidy fluctuations. Hence, the delocalization of all or part of the production process, such as the production of components and/or the decentralization of production locations, results in reduced costs advantages (i.e., vertical FDI) (Kinda, 2010; Pantelidis & Nikolopoulos, 2008; Sekkat & Veganzones-Varoudakis, 2007). Base on the aforementioned, Dunning and Lundan (2010) grouped the motives that drive FDI into four classes: resource seeking (which entails access to raw materials, labor, and physical infrastructure), market seeking (which involves a horizontal approach to exploiting the host country's domestic market), efficiency seeking (i.e., a vertical technique to benefit from reduced labor costs, particularly in developing nations), and strategic asset seeking (i.e., the desire to access research and development, innovation, and technological advancement).

There are other studies that have also highlighted the role of policy and non-policy factors as determinants of FDI (Fedderke & Romm, 2006). Some of the postulated policy determinants include degree of openness, product market regulation, organization of the labor market, trade barriers, corporate tax rates, direct FDI confinements, and infrastructure. On the other hand, the non-policy factors include the host country's market size (best measured by the GDP per capita), distance/transport costs, factor endowments, and stability in the political and economic space (Anyanwu, 2011).

In another study conducted by Sekkat and Veganzones-Varoudakis (2007), the determinants of FDI inflows were grouped into three categories: primary economic factors, trade and exchange market regulations, and other areas of the investment environment. Primary components of the economic factors include variation in the rate of return on capital across countries, the portfolio diversification technique of investors, and the host country's market size (Anyanwu, 2011), while volatility and changes in trade liberalization and exchange rate are linked to trade and exchange market regulations (Froot & Stein, 1991). The business environment factors are linked to infrastructure, cost of labor, availability of skilled workforce, incentive factors, political risk and stability, economic and social factors, the effect of institutions, the stimulating impact of foreign aid, and macroeconomic policy certainty (Anyanwu, 2011).

3.2. Empirical Review

There are a number of empirical studies that have assessed the role of population health in the determination of FDI inflows. However, effect of infrastructure development is often reduced to a moderating role in the population health–FDI inflow nexus. Further, population health measurement has been a challenge in most studies, resulting in observed variations in its effect, hence affirming the submission by Gallup and Sachs (2001) that variations in health dimensions may exert different economic effects. Some of these studies are reviewed below.

Alsan et al. (2006) assessed the effect of population health on FDI inflows for a group of 74 low- and middle-income countries. Life expectancy was the only measure of population health in the study, while the degree of openness and infrastructure were the study's control variables. Using panel data from 1980 to 2000, and a panel ordinary least squares (POLS) approach, the study found that life expectancy significantly and positively raises the level of FDI inflows, only when the control variables were used in the model. However, the concept of population health is multidimensional in nature; therefore, the exclusive adoption of life expectancy as the sole measure of population health is deficient in portraying the much broader effect of the concept.

Azemar and Desbordes (2009) used annual panel data of 70 developing countries, including 28 Sub-Saharan African (SSA) countries, to investigate the effect of public governance and health on FDI from 1985 to 2004. The study used the POLS technique and found that life expectancy, as a proxy for population health, significantly affected FDI inflows. However, fixed telephone mainlines per capita stock, which was one of the study's control variables, inversely and substantially affected FDI inflows. Poor measurement of population health and the moderating role of infrastructure were the observed limitations of this study.

Mottaleb and Kalirajan (2010) conducted a comparative study of FDI determinants in 68 developing countries from 2005-2007. Access to internet, and fixed-line and mobile telephone users per 100 persons were used to measure infrastructure. However, the study failed to consider the significant role of population health in FDI determination.

A reverse study on the effect of FDI inflows on population health for 14 developed countries was conducted by Herzer and Nunnenkamp (2012) from 1970–2009. Similar to prior studies, life expectancy was used to measure population health. Findings from the study's dynamic POLS analysis indicated that FDI has a general inverse effect on population health in developed nations. Nagel, Herzer, and Nunnenkamp (2015) also measured the effect of FDI on population health for 179 countries from 1980–2011. Population health was measured using infant mortality rate, while life expectancy was used for robustness. The study concluded that the FDI–health relationship is non-linear due to income level. However, the adoption of a narrow definition of population health constitutes the perceived challenge in both studies.

Ghosh and Renna (2015) adopted both the POLS and 2SLS approaches in measuring the effect of communicable disease on FDI inflows in 114 countries. Life expectancy, years of life lost to communicable diseases, and age-standardized mortality rates were used as a proxy for population health. GDP per capita (measured for market size), degree of openness (measured for trade cost), and telephone lines per capita (measured for infrastructure) were used as control variables. The study concluded that life expectancy had no significant effect on FDI inflows, while communicable disease had a significant negative effect. By adopting a narrow definition of population health, the actual all-encompassing effect of the concept on FDI was obscured.

Asiedu, Jin, and Kanyama (2015) used the HIV prevalence rate to measure the effect of population health on FDI inflows in a panel study of 41 SSA countries from 1990–2008. For the empirical analysis, the study adopted the generalized method of moments (GMM) and used the degree of openness, market size, and gross fixed capital formation as a percentage of GDP (to measure infrastructure development) as control variables. In addition, the study incorporated three measures of natural resources for analysis robustness and for further verification of the claim of FDI concentration in SSA's natural resource sector. The results from the study indicated that HIV/AIDS is inversely related with FDI inflows in SSA countries. Similar to prior studies, the measure of population health was not robust and infrastructure development was restricted to a moderating role.

In a study of the human capital–economic growth nexus for 49 African countries from 1996–2000, Eggoh, Houeninvo, and Sossou (2015) used health and education indicators together as a proxy for human capital. Specifically, health spending as a share of GDP, life expectancy, and survival to 65 years as a share of cohort were used to capture population health. Gross fixed capital formation as a share of GDP (measured for investment) and FDI served as moderating variables. The study concluded that there is a slight significant positive effect of human capital on growth. Measurement error of population health and constraining infrastructure development to a moderating role were the observed limitations of the study.

A similar flaw was found in the study by Erdogan and Unver (2015), who adopted a static and dynamic panel analysis and found that population health inversely affected FDI inflows in 88 countries between 1985 and 2011. Population health was measured using health spending as a percentage of GDP, while infrastructure and market size played moderating roles in the model.

In conducting a regional comparative study of FDI determinants into Africa from 1970–2010, Anyanwu and Yameogo (2015) adopted the OLS and the GMM methods. The study consisted of 53 African countries split into five regions. Life expectancy was used as a proxy for human capital and labor force, which produced mixed results across all regions. Infrastructure (number of telephone mainlines and mobile phone users per 100 people), trade openness, natural resource wealth, GDP per capita, and market size were other independent regressors in the study with varying outcomes.

Talukdar and Parvez (2017) used an OLS model to investigate the effects of population health and education on FDI inflows in 46 developing countries, from 1996 to 2011. Similar to prior studies, life expectancy was used as a proxy for population health, while GDP per capita (market size), trade openness, and fixed telephone lines per 100 persons (proxy for infrastructure) were adopted as moderating variables. A positive significant effect of population health on FDI inflows was found by the study. Nevertheless, the study limited the robust effect of population health due to measurement error and reduced infrastructure development to a moderating role.

In the study by Abimbola and Oludiran (2018), the drivers of FDI in the West African Economic and Monetary Union (WAEMU) was examined. The study analysis was based on a panel cointegration technique between 1980 and 2010. Empirical findings from the study indicated that high market size (measured by GDP per capita), a large degree of openness, and infrastructure development positively and substantially affect FDI inflows to the region. However, the neglect of population health effect is opined by this paper as a major constraint to the study's findings.

In an attempt to extend the study by Alsan et al. (2006), Bhattacharjee (2020) used panel data of 70 middle-income countries from 1994–2014 to evaluate the effect of population longevity on FDI inflows. Three measures of

longevity were adopted, which are life expectancy and male and female survival probabilities. GDP per capita was used to control for market size and income level. Likewise, the degree of openness, mobile subscriptions per 100 people (proxy for infrastructure) and governance indicators were other control variables adopted by the study. Methodologically, the two-stage least squares (2SLS) technique was used to derive the conclusion that longevity substantially and positively affects FDI inflows. Similar to prior studies, the effect of infrastructure was limited to a moderating role, while to effectively measure population longevity, the broadened determining factors of population health should have been captured by the study.

4. DATA DESCRIPTION AND STUDY METHODOLOGY

4.1. Data Description

This study's empirical analysis utilized panel data from 40 African countries selected from the ECOWAS, COMESA, and SADC regions spanning from 1980–2017. A total of 15, 21, and 16 countries constitute the ECOWAS, the COMESA and SADC regions, respectively. However, countries dropped due to the unavailability of data are Liberia (in the ECOWAS region), and Eritrea and Somalia (in the COMESA region). It is important to note that there are countries that belong to both the COMESA and SADC regions. The list of selected countries is presented in Appendix 1. All variables were sourced from the World Bank's World Development Indicators.

FDI inflows as a share of GDP ($fdigdp$) was used as the dependent variable to assess FDI share in the aggregate economy. As noted earlier, this study improves on existing studies in the measure of population health by adopting the five previously identified components. Hence, for the health care component, the birth rate per 1000 people ($brpt$) was adopted. The reasoning is that access to better primary health care can lower infant mortality rate, which is perceived to be high in Africa. To capture the individual behavior component, life expectancy at birth (le) was adopted. Its adoption was based on the intuition that life expectancy is a function of individual behavior or lifestyle. Individual lifestyle choices or habits can be spontaneous or based on a response to incentives such as exercise, diet, lifestyle, and substance abuse, which impacts life expectancy (Aladejare, 2022c). For the social and economic environment component, the degree of openness (dop) was used. It is believed that the more open an economy is, the higher its level of interaction with other economies. The physical environment component was measured using CO_2 emissions in metric tons per capita ($copc$). Growth in carbon emissions is known to have detrimental effects on the physical environment, which comprises water, land, and air. The genetic component was measured using the population growth rate (pog). Africa is reported to have the highest fertility rate in the world, and its population is projected to grow faster than any other region over the next century. To further buttress this point, the United Nations (2019) confirmed that SSA countries have the highest fertility rate (4.6%) in the world. This is because, unlike other regions, most African countries have a relatively large number of young people, as well as less educated and working-class women due to cultural beliefs.

Three variables were used to effectively measure infrastructure development. The first is gross capital formation as a share of GDP ($gcfgdp$). This variable measures the total amount expended by public and private entities on the construction of roads, hospitals, railways, schools, commercial and industrial buildings, and land improvements. It also includes the share of inventories with businesses, which is required to satisfy unexpected volatilities in production or sales. Fixed telephone subscriptions per 100 people (fts) was also used due to its common adoption in the literature. Transportation services as a share of service imports ($trcsm$) is the third measure used. It encompasses all forms of transport services used by residents of the host country and transport equipment repairs and maintenance. Having a developed and efficient transportation system is expected to make a country attractive to foreign investors. These measures are considered an improvement to empirical studies, where the effects from infrastructure development are subsumed only as control measures in population health–FDI studies.

Similar to empirical studies on FDI determinants, the GDP per capita growth rate ($gdppg$) was used to control for market size growth rate, or the growth rate of the absorptive power of the economy. Having a large and

continuously growing domestic market suggests a growing demand for goods and services capable of attracting foreign investors to the host country. However, empirical studies have been able to establish a non-monotonic GDP per capita–FDI inflow nexus for Africa. That is, it is likely that a certain threshold needs to be attained before either a positive or negative effect of market size on FDI inflows can be realized. For this purpose, the square of GDP per capita growth rate was also used. Total natural resource rent as a share of GDP ($nrgdp$) was used to control for natural resource intensity in African economies. Total natural resource rents are composed of all accrued rents from oil, natural gas, coal (hard and soft), minerals, and forests, since FDI in most African countries is suggested to be concentrated in natural resources (Anyanwu, 2011; Asiedu et al., 2015). Furthermore, the lag of FDI as a share of GDP is also included as a control measure, since FDI decisions may be based on historical information.

4.2. Methodology

Empirical studies have adopted different procedures in extracting exclusively long-run coefficients in multivariate analyses. Common among these estimators are the OLS, fully modified OLS (FMOLS) and the dynamic ordinary least squares (DOLS). However, Pedroni (2001) noted that the OLS approach is subject to second order asymptotic bias and serial correlation challenges. In addition, the procedure tends to yield bias estimates when dealing with small sample sizes. Both the FMOLS (Phillips & Moon, 1999) and the DOLS (Stock & Watson, 1993) correct for the deficiencies in the OLS and hence are considered more robust procedures. Furthermore, both the FMOLS and DOLS methods are based on the white heteroskedastic standard errors. However, the DOLS is parametric in nature, while the FMOLS is non-parametric. This study adopts the DOLS procedure because of the additional estimation restrictions posed by the FMOLS. One condition of the FMOLS estimator is that all variables must be integrated of the same order (Masih & Masih, 1996). Further, the DOLS is better enabled to deal with endogeneity or simultaneity bias in a model since it can regress any I(1) variable on other I(1) or I(0) variables and leads and lags of the first differences of any I(1) variables. Thus, the panel DOLS (PDOLS) representation of this study is presented as follows:

$$
\begin{aligned}
fdigdp_{i,t} = {} & \propto_i + \beta_{1i} brpt_{i,t} + \beta_{2i} le_{i,t} + \beta_{3i} dop_{i,t} + \beta_{4i} copc_{i,t} + \beta_{5i} pog_{i,t} + \beta_{6i} gcfgdp_{i,t} + \beta_{7i} fts_{i,t} + \beta_{8i} trcsm_{i,t} \\
& + \beta_{9i} gdppg_{i,t} + \beta_{10i} gdppg_{i,t}^2 + \beta_{11i} nrgdp_{i,t} + \beta_{12i} fdigdp_{i,t-1} + \sum_{k=-K_i}^{K_i} \gamma_{i,t}\, brpt_{i,t-k} \\
& + \sum_{k=-K_i}^{K_i} \delta_{i,t}\, \Delta le_{i,t-k} + \sum_{k=-K_i}^{K_i} \tau_{i,t}\, \Delta dop_{i,t-k} + \sum_{k=-K_i}^{K_i} \otimes_{i,t} \Delta copc_{i,t-k} + \sum_{k=-K_i}^{K_i} \Omega_{i,t}\, \Delta pog_{i,t-k} \\
& + \sum_{k=-K_i}^{K_i} \mathbb{\Gamma}_{i,t}\, \Delta gcfgdp_{i,t-k} + \sum_{k=-K_i}^{K_i} \aleph_{i,t}\, \Delta fts_{i,t-k} + \sum_{k=-K_i}^{K_i} \lambda_{i,t}\, \Delta trcsm_{i,t-k} + \sum_{k=-K_i}^{K_i} \theta_{i,t}\, \Delta gdppg_{i,t-k} \\
& + \sum_{k=-K_i}^{K_i} \vartheta_{i,t}\, \Delta gdppg_{i,t-k}^2 + \sum_{k=-K_i}^{K_i} \pi_{i,t}\, \Delta nrgdp_{i,t-k} + \sum_{k=-K_i}^{K_i} \rho_{i,t}\, \Delta fdigdp_{i,t-1} \\
& + \varepsilon_{i,t} \qquad (1)
\end{aligned}
$$

Where all variables remain as previously defined, and $-K_i$ and K_i denote the lags and leads respectively, while the PDOLS estimation for each regressor can be built up as follows:

$$\hat{\beta}_{brptDOLS} = I^{-1} \sum_{i=1}^{I} \hat{\beta}_{DOLS,i} \qquad (2)$$

where $\hat{\beta}_{DOLS,i}$ is the DOLS estimator applied to cross-section i.

5. EMPIRICAL ANALYSIS

5.1. Preliminary Tests

Some of the findings from the descriptive statistics test, as shown in Table 2, reveal that the average $fdigdp$ in the selected African countries is about 2.6%, and the highest country value is about 57.8%. The average life expectancy is approximately 56 years, and the maximum country value is approximately 76 years. The average $gcfgdp$ is approximately 21%, and the highest country value is about 89%. Table 3 shows the correlation test with evidence of less multicollinearity between the study variables. However, the observed (positive/negative) correlations above the 0.50 benchmark were mainly due to the use of population data for normalization.

Table 2. Full sample summary statistics (40 countries).

Variables	Obs.	Mean	Standard deviation	Minimum	Maximum
Fdigdp	1462	2.635	4.538	-28.624	57.838
Brpt	1520	38.697	9.213	10.100	56.688
Le	1520	55.772	8.532	27.610	75.943
Dop	1470	64.067	33.463	4.136	225.023
Copc	1383	1.010	3.190	0.000	9.998
Pog	1520	2.482	1.060	-6.766	8.118
Gcfgdp	1450	20.931	9.813	-2.424	89.381
Fts	1513	2.806	5.233	0.000	32.653
Trcsm	1409	48.070	17.610	2.578	89.692
Gdppg	1520	1.372	7.207	-70.053	121.780
Nrgdp	1489	9.645	9.551	0.000	68.778

Table 3. Correlation matrix of variables.

Variables	fdigdp	brpt	le	dop	copc	pog	gcfgdp	fts	trcsm	gdppg	nrgdp
fdigdp	1										
brpt	-0.222	1									
le	0.195	-0.739	1								
dop	0.295	-0.427	0.435	1							
copc	0.058	-0.470	0.422	0.234	1						
pog	-0.100	0.517	-0.208	-0.229	-0.303	1					
gcfgdp	0.384	-0.244	0.274	0.260	0.089	-0.097	1				
fts	0.206	-0.710	0.639	0.490	0.617	-0.482	0.185	1			
trcsm	-0.195	0.246	-0.037	-0.223	-0.160	0.250	-0.263	-0.192	1		
gdppg	0.139	-0.224	0.183	0.175	0.044	-0.152	0.178	0.120	-0.130	1	
nrgdp	0.014	0.190	-0.168	-0.120	0.057	0.165	-0.032	-0.200	-0.058	0.008	1

Table 4 presents the results of the panel unit root tests conducted on all study variables. Four panel unit root tests were adopted, the Levin, Lin and Chu (LLC) test, two Fisher-type tests based on the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests, and the Im, Pesaran, and Shin (IPS) test. Evidence from the output shows that the dependent variable $fdigdp$ is integrated of order 1, as the DOLS estimator requires, while the regressors attain stationarity at I(0) and I(1).

Table 4. Unit root test results.

Variables	LLC	Fisher–ADF	Fisher–PP	IPS W-stat
fdigdp	-4.054***b	174.287***b	280.927***b	-6.085***b
brpt	-9.130***a	229.387***a	128.064***b	-4.464***a
le	-21.276***a	465.061***a	155.549***a	-24.204***a
dop	-2.405***a	117.634***a	138.803***a	-2.405***a
copc	-8.648***b	433.764***b	114.643***b	-16.267***b
pog	-13.921***a	495.097***a	135.799***a	-17.894***a
gcfgdp	-3.356***a	116.430***a	151.183***a	-2.390***a
fts	-10.192***b	368.959***b	650.413***b	-13.797***b
trcsm	-4.929***a	189.775***a	206.158***a	-6.292***a
gdppg	-8.885***a	446.888***a	806.811***a	-16.860***a
nrgdp	-3.858***a	141.902***a	178.302***a	-4.473***a

Note: a and b represent stationarity at level and at first difference, respectively, while *** indicates statistical significance at 1%.

Since the order of integration of the variables has been established, a cointegration test was further conducted to determine if the variables co-move in the long-term. For this purpose, the Kao residual-based cointegration test was applied. The output in Table 5 reveals that the null hypothesis of no cointegration is rejected at the 1% significance level; hence, the variables used in the study co-move in the long term.

Table 5. Kao residual cointegration test.

Null Hypothesis: No cointegration		
Test statistic	**t-Statistic**	**Prob.**
ADF	-3.087	0.001***
Residual variance	13.185	
HAC variance	6.126	

Note: *** indicates statistical significance at 1%.

5.2. PDOLS Output Discussions

Table 6 presents the estimated results for the PDOLS regressions. Column 1 captures the output for all selected African countries, while outputs for the ECOWAS, COMESA and SADC regions are captured in columns 2, 3, and 4, respectively.

Analyzing the significance of the various components of population health shows that health care ($brpt$) has a substantial inverse effect on FDI inflows to the full sample, as well as to the ECOWAS and SADC regions. However, its effect on the COMESA region is insignificant, suggesting that a fall in the quality of and access to health care motivates FDI flows. Individual behavior (le) is revealed to have no significant effect on FDI inflows either to the full sample or each individual region. This contradicts empirical studies, especially on Africa, that have reported significant effects of life expectancy on FDI. The measure for social and economic environment (dop) is definitely positive for the individual regions as well as the full sample, indicating that the more open African markets are to the international market, the greater the inflow of FDI. On the other hand, the physical environment component ($copc$) has a substantial inverse effect on FDI inflows to the full sample and the ECOWAS region, but an insignificant effect on the COMESA and SADC regions. The inference from this outcome indicates that poor environmental conditions will not attract FDI inflows to Africa, especially to the ECOWAS region (judging from the coefficient size). For the genetic component (pog), the effect is revealed to be significant only for the ECOWAS region. This shows that peculiar genetic traits in the ECOWAS region could help attract the much-needed inflows of FDI.

Infrastructure development, gross capital formation and fixed telephone subscriptions had significant positive effects on FDI inflows for the full sample and the ECOWAS and COMESA regions, inferring that growth in FDI flows to these regions are strictly a positive function of infrastructure development. However, for the SADC region, gross capital formation and transportation services showed substantial positive and inverse effects. This outcome suggests that infrastructure development may have a neutral effect on FDI inflows in the SADC region. Hence, foreign investors may not be too critical of the level of infrastructure development in the region when considering investment decisions.

With respect to the control variables, market size ($gdppg$) is revealed to have significant effect on FDI inflows to the full sample and the ECOWAS region, suggesting that the large market size of the ECOWAS, and Africa in general, is capable of attracting more FDI inflows. However, the quadratic term is significantly inverse only for the full sample, providing evidence that an inverted U-shaped GDP per capita–FDI inflow nexus exists generally for the African region, against the U-shape reported in empirical studies (such as (Anyanwu & Yameogo, 2015; Asiedu et al., 2015)). This result shows that although foreign investors are attracted by Africa's large market size, the effect cannot be taken to be constant. Rather, for growth in GDP per capita above a certain threshold, FDI flows to Africa will reduce because, apart from foreign investors' motives of gaining market power, reducing transaction costs and increasing their access to resources, they also consider legitimacy issues and how to compete before entering a foreign market (Chan, Makino, & Isobe, 2006). For instance, a foreign firm trying to break into the African market for its

product will have profit and efficiency as its primary aims. However, because the firm is new in the market, it will want to copy the legitimate organizational style of existing firms in that particular market to guarantee its survival.

For the natural resource intensity measure, FDI flows to the ECOWAS, and to Africa as a whole, are motivated by the level of natural resource intensity, indicating that the decline in demand for their natural wealth due to health pandemics, such as the coronavirus, will limit their inflows of resource-seeking FDI. However, growth in natural resource intensity in the SADC region significantly diminishes its FDI inflows, which could signify growth in the flows of knowledge-seeking FDI to the region. Furthermore, estimates for lagged FDIGDP has a substantial positive effect on FDI inflows to the three regions, as well as for the overall sample, suggesting that foreign investors consider prior FDI inflows significant when deciding on current foreign investment inflows. This outcome further lends credence to the inverted U-shaped hypothesis confirmed in this paper.

Table 6. PDOLS estimated output.

Variables	Full Sample	ECOWAS	COMESA	SADC
Population Health Variables				
$brpt$	-0.010**	-0.040***	-0.032	-0.090**
le	-0.003	-0.001	0.019	0.025
dop	0.006***	0.015***	0.029***	0.037***
$copc$	-0.114***	-1.248***	-0.414	-0.243
pog	0.011	0.378**	-0.045	0.003
Infrastructural Development Variables				
$gcfgdp$	0.042***	0.024***	0.049**	0.060***
fts	0.065***	0.238***	0.093**	0.010
$trcsm$	-0.001	-5.51E-07	0.006	-0.035***
Control Variables				
$gdppg$	0.021**	0.035*	0.004	-0.002
$gdppg^2$	-0.001*	-0.0002	-0.001	-0.003
$nrgdp$	0.012**	0.050***	0.007	-0.078*
$fdigdp_{t-1}$	0.603***	0.426***	0.342***	0.339***
$Adj.R^2$	0.46	0.39	0.46	0.45
Cross-sections	40	14	19	16
No. of Obs.	1194	444	544	455

Note: *, ** and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 7. PDOLS robustness check estimated output.

Variables	Full Sample	ECOWAS	COMESA	SADC
Population Health Variables				
$brpt$	-0.010**	-0.035**	-0.034	-0.092**
le	-0.002	0.008	0.016	0.025
dop	0.007***	0.016***	0.030***	0.029***
$copc$	-0.116***	-1.393***	-0.430	-0.328
pog	0.013	0.319*	-0.041	0.014
Infrastructural Development Variables				
$gcfgdp$	0.044***	0.031***	0.051**	0.055**
fts	0.077***	0.143**	0.097***	0.022
$trcsm$	-0.001	-0.006	0.006	-0.030***
Control Variables				
$gdppg$	0.025**	0.039**	0.005	0.006
$gdppg^2$	-0.001*	-0.001	-0.001	-0.003
$fdigdp_{t-1}$	0.574***	0.491***	0.341***	0.353***
$Adj.R^2$	0.46	0.40	0.46	0.45
Cross-sections	40	14	19	16
No. of Obs.	1194	444	544	455

Note: *, ** and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

5.3. Robustness Regressions

To check if the estimated outputs in Table 6 are valid or robust, the measure for natural resource intensity in African countries was removed and the PDOLS model re-estimated. Table 7 reports the output of the robust regressions, and the results show no significant deviation from what was obtained in Table 6. As expected, all variables remained rightly signed with slight differences in their coefficient size and level of significance. Hence the conclusion that the inferences drawn in this paper are valid.

6. CONCLUDING REMARKS

This paper examined the effect of population health and infrastructure development on FDI inflows to Africa. Furthermore, a comparative study was conducted of the three biggest regions, or trade blocs, which are the ECOWAS, COMESA, and SADC regions. The essence was to determine which region is most and least preferred by foreign investors, and why. A panel dynamic OLS approach was adopted for 40 countries drawn from the three regions, from 1980 to 2017. Unlike previous empirical population health studies, the multidimensional effects of population health on FDI inflows were examined. Empirical findings from the study show that population health has a significant effect on FDI inflows to Africa, with the effect being strong in the ECOWAS region and weak in the COMESA and SADC regions. However, infrastructure development was found to be a major determinant of FDI flows to Africa and the three regions examined, thus suggesting that while foreign investors consider infrastructure development as key for investment in the three regions, population health is considered on an aggregate level and by ECOWAS foreign investors. This could be the reason for the higher FDI inflows to the COMESA and SADC regions ahead of the ECOWAS for close to two decades as observed by this study. Hence, in the event of health pandemics, such as the coronavirus, future flows of FDI to Africa, and particularly to the ECOWAS, is dependent on the success of both the population health and economic policy measures adopted.

It was also discovered that, although foreign investors are attracted by Africa's large market size, the effect cannot be taken to be constant since foreign investors also consider other factors such as legitimacy, competitiveness, and previous FDI inflows along with profitability and market efficiency. Therefore, this could be the factor for the lack of interest in African markets over the years by foreign investors. Furthermore, the disruption from health pandemics in the production of primary goods in resource-reliant African countries could cause some multinational firms to re-evaluate the future location and sectoral spread of their operations in the region. They could further reduce their future supply channels by closing the gap with their clients. Furthermore, multinational firms in the ECOWAS region may choose to diversify their supplier channels for the purpose of increasing their recovery from location-specific volatilities. Such measures may take the form of divestments from countries considered highly susceptible to health pandemics to expansion in other countries considered less volatile. However, with the health and economic challenges posed by the coronavirus pandemic anticipated to drive future growth in health care and ICT sectors, the SADC region may witness increasing flows in knowledge-seeking FDI than the two other regions in the future.

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Appendix 1. List of study countries by region.

ECOWAS	COMESA	SADC
Benin	Burundi	Angola
Burkina Faso	Comoros	Botswana
Cape Verde	D.R. Congo	Comoros
Cote d'Ivoire	Djibouti	D. R. Congo
Ghana	Egypt	Lesotho
Guinea	Ethiopia	Madagascar
Guinea-Bissau	Kenya	Malawi
Mali	Libya	Mauritius
Niger	Madagascar	Mozambique
Nigeria	Malawi	Namibia
Senegal	Mauritius	Seychelles

ECOWAS	COMESA	SADC
Sierra Leone	Rwanda	South Africa
The Gambia	Seychelles	Swaziland
Togo	Sudan	Tanzania
	Swaziland	Zambia
	Tunisia	Zimbabwe
	Uganda	
	Zambia	
	Zimbabwe	