PHD DISSERTATION

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ANALYSIS OF URBAN AGGLOMERATION AND REGIONAL ECONOMIC PERFORMANCE IN SUB-SAHARAN AFRICA

PhD Dissertation

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DECLARATION AND APPROVAL

Candidate's Declaration

I hereby declare that all sections and contents of this PhD thesis are my original work and have not been presented or used to award any diploma or conferment of a degree in this university or any other institution of higher learning. All the books, journal articles, and organizational websites have been correctly acknowledged through in-text citations and reference listing.

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DEDICATION

I dedicate this thesis work to several categories of people. First, I would like to dedicate this work to my late grandfather, Mr. Jackson Marama, who passed on while I was away from home. Despite his old age, he pushed my mother to make sure that I attain academic excellence no matter what. Secondly, I would like to dedicate this thesis work to my beloved aunt, Mrs. Dinah Marama Kanai, who passed on in my absence. Her immense counsel shaped my view on education. Thirdly, I dedicate this work to my late uncle, Mr. Mulinge, who died while I was away. His charisma and protection while growing up shaped who I have become today. Lastly, I dedicate this work to all struggling children from disadvantaged households in Mt. Elgon following forced displacements by the SLDF militia group that not only deprived them of education but also left them with unforgettable memories of atrocities committed against young girls, innocent women and older people through maiming and forced early marriages.

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LIST OF PUBLICATIONS

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International Conference Presentations

1. **Maker. I. J.** (2023). Socioeconomic and Poverty Vulnerabilities Among Urban Refugees in Kenya During COVID-19 Pandemic. AERC-World Bank Kenya Analytical Program on Forced Displacement Inception Workshop 13-16 June 2023, Mercure Hotel, Nairobi, Kenya.
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ABSTRACT

Urban agglomeration in several developing economies is essentially steadfast, accompanied by steady urban population growth, which impacts the general regional economic performance and human well-being of urban dwellers. Most Sub-Saharan African cities are becoming populous due to the perceived better opportunities and ideal living standards in major metropolitan regions. However, the new urban economics literature offers conflicting theoretical sustenance for industry-led economic development, which causes a positive agglomeration link between the urban population share, economic activity, and general human well-being in developing regions. This debate is vital for Sub-Saharan African countries, where urbanization is stirring.

The study aimed to determine the nexus between urban agglomeration and regional economic performance. Specifically, the study sought to determine the relationship between urban agglomeration and regional economic performance, the relationship between urban agglomeration and income inequality, and the relationship between urban infrastructural service accessibility and regional human well-being in Sub-Saharan Africa. By employing Pooled Ordinary Least Squares (OLS), Fixed Effect (FE), Random Effect (RE), Discroll-Kraay Fixed Effect, Difference Generalized Method of Moments (Difference-GMM), System Generalized Method of Moments (System GMM), Two-Step Instrumental Variable Generalized Method of Moments (2SIV-GMM), and Two-Stage Least Squares (TSLS)estimation techniques, the study analyzed the relationships for 22 Sub-Saharan Africa countries using panel data spanning from 2000 to 2020. The empirical analyses are explored in three chapters addressing each objective.

The first chapter in the empirical analysis investigates the relationship between urban agglomeration and regional economic performance. The chapter first evaluates the evolution of urban agglomeration from 2000 to 2020 in 66 economies sampled from Asia, Europe, and Sub-Saharan Africa and the extent to which urban agglomeration influences economic performance. It targets to overcome the shortcomings of the existing empirical literature by constructing a more nuanced measure of urban agglomeration, following the Herfindahl-Hirschman-Indices (HHI) calculation, which captures nations' urban demographic structure more robustly compared to indicators that have been used hitherto. The findings point out that urban agglomeration has, on average, declined across world economies against the long-

held notion of an increasing trend. Regarding the effects of urban agglomeration, the System GMM findings show a significant deleterious effect of urban agglomeration on economic performance in developing economies (Asia and SSA) and a beneficial effect in developed economies (Europe). However, the effect is beneficial depending on the urban specificities—urban infrastructure. Based on the findings, we conclude that the relationship between urban agglomeration and economic performance is country-specific. This chapter professes that country-specific policy frameworks, industrialization, and governance effectiveness in urban infrastructural development can augment the growth-enhancing effects of urban agglomeration.

The second chapter of the research addresses whether there is a significant non-linear relationship between urban agglomeration and income inequality. The study applied a dynamic panel model, following an inverted U-shaped Kuznets Hypothesis and balanced panel data for 22 countries from 2000 to 2020. The findings reveal a non-linear relationship between urban agglomeration and income inequality in Sub-Saharan Africa. Based on the findings, we conclude that income inequality rises with urban agglomeration in the first stage and declines in the later stages of urbanization. The findings indicate that enhanced governance capacity in providing urban infrastructural investment, industrialization, and opening up the peri-urban connecting rural regions through public-private development partnerships can help shorten the urbanization-driven income inequality inverted U-shaped Kuznets' turning point in the Sub-Saharan African region.

In the third chapter of the empirical research, we interrogate whether the quality of urban infrastructural service accessibility matters and how urban governance influences the link between urban infrastructure and human well-being using balanced panel data from 2000 to 2020 from 22 Sub-Saharan African countries. The System Generalized Method of Moments (Sys-GMM) findings show a significant positive link between urban infrastructural service accessibility and human well-being. Regarding the role of urban governance, Panel Fixed Effect-Instrumental Variable (FE-IV) findings indicate a significant negative effect of urban governance and its interaction with the urban infrastructure (proxied by electricity) on human well-being. Further, urban agglomeration is found to have a long, robust set of controls, from specification to different estimation techniques. Conclusively, effective

government policies influence higher levels of human well-being in regions with large urban agglomerations.

Keywords: Urban Agglomeration; Urban Infrastructure; Income Inequality; Economic Performance; Herfindahl-Hirschman-Index (HHI); Dynamic Model; Sub-Saharan Africa.

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LIST OF ACRONYMS AND ABBREVIATIONS

AfDB:	African Development Bank
AICID:	Africa Infrastructure Country Diagnostic
ALC:	Agglomeration Life Cycle
EA:	East Asia
EAT:	Evolutionary Agglomeration Theory
EU:	European Union
FE:	Fixed Effect
FE-IV:	Fixed Effect-Instrumental Variable
GDP:	Gross Domestic Product
GMM:	Generalized Method of Moments
HDI:	Human Development Index
HHI:	Herfindahl-Hirschman-Index
MCMC:	Markov Chain Monte Carlo
NEG:	New Economic Geography
OLS:	Ordinary Least Squares
RE:	Random Effect
RUP:	Rural Population
SSA:	Sub-Saharan Africa
SWIID:	Standardized World Income Inequality Database
UAG:	Urban Agglomeration Growth
UN:	United Nations
UNDESA:	United Nations Department of Social and Economic Affairs
URP:	Urban Population
WB:	World Bank
WDI:	World Development Indicators
WEF:	World Economic Forum

1. BACKGROUND OF THE STUDY

In this section, the dimension of the thesis is set by elaborating on the fundamental motivation of the study. The chapter consists of the actuality and justification of the topical research issues, which uncovers the existing research problem. Also, the chapter entails the research topic, objectives, conceptual framework, and the hypothesis setting of the study. Lastly, the chapter ends by summarizing the structure of the thesis.

1.1 Actuality and Justification of the Research Topic (Research Problem)

Urbanization is a valuable outcome of regional economic performance (Zheng et al., 2020). As nations develop, the urban share of the population in urban regions increases because a more extensive section of their total population shift from the perceived underdeveloped rural areas to the perceived developed urban areas full of economic opportunities such as employment, better income, and quality accessibility of social infrastructure such as water, sanitation, and energy (Kuznets, 1955; Castells-Quintana, 2018). Thus, the urban regions are deemed a critical prospective force in reflecting human prosperity and sustained economic performance as they contribute to consumption, innovation, and investment in developed and developing economies (Ikwuyatum, 2016; Moreno, 2017; Xue et al., 2020). As such, urban agglomeration in developing regions has been rising tremendously due to the increasing rural-urban influx of people in the urban areas searching for prosperity and a good life (Ikwuyatum, 2016).

Although the increase in urbanization is seen as a significant contributor to regional economic performance, there is still a hotly contested debate in the literature regarding the connection between urban agglomeration and economic performance in different contexts (Xue et al., 2020). On the one hand, some authors argue that the drift of population from rural to urban areas results in a commendable economic performance and a continuous urban opening in cities' agglomeration (Ahrend & Schumann, 2017; Song et al., 2019). On the other hand, other scholars posit that increased population entry into urban regions pauses great negative outcomes on economic performance, which impedes urban agglomeration as indicated by greater inequality in terms of urban living standards (Chong et al., 2016; Li et al., 2019; Tripathi & Kaur, 2017; Ferreira et al., 2016).

An urban agglomeration is defined as a spatial population within the demarcation of the adjacent region inhabited at the urban density level, regardless of the administrative boundaries (Han & Liu, 2018; Moreno, 2017). It refers to integrating the suburban areas within a given urban territory (UNICEF, 2012; World Bank, 2019). Although there has been a continuous improvement in the definition and delineation of the term urban agglomeration, there have been mounting controversies, especially regarding the geographical space and the share of urban population size to measure urban agglomeration. More recently, scholars have linked it with urbanization and equally viewed it as integrating sub-cities to form a major, spatially, vastly, and compact city of more than 1 million people (Fang & Yu, 2017; World Bank, 2019). Subtly, urban agglomeration comprises one big city promoting regional development through accelerating the flow of factors of production and advancing the scale of labor division and specialization (Zhen et al., 2017). The adjacent small and medium-sized cities become embedded in the agglomeration network supported by the central city to realize function borrowing through information connectivity, resource sharing, and industrial productivity (Han & Liu, 2018). The continuous urban agglomeration networks promote internal economic productivity, which leads to a coordinated state and dynamics of development of the region (Li et al., 2019).

In most developing regions, such as Sub-Saharan Africa, the growing share of the rural population has been declining relative to that of the urban share of the population due to the increase in rural-urban drift propensities in the quest to have an economically worthwhile standard of living (Bloch et al., 2015; UNDESA, 2018). Also, the lack of sufficient infrastructural drivers of economic opportunities in rural regions has been identified to be fueling the rural-urban migration and subsequent urban agglomeration pressures on limited urban economic opportunities and urban infrastructural service accessibility quality (Bloch et al., 2015; UN-Habitat, 2017; McPhearson et al., 2018). Continuous rural-urban migration not only accelerates the growth of urban agglomeration but also poses socio-economic challenges such as limited housing, energy, water, and sanitation infrastructural services, high crime rate, high unemployment rate, and retarded economic development as well as undesirable human well-being (Wei et al., 2017; Li et al., 2019; Liddle & Messinis, 2015; UN-Habitat, 2020; UNDESA, 2018).

Bourgeoning urbanization and subsequent urban agglomeration (unregulated concentration of people in urban regions) increases the uncontainable widening variation of income, retarded economic resources, and undesirable human well-being levels across different rural and urban areas (Bavier, 2018; Grafakos et al., 2019; Hardoon et al., 2016; Liddle, 2017; Tripathi & Kaur, 2017). In line with this conjecture, it is projected that by 2050, more than two-thirds of the world's population will be urban, with many living in informal and unplanned settlements and growing cities in regions such as Sub-Saharan Africa and Asia (UNDESA, 2018). Between 2015 and 2020, the global population grew by 397 million persons, with over 90% of the growth occurring in less-developing regions such as Sub-Saharan Africa (UNDESA, 2018). Most of these rising urban population growth rates are exceptionally pronounced in small and medium-sized city settlements of about 1 million people (UNDESA, 2018). Specifically, over 50% of Sub-Saharan Africa's population is projected to live in cities by 2050 (World Bank, 2015; World Bank, 2019). This is identifiable in the recent urban population growth trends, which have been rising gradually over recent decades. For instance, the urban population increased from 7.7 million in 1970 to 9.69 million in 1980 and 11.66 million in 1990 to 13.09 million in 2000. This trend has continued further, with an increase from 14.35 million people in 2010 to over 17.97 million people in 2022, with a positive propensity to increase to approximately 1.5 billion people by 2050 (Bavier, 2018; Grafakos et al., 2019; UNDESA, 2018; World Bank, 2022).

The sudden and unregulated upsurge in urban agglomeration preceding rapid urbanization presents conflicting outcomes in economic and human well-being in developing regions such as Sub-Saharan Africa (UN-Habitat, 2017). On the one hand, it leads to positive economic outcomes such as increased regional economic performance resulting from an increased labor supply pool, specialization, productive human capital, and proximity to urban industries (Ahrend et al., 2017). On the other hand, it leads to deleterious outcomes such as increased income inequality, urban poverty, and an increased share of the urban population living in slums and dilapidated urban settlements with inadequate access to urban infrastructural services such as water, sanitation, waste management, energy, and employment opportunities, hence impacting negatively on the overall human well-being and urban livability (Li et al., 2019; Liddle & Messinis, 2015; UN-Habitat, 2017a).

Notwithstanding the recently recorded regional economic growth and bursting urban agglomeration growth in Sub-Saharan Africa, general regional economic performance and human well-being attributed to urban agglomeration seem to be growing in the opposite direction in major Sub-Saharan African urban regions (Manteaw, 2020). Although the area is experiencing a massive rural-urban population drift, the occasioned regional economic performance attributed to the agglomeration of skilled labor in the urban region's industries is growing at a low pace (United Nations Population Division, 2018). The economic performance measured by the gross domestic product (GDP) growth averaged below 6% of the annual growth rate of urban agglomeration between 2000 and 2020 (World Bank, 2022). However, income inequality appears to have risen with urban agglomeration. In particular, the Gini coefficient, which depicts the distribution of income and the ng standards, has been increasing rapidly in recent decades (UN-Habitat, 2010). For instance, the income inequality in Sub-Saharan Africa averaged above 0.65 between 2000 and 2020 (Standardized World Income Inequality Database, 2022).

Whereas Sub-Saharan Africa has been experiencing better economic growth in recent decades, sustaining long-term economic performance is a figment without adequate urban structural adjustments (Goodfellow, 2020). Appreciably, no region can gain successful economic performance without undergoing the urbanization process. However, this can only bear fruits if urban regions are positioned as strategic economic hubs (Center for Strategic and International Studies, 2018). Revising regional policies and individual countries' policies related to interstate systems and building the regional capacity for managing urbanization are the main elements of sustainable economic performance. Investing in urban infrastructure, empowering local governments to deliver adequate social amenities, and tying them to national economic agendas and regional regulatory framework is the surest way of achieving ideal regional economic performance (Farrell, 2018). This requires concerted efforts by stakeholders such as urban planners, external donors of capital goods, city governments, development practitioners, and the private sector. Linking the concerted development efforts of different stakeholders presents the Sub-Saharan African region with an opportunity for a successful economic performance, given its immense demographic transitions (Center for Strategic and International Studies, 2018).

Furthermore, the urban infrastructure in Sub-Saharan Africa has encountered severe pressure from the rising urban agglomeration, hence rendering over 50% of the urban agglomeration in the acute proliferation of slums with limited access to better housing, water, sanitation, transport, and telecommunication infrastructural services (World Bank, 2022; Tuholske et al., 2020). While the infrastructural gap has been identified as significant in the region, some efforts have been made in recent years. Yet, there seems to be increasing income inequality and poverty levels in urban areas. Notably, this is due to the increasing urban agglomeration in Sub-Saharan Africa, which is much faster than urban infrastructure development and economic opportunities (Goodfellow, 2020; Lawhon et al., 2018). Also, the rising of small and mid-sized cities, annexation, and reclassification of previous rural regions as part of the central urban regions have been the major contributing factors to unplanned urban infrastructure in Sub-Saharan Africa (Güneralp et al., 2020). Partly, this is also contributed by urban governance mismanagement, lack of sufficient financial resources, and overlapping functions of the urban institutions, leading to the overall retarded per capita GDP growth, unsuitable investment, decreasing productivity, and undesirable levels of human well-being (World Bank, 2020; Güneralp et al., 2020).

Although Sub-Saharan Africa's urban infrastructure development trends appear to be meeting the needs of urban people and are similar to those of other rapidly expanding regions, it is essential to note that the driving factors for it differ expressively from those of the developed economies and other developing economies such as China (Güneralp et al., 2017; Pieterse, 2019). For instance, urban infrastructural service accessibility disparities are attributed to incoherent resource distribution, lack of adequate financial capacity, technical management, and urban governance mishaps in enhancing the complementariness between the urban and rural infrastructural development and resulting in imprudent fiscal decentralization and economic performance of the metropolitan regions (Behuria et al., 2017; Lawhon et al., 2018). For instance, Sub-Saharan Africa has invested approximately $26 billion annually in infrastructural development such as water, sanitation, transport, energy, and telecommunication, with 30% of this going to the national governments. In comparison, 50% and 20% have served urban and rural regions correspondingly in the last two decades (African Development Bank, 2016; Andrei et al., 2019; Simon, 2016). With positive urban population growth prospects, Sub-Saharan African cities would be required to execute unprecedented urban expansions with very few financial resources (Shi, 2019). Yet still, the region is facing a financing shortfall of between $68 to $108 billion (World Economic Forum, 2018). Ideally, two-thirds of the spending on the urban infrastructure required by 2050 is yet to be realized (World Economic Forum, 2018). Further complicating matters, most of the present urban financing is from the public sector due to regulatory and governance instability, which deters the private sector capital. The total capital investment in Sub-Saharan Africa from 1980 to 2011 averaged a paltry 20% of the region's GDP as contrasted to 40% of the GDP in the East Asian case during the same period of rapid urbanization (WEF, 2018).

Whether or not rising urban agglomeration is related to regional economic performance, income inequality, and urban infrastructure remains the puzzling question in this study. In line with the Agglomeration Life Cycle Theory, the Inverted U-shaped Kuznets Hypothesis, and the Theory of Good City Form, this dissertation sought to determine the relationship between urban agglomeration and regional economic performance, the relationship between urban agglomeration and income inequality, and the relationship between urban infrastructural service accessibility and regional human well-being. Agglomeration Life Cycle Theory considers the probability of exploiting economies of scale in local services and products through internal labor division and specialization resulting from the available large labor force pool (urban agglomeration) (Krugman, 1991; Camagni, 2016). The inverted U-shaped Kuznets hypothesis considers urban agglomeration and urbanization crucial in rearranging the developing economies dichotomized by a rural subsistence sector and an industrializing urban sector; hence, rural-urban population drift is a significant dimension of the regional economic processes such as income distribution and urban demographic transitions (Kuznets, 1955). The Theory of Good City Form considers various distinct extents of the urban statuses significant to infrastructural service accessibility and livable cities as the critical path toward better regional human well-being (Lynch, 1984; Cave & Wagner, 2018). Although the theory postulates several dimensions, for the context of this study, (vitality and access) dimensions are considered to evaluate whether there exists a link between urban infrastructural service accessibility quality and regional human well-being (Krugman, 1991; Camagni, 2016; Cave & Wagner, 2018).

Despite the glaring evidence of theoretical relationships between the variables, the empirical literature has no exhaustive clarity of arguments. For instance, studies conducted in developed regions display different findings from those undertaken in developing areas (Frick & Rodriquez-Pose, 2018). Also, a strand of literature focusing on the country level has observed strong negative and positive relationships between urban agglomeration and regional economic performance (Castells-Quintana, 2017; Fang &Yu, 2017; Frick & Rodriquez-Pose, 2018; Tumbe, 2016). In consonance with this empirical observation, some scholars have empirically observed that the linkage between urban agglomeration and income inequality could either be linear, non-linear, negative, or positive (Arouri et al., 2017; Liddle, 2017; Siddique et al., 2014; Wu & Rao, 2017). Moreover, regarding the connection between urban infrastructural service accessibility and regional human well-being, most of the studies have followed the subjective approach where regional human well-being has been measured by self-reporting and emotional feelings indicators such as the Organization for Economic Co-operation and Development's Better Life Index about urban life (Mercer, 1999; Malonado et al., 2016; Truelove, 2019; Das et al., 2022).

Inspired by the recent limited but considerably growing literature strand that is shifting the research attention to the regional level (Castells-Quintana et al., 2015; Li & Liu, 2018; Pitkey & Zucman, 2015; Li et al., 2019), and literature strand focusing on Sub-Saharan Africa (Adams & Klobodu, 2019; Asogwa et al., 2020; Bocquier, 2017; Bryceson, 2014; Nkalu, 2019; Sulemana et al., 2019; Beard et al., 2022; Marques Arsénio et al., 2018; Beard et al., 2022; Beard & Mitlin, 2022; Salite et al., 2021), we seek to contribute to the literature by determining the relationship between urban agglomeration and regional economic performance, the relationship between urban agglomeration and income inequality; and the relationship between urban infrastructural service accessibility quality and regional human well-being in Sub-Saharan Africa. To address these objectives, we focus on the current growing strand of literature and the latest panel data estimated by following the dynamic panel model using several methods such as Pooled OLS, Fixed Effects (FE), Random Effects (RE), Difference, and System Generalized Method of Moments (Sys_GMM).

1.2 Objectives of the Study

The study focuses on five main topics: 1) urban agglomeration, 2) income inequality, 3) urban infrastructure, 4) regional human well-being, and 5) regional economic performance. The topical concepts are assumed to be incredibly independent but highly sequential at the same time, and this lays down the practicality of developing a detailed panel dynamic model that can be used to model the ongoing infrastructural, demographic changes, human capital formations, and urbanization trends in Sub-Saharan African urban regions. In line with these topical issues, the broad objective of the study is to determine the relationship between urban agglomeration and regional economic performance in Sub-Saharan Africa.

The study sought to address the following specific research objectives:

i. To determine the relationship between urban agglomeration and regional economic performance in Sub-Saharan Africa.
ii. To determine the relationship between urban agglomeration and income inequality in Sub-Saharan Africa.
iii. To determine the relationship between urban infrastructural service accessibility and regional human well-being in Sub-Saharan Africa.

In line with these research objectives, the study answered the following leading estimation questions:

1. How does urban agglomeration in Sub-Saharan Africa influence regional economic performance through an increased share of the urban population and enhanced human capital formation?

Under this research question, the critical focus is identifying the existing association between urban agglomeration and regional economic performance and ascertaining how urban agglomeration contributes to human capital formation, contributing to regional economic performance through increased labor specialization and production efficiency.

2. To what extent does urban agglomeration influence income inequality in Sub-Saharan Africa, if any, and what factors are responsible for the linkage?

This research question gives a foundation for uncovering the resulting income inequality in the urban regions due to the unregulated migration of people from rural to urban areas and the dynamics of the urban population, which creates competition for limited urban social amenities and economic opportunities within the urban regions.

3. How does urban agglomeration influence urban infrastructural service accessibility and contribute to regional human well-being?

Under this research question, the key focus is to determine the driving forces of urban agglomeration and how the disparity between urban infrastructural service accessibility contributes to regional human well-being.

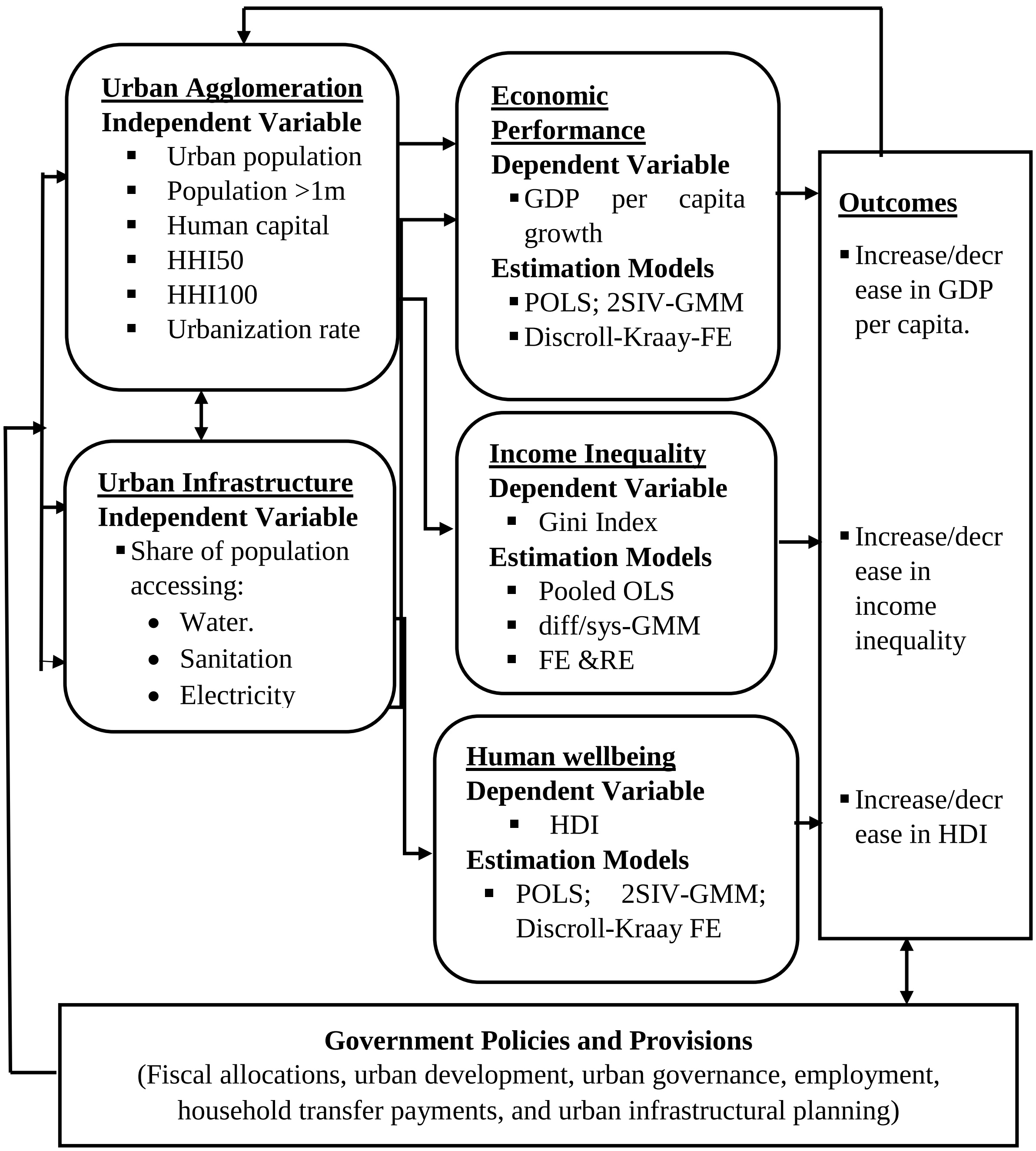
Therefore, the study determined the relationship between urban agglomeration and regional economic performance in Sub-Saharan Africa using panel data from 2000 to 2020 for 22 countries. We applied a dynamic panel data model estimated using various techniques (as discussed in subsequent chapters) to address the study's objectives.

1.3 Conceptual Framework and Hypothesis Setting

A conceptual framework is a diagrammatical representation of the study variables and concepts that are deemed to interact and, after that, produce an outcome. To answer the research questions and objectives stated above, a conceptual framework shown in (Figure 1) is developed to provide a pictorial interaction of the independent and dependent variables. The arrows indicate the direction of relational influence. The conceptual framework regards urban agglomeration and urban infrastructure as the leading independent variables influencing regional economic performance, income inequality, and regional human well-being, which are the dependent variables. An urban agglomeration is evaluated by focusing on the urban demographic changes such as population growth, urban concentration structure, and how the continuous concentration of people creates a large pool of skilled human capital. These demographic changes contribute to regional economic performance and urban income inequality. These factors of urban agglomeration influence regional economic performance. Regarding the impact of urban agglomeration on income inequality, the study considers the share of the population speeded up by the urbanization rate and rural-urban migration. Increased migration and urbanization rates increase the urban percentage of people, creating stiff competition for economic opportunities among urban dwellers.

Urban infrastructural services, such as sanitation, energy, and water, influence urban agglomeration by attracting the concentration of people and further development. Further, urban infrastructure offers an opportunity for multinational firms to set up factories, transport, and receive factors of production such as capital goods and labor. Moreover, government infrastructure provisions such as water, health care, education, housing, and sanitation directly influence people's concentration, active participation in economic activities, and overall well-being. The interaction outcomes between these independent and dependent variables are significant for the people at a particular period and the region and enhance the distribution of socio-economic well-being of the entire regional population. For example, increased GDP per capita or several engaged urban people and income can further increase urban agglomeration, infrastructural fiscal allocations, and service accessibility. To summarize, this study follows a deductive approach whereby the conclusive deductions are founded on the multiple set hypotheses presumed to be accurate as suggested theoretically and empirically by various previous studies. The conceptual framework sown in Figure 1 illustrates the interaction of the variables.

*Figure 1:*Conceptual Framework—Urban Agglomeration and Economic Performance



Source: Author's Construction (2024)

As presented in the conceptual framework (Figure 1) above, this study follows a deductive approach whereby the conclusive deductions are founded on the multiple set hypotheses presumed to be accurate as informed theoretically and empirically by various previous researchers. The overall hypothetical statement per each research objective is grouped case-wise to address the connection between the variables as depicted in the research questions. The hypotheses are formulated following the deductive approach and are presented under grouped cases as follows:

Case 1: Urban Agglomeration and Regional Economic Performance

Urban agglomeration influences regional economic performance through the supply of production factors such as labor and human capital accumulation. Also, the economic performance measured by GDP per capita is determined by dividing using the total population of that region. The size and structure of the urban population primarily inform the government's role in distributing economic benefits. The quality of government service provisions, such as energy, water, and sanitation, is critical in influencing the urban population's productivity. Thus, it is ideal for examining the influence of urban agglomeration on regional economic performance by also focusing on the quality of urban infrastructure if it augments the growth-effect of urban agglomeration. Therefore, we hypothesize that:

H1: Urban agglomeration influences regional economic performance in SSA.

Case 2: Urban Agglomeration and Income Inequality

The movement of people from rural to urban regions searching for a better life in terms of better income is a timely research question. Generally, the movement of people from the rural agricultural sector to the urban industrial industry is presumed to be drifting from low-income to high-income regions. This assumption has been proven otherwise in both theoretical and empirical literature, especially in the context of developing regions. Uncontrolled movement of people to the cities results in externalities of poor housing, poor access to water and sanitation, segregated urban households, low employment absorption rates, and related social problems such as abject poverty and crime. Nonetheless, several previous studies have focused on income inequality as influenced by other factors but ignored how the variation in the share of the urban population speeded up by rural-urban migration could contribute to income inequality. Another gap not yet exhausted in literature is the inclusion of the urbanization rate as the catalyst for urban agglomeration and income inequality. Thus, it is worth understanding how the share of the urban population, an essential measure of urban agglomeration, influences income inequality. We hypothesize that:

H2: Urban agglomeration influences income inequality in Sub-Saharan Africa.

Case 3: Urban Infrastructure and Regional Human Well-being

The critical question is what propels rural-urban migration, especially in developing regions. Some scholars argue that people migrate from underdeveloped agricultural, rural areas to developed industrial urban regions. Another section of researchers discusses that the movement of people from rural to urban is pushed by anticipation of better access to infrastructural services such as affordable housing, clean energy, water, sanitation, and waste management, as well as plenty of economic opportunities such as better paying jobs and income in urban regions. Driven by perceived better life in urban regions, underdeveloped regions such as Sub-Saharan Africa, where rapid urbanization is taking place, are currently grappling with acute pressure of containing the bursting urban population in line with making cities livable, resilient, safe, and sustainable (Sustainable Development Goal 11). The limited access to urban infrastructural services such as water, sanitation, and energy has pushed over 50% of the urban dwellers to shanties and slums with the acute proliferation of human well-being. Partly, this is due to limited fiscal allocation, overlapping urban governance functions, and lack of the state's goodwill to ensure an adequate supply of essential services. The connection between urban infrastructural service accessibility and regional human well-being in Sub-Saharan Africa is worth investigating. The theoretical literature indicates that better access to urban infrastructural services such as clean water reduces human disease infection and creates better urban livability conditions and human well-being at the city level. We hypothesize that:

H3: Urban infrastructural service (water, sanitation, and energy) accessibility quality influences regional human well-being in Sub-Saharan Africa.

1.4 Thesis Structure

This thesis is structured into the following seven distinct chapters. The first chapter introduces the research concept of the study in the form of the research problem, objectives, and hypotheses that direct the study. The second chapter provides the conceptualization and theoretical literature on urban agglomeration, urban infrastructure, income inequality, regional economic performance, and regional human well-being. The third chapter overviews population growth dynamics, GDP per capita growth, regional human welling, income inequality, and urban infrastructural growth trends in the last two decades. The chapter also provides a comparative analysis of urban agglomeration and economic performance patterns in SSA vis-à-vis that of East Asia. Also, the chapter encompasses the theoretical model from which the model estimation strategy is developed. In addition, Chapters Four, Five, and Six describe the variables and various statistical tests carried out as part of the model estimation. In chapter four, the analysis of the nexus between urban agglomeration and regional economic performance is carried out by comparing SSA, East Asia, and European economies in the last two decades. Chapter Five estimates whether the inverted U-shaped Kuznets Hypothesis holds for SSA by evaluating the relationship between urban agglomeration and income inequality. Chapter Six analyzes the relationship between urban infrastructural service accessibility and regional human well-being. Lastly, chapter seven provides a detailed summary of the key findings, concludes, suggests policy implications, and provides a roadmap for future studies.

2. CONCEPTUALIZATION AND THEORETICAL OVERVIEW

This section entails the theoretical overview based on the theories, suppositions, and notions from which the study sets its theoretical footing for elaborating its topical issues. The theoretical overview clears the path from which various empirical studies are conducted regarding the objectives, enabling us to anchor our study in subsequent empirical chapters on reliable theoretical notions and empirical evidence from previous studies. Specifically, this chapter conceptualizes, reviews theoretical concepts, and provides a basic literature review to introduce the detailed and objective contextual empirical literature in chapters 4, 5, and 6. In summary, this chapter gives a bird's-eye view of the dissertation's topical concepts and how theoretically related they are. However, in the respective empirical chapters 4, 5, and 6, focused empirical literature follows a refined background anchoring theory, from which an empirical model is built per each set hypothesis.

2.1 Theoretical Introduction

Urban agglomeration is a complex topic that refers to the urban concentration of people, economic activities, and firms in one complex city (Duranton & Puga, 2004). Therefore, to understand its occurrence, urban infrastructure, regional economic performance, human well-being, and income inequality resulting from the externalities of rapid urbanization and continuous concentration of urban population come into play (Duranton & Puga, 2004). The underpinning of the urban agglomeration concept is traced in the works of Marshall (1890), who likened it to urban concentration in the form of population density, frequently settled commuters, and other connecting residential regions at urban levels, resulting in the division of labor and economies of scale. In line with Marshall's proposition, several theoretical studies have progressively emerged with different coining of the term urban agglomeration. For instance, Yao et al. (2006: pg 469), in their book titled "China's Urban Agglomeration," referred to urban agglomeration as an "aggregate of cities that vary in size, features, and functions within a specific geographical region." The authors note that one core city connects other peripheral sub-cities through increased information and transport networks to form an incorporated collective city unit.

The increased flow and resultant concentration of people into and within urban regions with favorable industrial concentration, infrastructural accessibility, and favorable development incentives end up creating a pool market for labor, proximity to suppliers, and an interconnection between different city sectors, in turn, improve the general level of economic and social efficiency of the city (Duranton & Puga, 2004). Arguably, urban agglomeration speeds up the distribution of industries, construction of urban infrastructure, and urban planning and hence provides urban social-economic development through synchronizing different development master plans, transportation networks, and industrial chains to accommodate the increasing urban population growth (Fang, 2015).

Urban agglomeration drives the division of labor resulting from a large labor market pool, thereby increasing productivity and city growth benefits due to human capital specialization (Backman & Kohlhase, 2013). Spatial agglomeration occurs around specific products or services, creating efficiencies and enhanced labor skills driven by the ever-increasing population and central city incentives (Fang et al., 2010). Specializing at the city level means focusing on specific urban agglomeration functions that benefit building a distinctive city advantage. Further, specialization gains more significance as the competition of city firms increases and the population increases. Eventually, economic activities become more connected through transportation and production processes (Ni, 2008). This rudimentary concept is largely formalized by New Economic Geography (NEG) literature by Krugman (1991), which points out that increasing returns to scale and accessing the market are additional drivers of urban economic performance.

This leading theoretical view regarding how population concentration creates a dynamic urban economic performance due to human capital can be summarised in three main functional dimensions: sharing, matching, and learning (Storper & Michael, 2010). First, cities aid firms in matching their unique human capital requirements and material inputs since labor markets are more significant and various choices are available (Webster & Lai, 2003). Secondly, cities can accord firms access to a broader array of shared infrastructural and government services due to the scale of the economic activity (Glazer et al., 2003). In this regard, labor division, diverse consumer preferences, international inflows, globalization, urban governance efficiency, and efficient trade drive further urban agglomeration, regional economic performance, and general human well-being (Bertinelli & Black, 2004). Moreover, cities provide better external connectivity for firms and people through urban transport links and the transfer of knowledge and skills (Eekhout et al., 2014). Thirdly, city firms from distinctive person-to-person information flow in cities that promote more innovation and learning, thus resulting in increased human capital productivity and economical production processes (Glaeser & Resseger, 2010). Also, the increased proximity of people and firms promotes communication and sharing of composite production and management ideas (Mata et al., 2007). Further, urban agglomeration aids people and firms in comparing, collaborating, and competing, leading to a self-reinforcing circle that enhances creativity and economic performance within a city (Ahrend et al., 2017).

Based on these theoretical standpoints, the city represents a space whereby positive urban agglomeration externalities emerge and intensify as economic activities meet both intangible and tangible assets linked to business services and an innovative environment that is very distinctive of a differentiated urban structure (Florida, 2002). The presence of people from different walks of life endowed with varying levels of skills, with available physical infrastructures and government-private services in clear-cut defined urban agglomerates, turn cities together into drivers of modern dynamics of urban economic performance and subsequent long-term economic development as well as further increased urban aggregates (Duranton, 2015; World Bank, 2009).

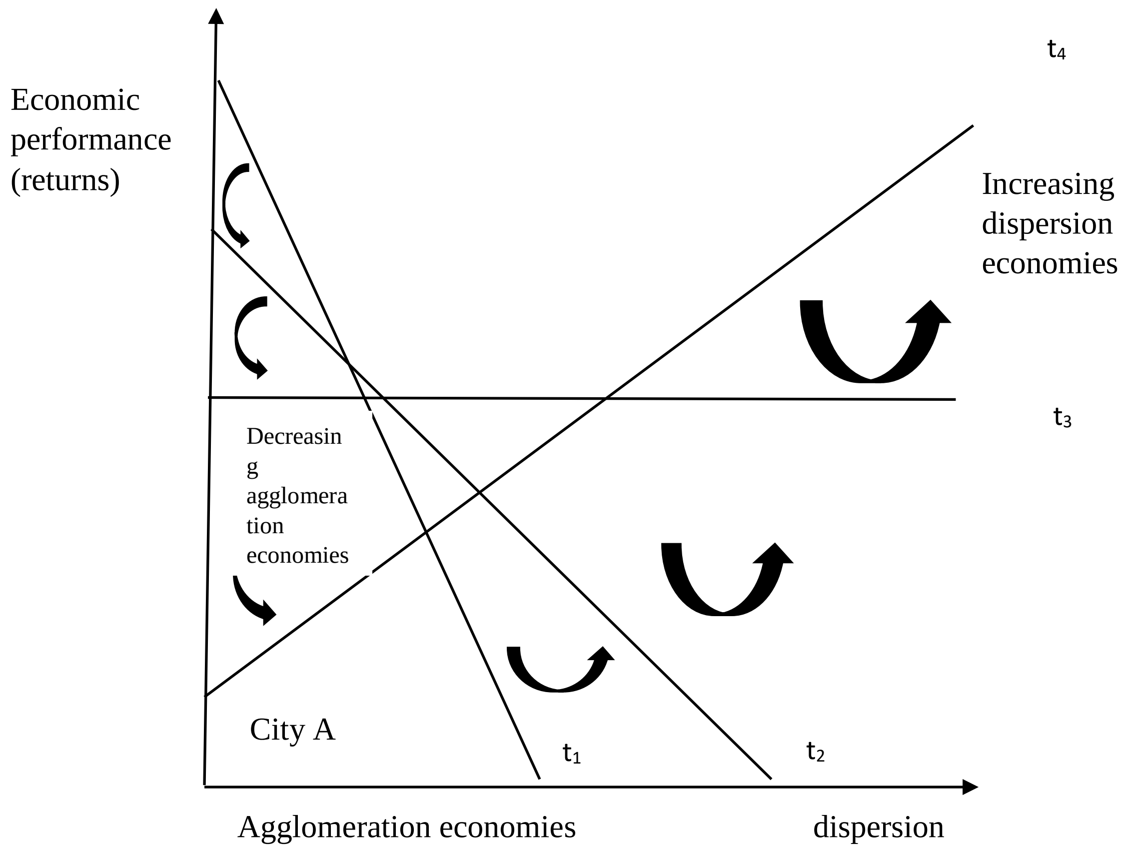
The economic benefits of urban agglomeration vary across different sectors of an economy, rising from the implication nexus between urbanization and regional economic growth (Fang & Guan, 2011). Generally, the city's socioeconomic well-being involves shifting from the agriculture sector, land-intensive in the countryside, to the service industry sector, favored by the urban concentration of skilled labor with integrated technological advancement (Fang & Yu, 2016). Urban agglomeration, comprising a qualified pool of labor force, spurs economic growth relative to the countryside's agricultural economic sector (Glaeser & Resseger, 2010). However, based on this theoretical standpoint, the economic adjustment should result in a national spatial structure defined by the efficient distribution of agents to maximize productivity at the country and city levels (Duranton & Puga, 2004). Having explored the general overview regarding the topical issues of urban agglomeration, income inequality, urban infrastructure, regional economic performance, and human well-being, as well as the interrelationships, it is essential to narrowly disentangle the variables and specific associations case-wise as outlined under the following subsections.

2.1.1 Urban Agglomeration and Regional Economic Performance

By building on Marshall’s (1890) theoretical dimension, we evaluate the evolutionary agglomeration theory (EAT) that elaborates how city, firm, and urban population impact immensely the variation of urban agglomeration and regional economic performance across various geographical regions and over time. Ideally, this study is built on the argument that increased urban agglomeration (concentration of population, firms, and economic activity) creates increased economic efficiency and performance resulting from rising returns at later stages of the city’s growth. In this case, a city is considered as a space where economic agents such as people, firms, and government interact, share and compare knowledge, thereby forming a compact unit that links other sub-regions (small cities through increased transportation, information, and communication networks (Gerritse & Arribas-Bel, 2018; Camagni, 2016; Krugman, 1991; Yao et al., 2006).

The agglomeration life cycle (ALC) theoretical model (Figure 2) is developed to illustrate how urban agglomeration and economic performance change over time. The model is an extension of the most recent economic geography theory (Boschma & Frenken, 2006) and a modification of the evolutionary agglomeration theory implicitly presented by Potter and Watts (2011). This study considers the city life cycle and not the industry life cycle, as in the case of the model by Potter and Watts (2011). The regional economic performance or returns are presented on the y-axis, and the varying aspects of agglomeration and dispersion economies are shown on the horizontal x-axis. The agglomeration life cycle model is presented in Figure 2.

*Figure 2:*Agglomeration Life Cycle (ALC) Model



Source: Potter and Watts (2011).

The four lines elaborate on the association between agglomeration economies, regional economic performance, and the economic dispersion that the urban region experiences over time. Assumingly, consider city A represented along the x-axis. Suppose the city experiences an increase in agglomeration by either increased employment from the available large pool of labor force or by sourcing raw materials for a firm in the nearby city through increasing the dependence on the local knowledge spillovers. In this case, the city will grow towards the left of the x-axis. Such a move will cause the city to experience increased economic performance during the early stages (t_1 and t_2), constant performance during the middle phase (t_3), and declining economic performance at later stages (t_4).

This theoretical model has been supported by different theoretical notions such as economics, regional demographic science, and New Economic Geography (Alonso-Villar, 2007; Fujita & Krugman, 2004). Also, the theoretical model is backed up by the most recent research on urban agglomeration (Boschma & Franken, 2010). The operational approach to the dynamism of a city is a representation of the traditional model, which entails both network and spatial dimensions (Camagni, 2016). In this model, the city is defined and equated with agglomeration, which delivers an economic advantage through economies of scale and urban externalities. Moreover, a city is an interconnection of communication, skills, social, political, power, and cultural networks (Camagni, 2016).

Agglomeration economies entail the probability of exploiting economies of scale in local services and products through internal labor division and specialization, resulting in an available large pool of labor force (urban share of population) (Krugman, 1991). Beyond this, the city context supplies possibilities for interpersonal communication through face-to-face contact and economic externalities from the available public goods, urban infrastructure, and local government service provisions. Population contact, sectorial differentiation, and closeness acting as the representation of distinctive features of the city allow the circulation of information, skills, transportation, and transaction costs, thereby enhancing urban productivity and international economic connectivity (Krugman, 1991).

Further, in line with the elaborations presented in (Figure 2), over time, the role of agglomeration economies improves as introduced in Glaeser's (1999) model, which considered the city as an essential public good characterized by non-exclusion interactive association among users, whereby utility rises when the number of users increases (interaction-and-sharing). Glaeser (1999) provided a related model of urban learning, whereby urban people acquire knowledge through interaction while working in urban industries whose probability rises with the size of the city. In the same connection, Duranton and Puga (2004) developed a micro-established model of interaction (sharing), search for jobs (matching), and flow of information (learning) in elaborating agglomeration economies. In all these conceptual progression cases, there is a link between the regional economic space and the number of intermingling agents. Broadly, the productivity of large cities is wholly accepted, but it emanates from a comparative or static representation: the size derivative, which differs from the time derivative (Camagni et al., 2016).

Following these theoretical concepts, it is essential to point out the main driving factor of urban agglomeration. Arguably, urban agglomeration has been identified due to the population shift from rural to urban regions (Barrios et al., 2006). Thus, we argue that rural-urban migration is vital to the theoretical notion around the urban agglomeration-regional economic performance nexus (Bloom et al., 2008; Fay & Opal, 2000). Holding this gasp, Heberle (1983) proposed the theory of population where rural-urban migration was identified as one of the key “push-pull” factors of urban agglomeration and regional development. Based on this theory, Bogue (1959) analyzed comprehensively and deduced different factors of “push” and “pull” factors responsible for the rapid urban population and agglomeration economies in China. Arguing within the same precincts, Bloom et al. (2008); Fay an Opal (2000) and Lee (1966) suggested the mass rural-urban migration of the floating population as a choice made under the vital precondition of the urban agglomeration-regional economic performance connectedness following four different factors (factors of destination, personal factors, destination, and intermediate obstacles).

Similarly, Lewis (1954) states that the industrial economic structures of the developing nations comprise the present-day rising urban processing industries and declining conventional agricultural sectors in developing countries. Contrary to this theoretical strand of literature, Duranton and Puga (2015) argue that urban agglomeration produces crowding effects, whereby a continuous unregulated increase in urban population density, out of which a chain of problems such as traffic congestion, environmental pollution, and rising the cost of living occur in urban regions. Thus, the crowding effect jeopardizes the further flow of people and supply of production factors, leading to unsustainable regional economic performance (Henderson, 2000; Klimczuk-Kochanska & Klimczuk, 2019). In agreement with the positive nexus notion, urban agglomeration resulting from rural-urban migration accommodates industrial clusters, offers institutional diversity, propels dynamic innovations, and delivers better economic development as indicated by reasonable GDP per capita of the urban dwellers (Duranton, 2015; Ning et al., 2016).

Theoretically, two notions of positive and negative nexus between urban agglomeration and regional economic performance have been identified in the most recent literature, making the relationship between urban agglomeration and regional economic performance attractive for research discourses. For instance, Agglomeration Life cycle and New Economic Geography theories (Baldwin & Okubo, 2006; Bertinelli & Black, 2004; Fujita & Thisse, 2002; Hohenberg, 2004: Glaeser & Gottlieb, 2009; Henderson, 2010; Leitão, 2012) observe a very strong positive association between urban agglomeration and regional economic performance. Similarly, Wang et al. (2019) and Zheng and Du (2020) allude that urban agglomeration helps improve sustainable urban development through the proximity of production factors such as human capital and accessibility of the market, thereby enhancing regional economic efficiency. Ahrend et al. (2017) and Tumbe (2016) indicated a significant positive nexus between urban agglomeration growth and regional economic performance measured by GDP per capita.

On the contrary, another strand of literature shows a negative relationship between urban agglomeration and regional economic performance. In line with this argument, Deilmann et al. (2018) and Tam and Lu (2019) observed that urban agglomeration does not guarantee or lead to reduced sustainable economic production efficiency. Frick and Rodriquez-Poze (2018) marked a positive relationship between cases of developed and negative relationships for developing economies. Similarly, Berdeque et al. (2015) and Castells-Quintana (2017) conclude that the relationship between urban agglomeration and regional economic performance is country-specific.

In the African and Sub-Saharan African contexts, the relationship between urban agglomeration and regional economic performance has gained special research attention in recent decades. In a recent study, Asogwa et al. (2020) established a strong positive relationship between urban agglomeration and regional economic performance. Similarly, Nkalu et al. (2019) concluded that the relationship between urban agglomeration and economic growth follows the Williamson-Kuznets Hypothesis. Castells-Quintana and Royuela (2015), utilizing African, Asian, and Latin American economies, indicated that urban agglomeration fosters regional economic performance across the regional economies. Similarly, Ruhiiga (2013) analyzed the growth of urban agglomeration nodes in Eastern Africa and observed that the future of urbanization points to the rising urban agglomeration forces through which urban regions will continuously create a compact unit of increased economic performance. In summary, this sub-section provides an overview of the relationship between urban agglomeration and regional economic performance without uncovering research gaps, as discussed later in the empirical section in chapter 4.

2.1.2 Urban Agglomeration and Income Inequality

Income inequality is an unequal income distribution among groups, households, countries, or regions (Kuznets, 1955). Specifically, income inequality is linked to unfairness, as a large share of income is in the hands of the few, and a large share of the population has the smallest share of income (Todaro, 1977; Hardoon et al., 2016). Structural development entails an invariable auxiliary of development: the massive shift away from the agricultural sector to the industrial sector in what is termed industrialization and urbanization (Kuznets, 1995). Thus, in a simple theoretical model, income distribution at the national level is the summation of income among those in urban and rural regions (Piketty, 2006). However, in the current rapid urbanization, as witnessed in the Global South, it has been observed that income per capita is relatively low in rural regions compared to urban areas.

Increasing the share of the urban population (urban agglomeration) does not imply a reduction in economic performance; empirical evidence has pointed out that economic performance may increase since urban per capita production efficiency rises faster than in the agricultural sector. If this holds, income inequality increases (Bourguignon & Morrisson, 1998; Piketty, 2006). Therefore, urbanization-driven urban agglomeration has become a necessary process affecting income distribution and, by and large, causing income inequality. However, income inequality rises in the first phase of urban agglomeration, where structural development is still on course. Still, income inequality decreases with fair urban infrastructural development and industrial distribution (Piketty, 2006).

A typical economic model from an urban and rural regional perspective consists of four crucial components: 1) urbanization level, 2) urban income inequality, rural income inequality, and 4) urban-rural income difference. Keeping rural and urban differences constant, Kuznets (1955) developed an inverted U-shaped association between urban population share and income inequality. As discussed in chapter five, this theoretical school of thought is central to this study. In line with this postulations, a host of evidence supports that urbanization-driven urban agglomeration spurs economic performance, at least in the first phases of development, signifying the existence of a balance between income distribution and economic performance. Consonant to this notion, Brülhart and Sbergami (2009), in their study on urban agglomeration and economic growth, deduced that developing economies face an obdurate policy choice between pursuing the reduction of income inequality or enhancing economic performance from an urbanization dimension.

Other schools of thought, such as the classic dual economic model investigating structural change, depict income inequality as an unavoidable urbanization outcome that is a feature of economic performance (Harris & Todaro, 1970; Rauch, 1993). Holding a similar view, the New Economic Geography theory aids in explaining how economic performance is linked to greater urbanization as described by urban agglomeration and income inequality in its first phases (Krugman, 1991). In both theoretical models, there is an increasing economic return from urban agglomeration, in that most urban industries are located where there is large agglomeration and urban labor force to find where there is better income wage. That is to say, economic performance is enhanced by structural changes in an economy, enabling it to benefit from increasing urban agglomeration economies.

Arguably, the urbanization process brings about economic structural changes, with people and other factors of production being transferred from the conventional agricultural sector to the modern urban industrial sector. Therefore, this process is linked to increased income inequality, with greater income levels in urban regions than rural regions. In this narrow sense, both higher income inequality and large urbanization-driven urban agglomeration can spur increased concentration of factors of economic production, at least in the first development phase, thereby strengthening continuous reallocation of the labor force from rural to urban regions (Ross, 2008). Thus, both income inequality and demographic transition indicate, to a great extent, capital accumulation (both human and physical). However, in later development phases, chiefly urban growth of large agglomeration—urban concentration—is associated with increasing income inequality, especially in Global South regions such as SSA and East Asia, where urban infrastructural development is weak due to governance ineffectiveness and limited infrastructure investment capacity and technical know-how (Behrens & Robert-Nicoud, 2009).

In line with these theoretical postulations, research attention is dramatically shifting to investigating the link between urbanization-driven urban agglomeration and income inequality. One strand of empirical literature has maintained a significant positive relationship between urbanization-driven urban agglomeration and income inequality (Ha et al., 2020; Sulemana et al., 2019). However, two opposing findings have been observed in the recent empirical literature. On one and, some empirical studies have deduced that urban agglomeration worsens income inequality. Ekeocha (2021) opined that urban agglomeration could add to income inequality because of the large concentration of highly unskilled labor force in urban regions, especially in developing SSA and East Asia economies. Similarly, Nguyen et al. (2020) concluded that urban agglomeration could significantly ensure fair income distribution unless good policy preference toward education supplements it.

On the other hand, some studies have revealed that urban agglomeration could result in reduced income inequality. For instance, Turok and McGranahan (2013) explained that urban agglomeration could reduce income inequality by promoting industrialization, employment, and increased wage earnings. These findings have been corroborated by the recent World Bank report, positing that urban agglomeration and concentration of economic activities could result in improved living standards, hence reducing poverty and income inequality (Turok & McGranahan, 2013; World Bank, 2022).

In this part of the dissertation, we evaluate the link between urban agglomeration and income inequality by incorporating other structural development supplementing factors such as governance policy preference and quality of education. Indeed, good governance policy preference is the pivot through which urban agglomeration can influence income distribution. For instance, Acemoglu et al. (2004) argued that the quality of institutions plays a more significant role in containing urbanization challenges and directing economic performance. In the same spirit, Dossou et al. (2021) argue that no economy can realize sustainable urbanization-driven economic performance with proper institutional policy preferences. For instance, good policy preferences and institutions could engineer urban infrastructural development and reduce income inequality as more urban people earn wages (World Bank, 2011). In regards to the education quality effect, Di Clemente et al. (2021) and Le et al. (2020), good policy preferences spur increased investment in quality education, which remains a significant factor in closing income gaps, boosting agglomeration economies, thereby reducing income inequality among people. This sub-section provides a brief overview of theoretical notions and trends in literature. However, since the main aim of this study is to evaluate the link between urban agglomeration and income inequality, a detailed analysis of the inverted U-shaped hypothesis of Kuznets and empirical literature is provided in chapter 5.

2.1.3 Urban Infrastructure and Regional Human Well-being

According to the World Health Organization (2016), regional human well-being is a complete mental, social, and physical wellbeing, where an individual or a group should realize aspirations, satisfy needs, and alter or cope with their environmental surroundings. Similarly, several definitions of regional human well-being in literature as an individual's happiness, life satisfaction, and quality of life, where well-being is a state of being healthy in ways from a social, spiritual, mental, and physical perspective (Dolan et al., 2006; Kovacs-Györi et al., 2019). Therefore, health is a public resource for day-to-day life, not the living objective. It is a positive concept stressing personal and social resources and physical capacities (Dolan et al., 2011; McGillivray & Clarke, 2006).

A significant explanation of regional human well-being is Maslow's hierarchy of needs: safety, physiological, belonging, and self-esteem (Maslow, 1968). Though literature disavows the hierarchy of Maslow's model, the elements are still significant (Rapport et al., 1998). In line with this argument, Hagerty et al. (2001) reviewed 22 research studies that unpacked seven broad components of human well-being: health, work, relationships among family, feeling part of the community, individual life, material well-being, and emotional well-being.

A breath of literature across many subjects has tried to unpack human well-being from an urbanization perspective by connecting individuals' satisfaction from accessing urban infrastructural services such as green spaces, water, sanitation, electricity, and transportation (Coppel & Wüstemann, 2017). So, what is urban infrastructure? Urban infrastructure is broadly defined as the systems that provide energy, water, sanitation, waste management, communication, transportation, public green spaces, and affordable housing services, which are vital in supporting human well-being and economic prosperity in city regions (Ramaswami et al., 2012). Consequently, the quality of accessing these urban infrastructural services refers to the ease and extent with which the urban population can obtain these services, as determined by proximity and the efficiency of getting them (Rode et al., 2019; Dewita, Burke & Yen, 2019). Driven by the increasing urban share of the population, urban human demands dominate these services (Seto et al., 2016). Regional human well-being has received significant attention and importance in urban planning and public governance discourses (O'Neill et al., 2018).

Still, scholars have tried to define regional well-being as a human behavior-related function of the interaction between personal attributes, infrastructural service provisions, and environmental factors (Badland et al., 2014). Recently, Cave and Wagner (2018), in their work—livable cities from a global perspective, defined regional well-being based on Kevin Lynch's Theory of Good City Form, which considers various distinct extents of the urban statuses that are significant to the notion of infrastructural service accessibility and livable cities, as the critical path toward better regional human well-being (Lynch, 1984).

One of the notable dimensions considered by Lynch's theory is *vitality,* which refers to the extent to which urban region backs people's vital functions and abilities (Lynch, 1984). Under this dimension, Lynch identified the aspects of *sustenance, safety,* and *access* (Lynch, 1984). By sustenance, the author refers to the ability of the urban region to offer a sufficient supply of social amenities such as water, energy, food, quality air, and safe disposal of waste as well as any other physical or natural goods people need to stay in that particular urban region (Cave & Wagner, 2018). By *safety*, the author denotes the absence of controlling poisons and hazards in a settlement. Another critical dimension is *access*, by which the author refers to the extent to which the urban population can access infrastructural services such as water, sanitation, health, energy, recreational places, educational places, employment, and sources of information (Cave & Wagner, 2018). Holding similar gasp, Paul and Sen (2018) define regional human well-being as the general standard of living within a city or region, which can be measured subjectively or objectively.

In this connection, literature has classified human well-being measures into subjective and objective, often measured through economics, environmental, and social statistics, mostly with ordinal metrics (McGillivray & Clare, 2006). Regarding subjective measures, regional human well-being comprises life satisfaction, such as gratification with overall life, emotional well-being, hedonic well-being, and eudemonia, which refers to the feeling of meaning and self-actualization in life (OECD, 2013). By focusing on measures of general life evaluation as well as human emotions at a particular time and place, subjective human well-being is a consistent, scientific method to measure the trends of regional human well-being and has a more significant public policy aim worldwide (Diener, Oishi, & Tay, 2018; Veenhoven, 2012; OECD, 2013).

In this accord, the science of measuring subjective human well-being has converged, and several scales have been established to measure emotional, evaluative, and eudemonic subjective well-being (Das et al., 2022). Nevertheless, although subjective regional human well-being measures exist across different regions, and there exist several studies linking subjective measures of regional well-being to specific urban infrastructural service provisions, such as water supply, sanitation, waste management, and energy (Singleton, 2019), a handful empirical studies have investigated how different urban infrastructural service accessibility quality shapes the regional human well-being following an objective approach that captures the living conditions and economic stability of urban dwellers, mainly focusing in an economy-wide unit of analysis and utilizing sophisticated quantitative econometric approaches (Dunaeva, 2018; Ramaswami, 2020).

Therefore, this dissertation’s section follows and maintains the objective measure of regional human well-being, a new and limited but vastly growing strand of literature (Enqvist & Ziervogel, 2019). Unlike previous subjective studies, most current quantitative studies incorporate the need for concerted urban governance (municipal council and local leaders) efforts toward providing urban infrastructural services within and across different regions so that adequate access occurs hand in hand with transitioning toward sustainable, resilient, and livable urban areas (Simon, 2016; UN-Habitat, 2020; Parsons et al., 2019). In line with this surmise, Ramaswami et al. (2016) observed the significance of seven urban infrastructural service provisioning, such as water, green space, waste management, transportation, energy, housing, and food provisioning, to positively impact human health. Collaboratively, Matas et al. (2015) indicate that a rise in regional infrastructural accessibility enhances overall regional human well-being.

Similarly, the literature review focusing on the African and SSA context has validated the relationship between urban infrastructural service accessibility and human well-being. Nzengya (2018) concluded that management enhances the availability and accessibility of water services and the general well-being of the urban population. Beard and Mitlin (2021) established that the cost of accessing piped water is high due to privatization, infringing low-income or unemployed urban household members. Similarly, Strande and Brdjanovic (2014) observed that many people in Sub-Saharan African cities who use onsite sanitation infrastructure services have no access to better fecal sludge management, including waste treatment before proper disposal, hence suffer from chronic diseases such as cholera and typhoid, thus low human well-being. In a recent study, Marques Arsénio et al. (2018) established that most urban households have inadequate access to sanitation infrastructure, resulting in health risks. Using 15 Sub-Saharan African cities, Beard et al. (2022) demonstrated that 62 percent of urban waste is not safely managed. In most cities with limited access, households engaged in unsafe sanitation practices create public health threats.

In summary, this sub-section has provided in-depth theoretical notions and brief literature supporting the relationship between urban infrastructural service accessibility and regional human well-being. A detailed evaluation of empirical literature is provided in chapter 6, showing this thesis's sub-sections, research gaps, and estimation methods.

3. RESEARCH METHODOLOGY

This chapter provides research methodology by first providing a statistical overview of the Sub-Saharan African region regarding urban agglomeration, urban infrastructure, income inequality, and regional economic performance. The chapter provides an in-depth evaluation of the urban population growth dynamics, which is the main contributor to urban agglomeration, which subsequently exerts pressure on the available urban infrastructural services such as water, energy, sanitation, health, education, and overcrowded transportation networks. Inadequate access to government provision culminates in inequality of the living standards among the urban population; hence, it impacts the urban regions' well-being and general economic performance. This first subsection is divided into four parts: urban agglomeration dynamics in SSA, urban infrastructure and government services in SSA, income inequality trends in SSA, and regional economic performance of the SSA region. The last section of this chapter provides a general methodological overview of theoretical model specification, estimation techniques, variable description, and basic data stylized facts.

3. 1 Descriptive Statistics of Urban Agglomeration in Sub-Saharan Africa

The urban population in entire Sub-Saharan Africa has been increasing at a breakneck pace in the past 20 years, with significant agglomeration on the most prominent cities' periphery where most of the urban households live in dilapidated informal settlements primarily known as slums (UN-Habitat, 2017). The neck-breaking pace of urban population growth can be attributed partly to increasing rural-urban migration and internal urban population growth (Jedwab et al., 2015). Most of Sub-Saharan Africa's cities are characterized by high population concentration, culminating in other social inequalities such as poor housing and access to inadequate infrastructural services (Marx et al., 2013; UN-Habitat, 2016). Further, it is projected that Africa alone as a continent will add one billion urban residents over the next 30 years, based on ballooning 491 million people in 2015 to approximately 1.5 billion by 2050 (UNDESA, 2018; UN-Habitat, 2016).

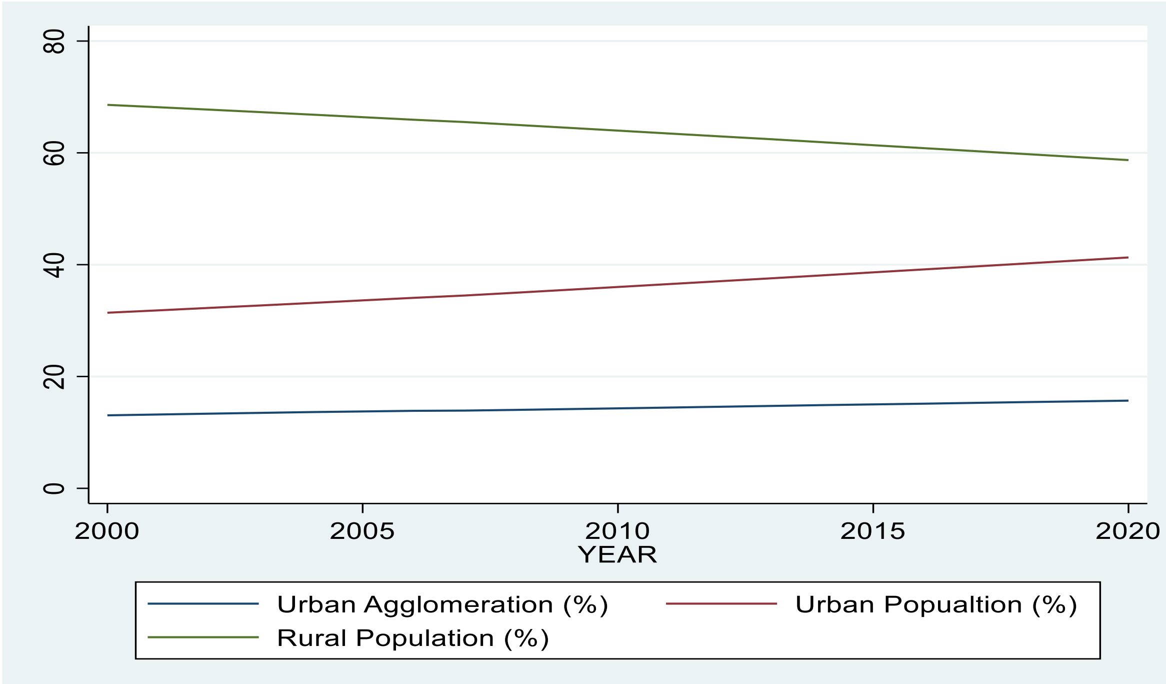
Continuous rural-urban population drift has encountered tremendous growth in structure and size, resulting in large urban agglomerations of more than 1 million people staying in the nation's largest metropolitan regions in recent decades (Oyeleye, 2013; World Bank, 2019). The unparalleled rise in rural-urban migration growth is associated with inadequate development in the rural areas to absorb the rising rural population, of which 60%

of the entire population is unemployed semi-and skilled youths (Bloch et al., 2015). According to UN-DESA (2018), the growth of rural-urban migration is manifested in the perceived discrepancy in the provision of infrastructural services, which are not restricted to social facilities and other socio-economic amenities to spur economic performance. More subtly, the quest for better employment, numerous trade opportunities, and communication and transportation services significantly contribute to the increasing urban population (Ikwuyatum, 2016; UN-DESA, 2018).

Among the primary drivers of urban population growth and urban agglomeration in Sub-Saharan Africa has been attributed to the natural internal urban population growth characterized by the predominance of the high birth rate over the death rate (Mo Ibrahim Foundation, 2015). This natural growth has been estimated to account for a minimum of 60% of the overall urban population growth, but the absolute numbers vary across Sub-Saharan African nations. Demographers posit high uncertainty about how fast the fertility rate is likely to decrease in Sub-Saharan African urban spaces as contrasted to the national aver and other global regions (Bongaarts, 2017). Another critical factor is the cross-border influx of migrations and the annexation and reclassification of the previous rural areas as the urban regions have significantly resulted in overall urban population growth in Sub-Saharan Africa (AfDB & OECD, 2016; Mo Ibrahim Foundation, 2015).

Figure 3 shows the interactive trends of the urban population, urban agglomeration (% of the urban population in agglomerations with over 1 million people), and rural population growth in Sub-Saharan Africa over the recent two decades, 2000 to 2020. The data trend reveals that the urban population has been rising steadily, with an average value above 25% of the total population between 2000 and 2015 before rising to over 40% between 2017 and 2020 (Mo Ibrahim Foundation, 2015). Urban agglomeration has also increased gradually, with an average value above 10% of the region’s population over the last two decades. On the other hand, the rural population has been declining drastically from 65% in 2000 to about 58% in 2020. In addition, the rural population fell from 2.1 million in 2007 to 1.7 million people in 2020 (Nkalu et al., 2020).

*Figure 3:*Population Growth Dynamics in Sub-Saharan Africa



Source: Author's Computation from WDI (2023)

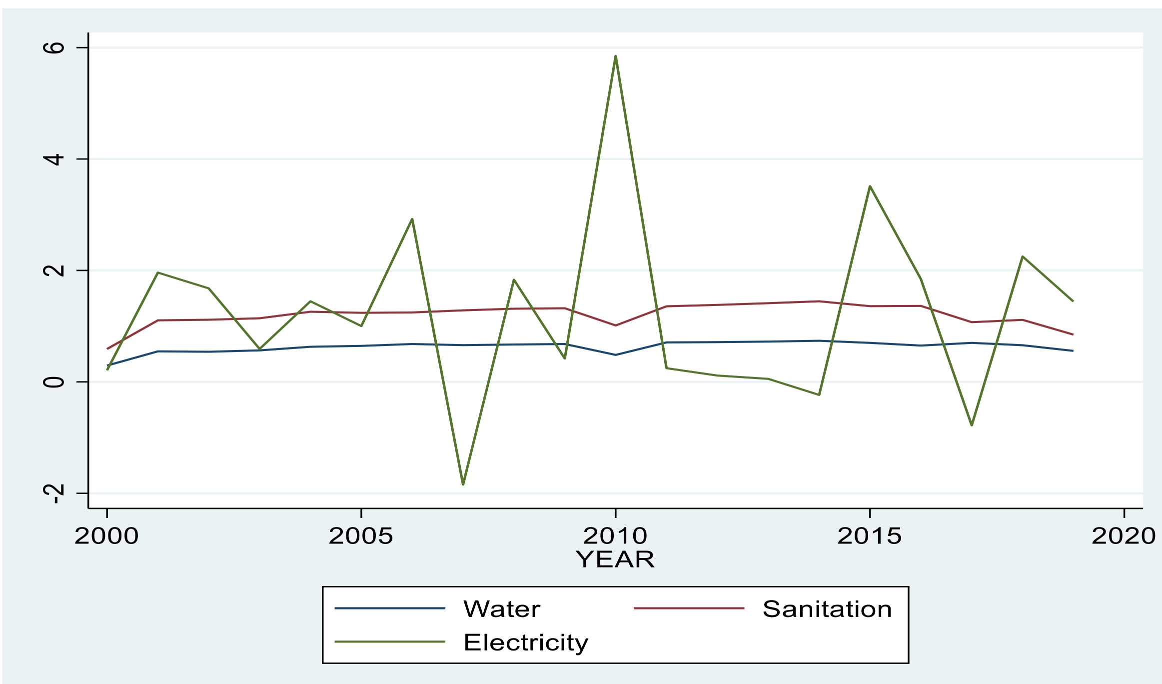
3. 2 Descriptive Statistics of Urban Infrastructure in Sub-Saharan Africa

The increasing urban population and subsequent urban agglomeration in developing regions such as Sub-Saharan Africa have been regarded to be much faster than the pace of urban infrastructure development (Goodfellow, 2020; Lawhon et al., 2018). Also, the rising of small and mid-sized cities, annexation, and reclassification of previous rural regions as part of the central urban regions have been the major contributing factors to unplanned rapid urbanization in Sub-Saharan Africa (Güneralp et al., 2020). Although Sub-Saharan Africa's urbanization trends appear similar to those of other rapidly expanding regions, it is essential to note that the driving factors for it differ expressively from those of the developed and experienced economies and even in other developing economies such as China (Güneralp et al., 2017; Lawhon et al., 2018; Pieterse, 2019).

Most of the rapid growth of urban population and urban agglomeration dynamics in Sub-Saharan Africa are occurring in an unplanned and unregulated manner, thereby pointing out the institutional and financial failures of the governments to accommodate the booming urban population (Farrell, 2018; Aliyu & Amadu, 2017). Within much of the Sub-Saharan African urban infrastructural development discourse, the cities are framed sites of deficit or inadequacy-featured by immense infrastructure bottlenecks and subsequent limited access to government infrastructural service provisions such as water, sanitation, and electricity (Farrell, 2018; Goodfellow, 2020; Silver, 2014).

Based on the urban infrastructure access shown in Figure 4, it can be seen that in the last two years, the growth of urban infrastructural service accessibility has been below 5% every year. Notably, the share of the urban population accessing basic water for drinking and sanitation has been relatively stagnant, below 2%, way below the annual urban population growth rate. Regarding the share of the urban population accessing electricity, the growth has fluctuated, signifying unreliable and temporary electricity infrastructure development in SSA. Still, the urban share of the population accessing electricity averaged below 5% in the recent two decades, from 2000 to 2020 (World Bank, 2023).

*Figure 4:*Urban Infrastructural Service Accessibility Growth in SSA 2000-2020



Source: Author's Construction based on WDI (2022)

3. 3 Descriptive Statistics of Income Inequality in Sub-Saharan Africa

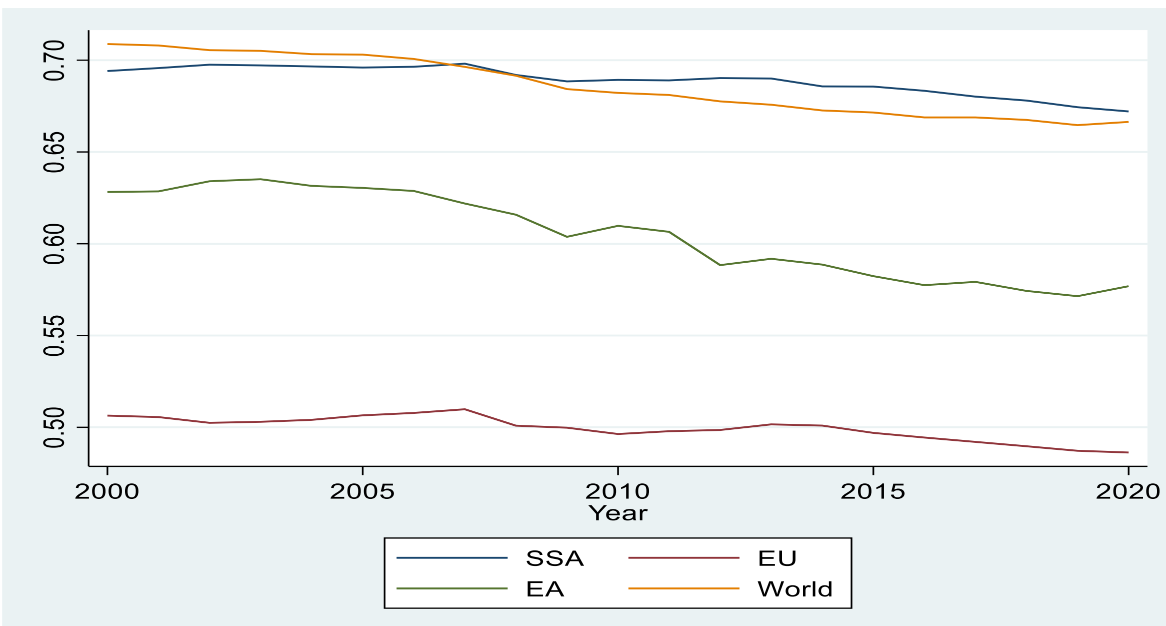
The rapid growth of urban population and agglomeration presents many socio-economic challenges in most Sub-Saharan African countries. This is because urbanization depicted by the massive population shift from rural to urban regions has not resulted in concurrent regional economic growth and equitable economic benefits for most Sub-Saharan

African city dwellers (UN-DESA, 2018; Fox, 2012). According to UN-Habit estimations, over 50% of the Sub-Saharan African urban population lives in slums today with limited access to basic social infrastructural services such as water, sanitation, and energy (Manteaw, 2020). Also, the ravaging income inequality among city dwellers in most Sub-Saharan African cities is identifiable by the number of people regularly experiencing food insecurity (Tuholske et al., 2020). According to UN-Habitat (2020), continuous unregulated influx and natural birth within cities have kept on putting pressure on the limited financial capability of most Sub-Saharan African governments since the majority are cash-strapped and lack the technical and institutional capacity to provide essential services to the city citizens. Therefore, the most significant shares of slums and informal settlements coupled with social exclusion from standard social amenities have rendered most Sub-Saharan African cities an atmosphere of fear, violence, and theft for economic survival (Bloch et al., 2015).

Socio-economic reports indicate a disproportionate demographic transition within Sub-Saharan African city regions with a bias toward exploding working-age population of age distribution between 15-34 years. This population cohort constitutes a whopping 74% of the entire urban population. In absolute figures, the number rose from 45 million in 1980 to 176 million in 2015 (Mo Ibrahim Foundation, 2015). This increasing population has created unequal access to employment opportunities (Mo Ibrahim Foundation, 2015). With the weak link between the urbanization rate and urban industrialization, the youthful populace is left with no economic alternatives, engaging in criminal activities, drug abuse, and destruction of the built environment, thereby continuing the dilapidation of the city's well-being. Further, the inadequate economic opportunities push over 50% of the entire urban share of the population to the informal sector, where even the income cannot meet the soaring housing demand (UN-Habitat, 2016).

Inequality is also evident in access to urban infrastructural services amidst soaring demand, with biases skewing toward the minority high-income group. For instance, 80% of the urban electricity connectivity goes to the wealthiest, and the remaining 20% goes to most residents of informal settlements in Sub-Saharan Africa (World Bank, 2020). Similarly, reports show that 52% of Sub-Saharan Africa have access to basic sanitation facilities, out of whom over 55% have shared access to sanitation facilities. This is partly due to the household poverty level and the lack of formal housing titles needed before connections (UN-Habitat, 2018). Shockingly, over ½ of the Sub-Saharan African urban dwellers do not have access to reliable electricity, water, and safe sanitation (UN-DESA, 2019). This intertwined increase in demand for social amenities driven by the steady rise in urban agglomeration and inadequate economic opportunities has continued to widen the income gap, as indicated by an increase in the Gini Index, as presented in Figure 5. Based on the income inequality trends in Figure 5, the Sub-Saharan Africa trend conforms strongly to the world pattern. The Gini Index computation shows that income inequality for SSA in the last two decades has averaged above 0.67, with a stable trend. This implies that there is a significant heterogeneous income distribution in SSA. Compared with other urbanizing regions such as East Asia (EA), SSA income inequality still ranks as EA has averaged below 0.65, drastically declining below 0.60 between 2011 and 2020. European Union (EU) patterns show a significant drop in income inequalities, as depicted by an average value of 0.51 in the last two decades.

*Figure 5:*Income Inequality Growth in SSA, Europe, East Asia and World; 2000-2020



Source: Author's Computation using (SWIID) Estimates (2023)

3. 4 Descriptive Statistics of Economic Performance in Sub-Saharan Africa

Urbanization is the crucial characteristic of the structural transformation that engineers economic wellbeing in developing economies. As economies urbanize, workers move from rural to urban regions for productive and better-salaried jobs. Similarly, entrepreneurs locate their companies in city regions where agglomeration economies increase their output. The productivity gains contributed by scale, economic interactions, and population density are substantial factors for cities in developed economies and might even be the largest for cities in developing economies (Glaeser & Xiong, 2017). While cities promise high job creation and economic productivity, they can fail to deliver these economic benefits due to rapid urbanization. Recent experiences in developing regions, including Sub-Saharan Africa and East Asia (Venables, 2018). East Asia has successfully generated more job opportunities, higher economic productivity, and infrastructural services, contributing to more livable cities. In contrast, Sub-Saharan African cities have left a more significant share of their urban population without formal jobs and limited access to infrastructural services necessary for spurring economic performance (Venables, 2018).

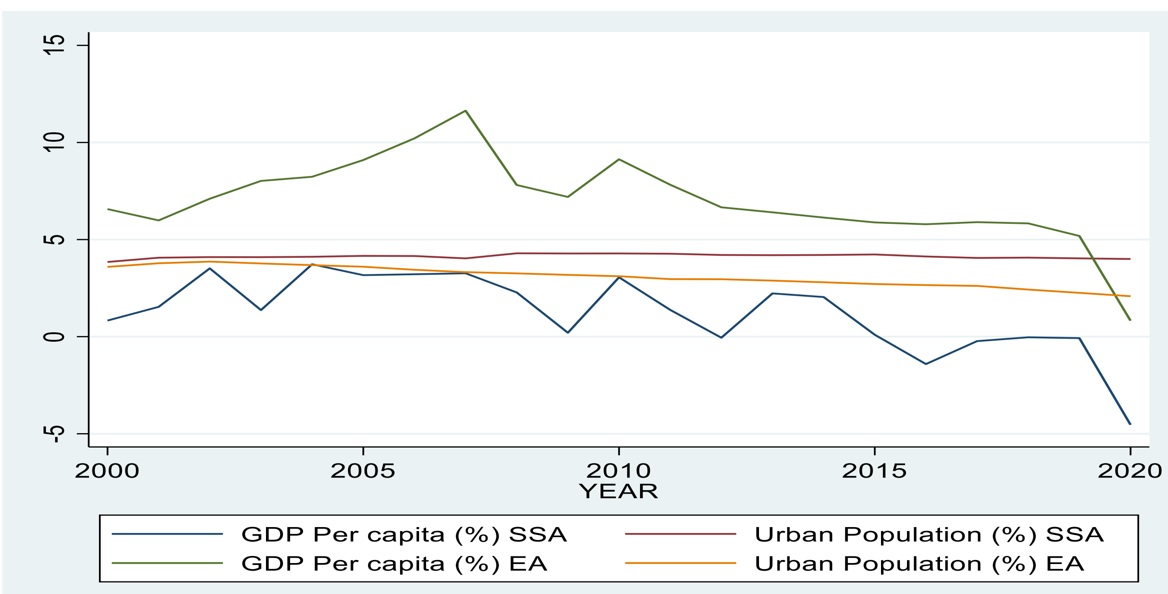
Evidence shows that urban regions of Sub-Saharan African entail weaker growth of manufacturing and high productivity services, signifying a lack of capacity to generate sufficient job opportunities to absorb the growing labor force, thereby pushing a considerable chunk of the labor force into the informal sector. For instance, the African urban labor force working outside the registered enterprises stands at a high 80%, and the share of the working-age population working in the manufacturing urban sector stands at a staggering range of 5% to 15% (Venables, 2018). This points out that substantial social and economic transformations do not accompany urbanization in Sub-Saharan Africa as in the case of developed economies and other developing regions (UN-DESA, 2018).

The statistical evidence of regional economic performance in GDP per capita growth points out a weaker correlation with urbanization in Sub-Saharan Africa compared to other developing regions such as East Asia. For instance, the urban share of the population has risen approximately below 16% in both Sub-Saharan Africa and East Asia between the 1960s and 2000s. However, the GDP per capita has increased by only 50% in Sub-Saharan Africa and 340% in East Asia (Malik et al., 2017; Turok, 2015). Besides, urbanization in Sub-Saharan Africa has kept rising even during economic downturns, primarily carried by the previous urbanization levels (Namasaka & Kamaru, 2017). To fully uncover the regional economic performance in Sub-Saharan Africa, we graphically illustrated the correlation between GDP per capita growth and urbanization rate in SSA and East Asia over the 2000 to 2020 period.

Based on the trends of urban population share and GDP per capita growth in Figure 6 below, it is evident that there has been a stable urban population growth trend in SSA in recent decades. Comparatively, the urban population growth in SSA has been above that of East Asia, although the two regions mimic each other regarding urbanization rate and aftermath urban agglomeration. Although the urbanization rate measured as urban population growth (%) has been stable and growing steadily in SSA, there seems to be a slight decline in the urbanization rate in the East Asian region, especially in the last decade. This can be attributed to distributive development undertaken regarding agricultural mechanization and heightened industrialization compared to SSA.

Regarding economic performance, the GDP per capita growth (%) averaged above 5% annual growth in East Asian economies, with a high value above 10% recorded immediately before the global financial crisis of 2007-2009. On the other and, the GDP per growth in SSA averaged below 5% during the same period. Between 2010 and 2019, SSA's economic performance fluctuated with a growth rate nearing 0 compared to East Asia, whose economic performance maintained higher performance above 5%. Also, the economic performance fragility of SSA is indicated by a sharp slump during the COVID-19 period from 2019 onwards, where the region experienced negative growth compared to the East Asian region, which maintained its growth above 1% even though it experienced a decline.

*Figure 6:*Urban Population and GDP Per Capita Growth in SSA and East Asia: 2000-2020



Source: Author's Computation using WDI Data estimates (2023)

3.5 Descriptive Statistics of Human Well-being in Sub-Saharan Africa

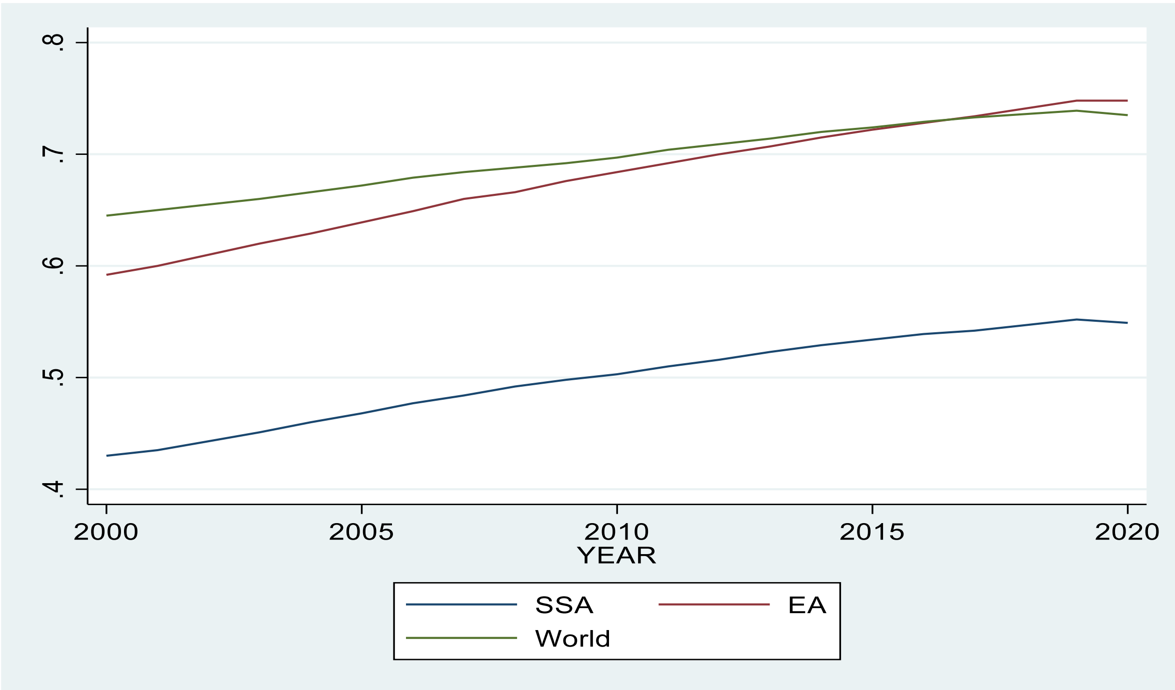
It is broadly acknowledged that rapid urbanization impacts human well-being in various ways (AbdouMaliq & Pieterse, 2012). Urbanization in Global South―SSA and East Asia is happening at a neck-breaking speed; according to 2015 UNDESA estimations, over 70% of the globe's urban share of the population lived in these regions and accounted for 94% of the rise in the worldwide urban population between 2010 and 2015 (UNDESA, 2019). Of today's 33 global megacities, 27 are from the Global South (UNDESA, 2019). Thus, urbanization is increasingly becoming a phenomenon linked with SSA and East Asia, and this unparalleled urbanization process is associated with dramatic changes in human well-being, specifically with a rapid rise in disease infections and joblessness (Comaroff & Comaroff, 2011; Mimiko, 2012). The rising urbanization rate in SSA is associated with increasing informal settlements and slums, where over 60% of the urban population stays in slums (UNDESA, 2019; UN-Habitat, 2016).

One channel through which rapid urbanization in SSA has impacted regional human well-being is through health and other social factors of health. Social determinants of human well-being are based on the acknowledgment of the trends of mortality and disease infections as a result of conditions in which people are born, survive, work, live, cope and unequal living conditions, which in turn results in deeper structural conditions (Commission on Social Determinants of Health, 2008). Regional human well-being disparities in most cities in SSA are buttressed by the fact that a significant share of the urban population lives in dilapidated environments without adequate water, sanitation, and access to economic opportunities, healthcare services, and social and recreational institutions (Smit et al., 2011).

The increased share of the urban population living in slums has continued to worsen the regional human well-being in SSA, with rising cases of infectious diseases such as diarrhea, malaria, and respiratory illness standing at all-time levels in most cities in the region. Besides disease infection, most slum city regions are experiencing overcrowding, inadequate government services, insecurity, and dangerous housing locations, compounding a more significant burden on human well-being (Sverdlik, 2011). In addition, most residents of the informal settlements suffer disproportionately from low human well-being standards throughout their life cycle and are always vulnerable to global well-being shocks. For example, in 2020, a high prevalence of COVID-19 infection occurred in South African informal settlements due to overcrowding and inadequate urban infrastructural service accessibility (Smit, 2020; Sverdlik, 2011).

In this dissertation, we plotted the Human Development Index in SSA, East Asia, and the world to draw the overall picture of regional human well-being over the last two decades. As indicated in Figure 7, the human well-being in SSA averaged below the 0.5 mark between 2000 and 2010 before rising steadily to above 0.5 in 2019, signifying the devastating status of health, education, and economic returns. Comparatively, the region has a low level of human well-being compared to similar urbanizing East Asian areas, with an average HDI of above 0.6 since 2002. In addition, the East Asian region has continued to record a sharply increasing human well-being owing to a fair distribution of economic opportunities, scaled industrialization, and opening up of rural areas, thereby balancing access to economic gains as opposed to shrinking rural development and unreliable urban industrialization in SSA. Notably, the region witnessed a sharp decline in human well-being during the COVID-19 pandemic following the closure of borders and overrun healthcare systems. This was the case for the world and East Asian samples as well.

*Figure 7:*Human Well-being (HDI) Growth in SSA, World and East Asia: 2000 to 2020



Source: Author’s Computation (2023)

This section compares SSA and East Asia, the second most urbanizing region, and draws growth references from the world's or EU's economies. Regarding urban agglomeration growth, the SSA is witnessing a sharp rise in urban population share, especially in agglomerations with over 1 million inhabitants. At the same time, the rural population growth has been drastically declining in the last two decades. Although the urban population and urban agglomeration growth patterns follow the same direction, SSA growth is above East Asia's. Concerning income inequality, the SSA trend shows a high level of heterogeneity compared to EA and EU, depicting a fragile economic performance situation in the region. Justifiably, the GDP per capita growth has been steadily below that of the EA and EU. The chapter also provides a significantly low level of urban infrastructural service accessibility, pointing to the lowest regional human well-being in the region as indicated by very low HDI compared to that of EA and EU.

3.6 Subject of Research (Unit of Analysis)

The dissertation focused on city regions of Sub-Saharan African member countries. Geographically, Sub Sahara Africa consists of 48 out of 54 independent African nations. The area lies to the south of the Sahara Desert and thus politically and economically categorized as a region of an African continent by the United Nations. The region comprises (25) coastal countries, (7) inland countries, and (16) landlocked countries. Regarding surface area, Sub-Saharan Africa covers the largest region in Africa. The land surface occupied by Sub-Saharan Africa is more significant than the 28 European Union member states combined. It is the second largest after the Asian continent as far as land area is concerned. Regarding demographics, the region has a population of over one billion and a population density of 46.34 square kilometers. Further, the region’s population spans over 3,000 ethnic groups with more than 1,000 spoken languages (UN-DESA, 2019).

In terms of urbanization, the region has a current urbanization rate of 3.987%, a share of the urban population standing at 468 million people, out of which 15.889 million people stay in the largest agglomeration of more than 1 million, and 26.497% of the urban population stay in largest metropolitan cities. Due to governance's inability to regulate the region’s rural-urban migration, over 50% of the share of the urban population remains in dilapidated slum informal settlements under acute conditions of poor housing, inadequate access to water services, safe sanitation facilities, and energy services (World Bank, 2020).

The region also boasts rich natural resources such as gold deposits, bauxite, iron core, chromium, uranium, manganese, diamond, and vanadium. Countries like South Africa are the largest producers and exporters of platinum, chromium, and manganese. Nigeria, Cameroon, Congo, Angola, Equatorial Guinea, and Gabon are critical oil exporters worldwide. Ghana, Mali, Namibia, and Botswana produce and export the best diamonds in the world. Further, the Sub-Saharan African region has high-grade uranium, iron core, copper, and bauxite. Other critical natural resource-producing countries include the Democratic Republic of Congo, Niger, Liberia, Guinea, and Zambia. Countries like Kenya, Uganda, Tanzania, and Ethiopia are leading agricultural countries in SSA regarding coffee, tea, sugar cane, and rice. These natural resources have aided the economies in boosting regional economic performance, as indicated by the current net adjusted income per capita (constant 2015) stands at $1,335.616 (World Bank, 2020; Suma, 2007).

This dissertation considered 22 Sub-Saharan African countries as part of the unit of analysis. The 22 Sub-Saharan African countries randomly sampled for this study are Angola, Burkina Faso, Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Liberia, Malawi, Mali, Mozambique, Madagascar, Zimbabwe, Nigeria, Democratic Republic of Congo, South Africa, Tanzania, Uganda, Zambia, Togo, Republic of Congo, and Niger. The study was restricted to the selected countries' urban population, income inequality, urban infrastructure, regional economic performance, and human well-being. The chosen countries are deemed independent geographically but economically, socially, and politically interconnected. Additionally, the study considered countries with similar demographic growth trends; hence, countries with extremely low urban population shares were excluded from the final list (Suma, 2007). The unit of analysis of selected SSA countries is depicted in Figure 8 below.

Figure 8: Selected Sub-Saharan African Countries

Source: Own Construction (2024)

3.7 Theoretical, Empirical Model, Data Description, and Estimation Methods

In this subsection, our primary focus is to build the theoretical model, expound on the variables of crucial interest, their measures, data type, and data source, and develop the model estimation framework. The theoretical model is built based on the gathered literature regarding the nexus between urban agglomeration and regional economic performance from a theoretical view. The empirical strategy is built within the premise of the established theoretical model by exploring different specifications and application forms of the panel dynamic model, which is our primary estimation approach in this study. In this effect, we present the recent development of the dynamic panel model and various methods used in estimating the model, from conventional regression approaches to the generalized method of moments. After reviewing the general panel dynamic model specification, we contextualize the econometric model to attain the study's main objectives. Lastly, we describe these variables and data by pointing out how various variables will be measured and the associated data and sources. The last section of this chapter lays down the model estimation procedures and techniques to attain the study's objectives.

3.7.1 Theoretical Model

How is urban agglomeration linked to regional economic performance? Economists have repeatedly been interested in modeling the nexus between urban agglomeration, urbanization, productivity, and regional economic performance (Lewis, 1954; Marshall, 1890). Over the recent decades, the urban economists' agglomeration life cycle theory and the New Economic Geography (NEG) theory are among the latest literature strands to evaluate the relationship's avenues. In cooperation, the two schools of thought undertake different but complementary dimensions for assessing the link, and the ultimate tenor, specifically from the empirical literature, is that urban agglomeration orchestrated by rapid urbanization is a significant precursor of regional economic performance through the influence on population's productivity at a regional level (Hoselitz, 1953).

According to the agglomeration life cycle and NEG theoretical models, the nexus between urban agglomeration and regional economic performance occurs at the national or regional level (Krugman, 1991). In the NEG framework of the location of industries, the external economies of scale, induced through the co-location of the urban population and urban economic activities, make urban dwellers and companies more productive (Krugman, 1991). Among the many mechanisms through which external economies enhance urban productivity and human well-being are the pooled labor markets facilitated by urban agglomeration, driven by rural-urban migration that enables more accessible learning, sharing, and matching between workers and firms. In tandem, centrifugal forces such as high urban land prices, pollution, limited urban infrastructural service accessibility, and skewed urban governance work in the opposite direction as urban agglomeration rises and hence decrease the productivity and overall human well-being of the urban population (Brülhart & Sbergami, 2009; Castells-Quintana, 2017; Ottaviano, 2001).

Several recent empirical studies have analyzed the predictive efficiency of the theoretical agglomeration and NEG models (Brülhart & Sbergami, 2009; Castells-Quintana, 2017; Henderson, 2003). The emphasis of these studies has been majorly on evaluating whether urban agglomeration, as measured by the population of a large city (urban primacy), is an economic performance-inducing factor as opposed to analyzing the growth effect of urban agglomeration (urban share of population), the topic with which our study is concerned with. This study follows the theoretical literature strand of Brülhart and Sbergami (2009) and Castells-Quintana and Royuela (2014), who used a share of urban population living in city regions above 1 million dwellers as an indicator of urban agglomeration. The two studies observed supporting evidence of the urban agglomeration-regional economic performance link: the larger the urban agglomeration measured by the share of urban population above the threshold of 1 million, the better the regional economic performance of the target countries, specifically those at the lowest level of economic development. However, one disadvantage of this literature is that it overlooks the vast differences in the size of the urban population and its implication on urban infrastructural service accessibility and general human well-being across nations (Frick & Rodriguez-Pose, 2018). It is thus necessary to add more nuance to urban agglomeration analysis to have a unified relationship with regional economic performance outside the threshold of 1 million people. Therefore, in this study, we consider the urban share of the population as an indicator of urban agglomeration, bearing in mind the sizes of the largest cities' populations, particularly small countries with less than 1 million people in their capitals. We also factor in the implication of urban agglomeration on urban infrastructural service accessibility and how it impacts human well-being.

To derive the theoretical model in line with and agglomeration life cycle and NEG theory, we base our argument on a GDP per capita growth outline, which enables us to analyze, in reduced form, the impact of urban agglomeration, following the works of Henderson (2000), Brülhart and Sbergami (2009) and Castells-Quintana (2017). These studies relied on the regional economic performance foundation's neoclassical backgrounds in deriving specific empirical models for standard cross-nation growth regressions (Bates, 1981). In this framework, one can consider the country-specific attributes, for example, location, resources, institutions, features of economic geography, and well-being of the people to allow for the heterogeneity in initial conditions, as well as in efficiency growth pathways, that impact economic performance, human well-being, and income distribution. Consequently, cross-nation differences in GDP per capita growth rates, HDI, and Gini Index are anticipated to rely not only on their initial growth levels and accumulation of factors but also on the differences in the specific country attributes:

Following the neoclassical framework of economic performance foundation for an ideal cross-country growth regression model, we begin as follows:

$$\Delta yi = \beta logy_{i,0} + \varphi X_{i,0} + \pi Z_{i,0} + \varepsilon i \quad (3.1)$$

whereby Δy_i is the GDP per capita growth rate, HDI, and or Gini Index for country i, $y_{i,0}$ are the initial levels of GDP per capita, HDI, and Gini Index, $X_{i,0}$ is the variable representing factor accumulation (that's standard Solow determinants) plus the constant term, $Z_{i,0}$ is the vector representing the country-specific attribute explaining the cross-country variances in growth efficiencies or initial conditions and ε_i is the error term taking care of other factors.

By introducing urban agglomeration as the determinant of regional economic performance, regional well-being, and income inequality, we consider it within the vector $Z_{i,0}$. The extent to which urban agglomeration is an ideal attribute influencing growth efficiency (Henderson, 2003; Castells-Quintana, 2017), as it reflects the unexploited agglomeration economies and thus provides the possibility for growth changes or become exhausted is stated as follows:

$$\Delta y_i = \beta\left(logy_{i,0}\right) + \varphi X_{i,0} + \lambda urbshy_{i,0} + \pi Z_{i,0} + \varepsilon_i \quad (3.2)$$

whereby $urbshy_{i,0}$ is the extent of the urban share of the population, as our selected indicator for urban agglomeration and $Z_{i,0}$ represents other pertinent country-specific elements. However, as alluded to in the introductory section, how the urban share of the population (an indicator of urban agglomeration) influences the growth efficiency of regional economic performance, regional human well-being, and income distribution depends on the specificities of the urban process. In particular, urban infrastructural service provision defines the urban environment, resulting in distinct capabilities for the metropolitan region to benefit from agglomeration economies and to contain an upsurge of people, otherwise known as congestion diseconomies. As noted by Henderson (2003), urban infrastructure affects not only the resources allocated to improving urban well-being but also impacts the economic productive efficiency and income distribution, that's, the extent to which knowledge spillovers are optimally harnessed and exploited. Bertinelli and Black (2004) stylized the urban economics model, which suggests a testable prediction that the quality of urban infrastructure significantly influences the growth-inducing effects of urban agglomeration. Hence, taking this into prediction account, we extend equation (3.2) to:

$$\Delta y_i = \beta\left(logy_{i,0}\right) + \varphi X_{i,0} + \lambda_1 urbshy_{i,0} + \lambda_2 urinf_{i,0} + \lambda_3 urbshy_{i,0} * urinf_{i,0} + \pi Z_{i,0} + \varepsilon_i \qquad (3.3)$$

where $urinf_{i,0}$ is the specificity of the urban process indicated by the quality of urban infrastructure and $urbshy_{i,0} * urinf_{i,0}$ is the interaction term between urban infrastructure and urban agglomeration.

Equation (3.3) above is our general theoretical model based on the neoclassical growth framework backed up by the agglomeration life cycle, inverted U-shaped Kuznets, NEG theory, and the theory of a good city. In this theoretical model, the main objective is to depict how urban agglomeration influences growth efficiencies of regional economic performance through the quality of urban infrastructure and other factors of a specific city. Secondly, the model captures how urban agglomeration affects regional well-being through the precincts of competition for urban infrastructural services, resulting from skewed urban governance and limited financial resources. Thirdly, the model sheds light on how urban agglomeration influences income distribution. As argued in the literature, as the urban share of the population increases, the urban employment opportunities dwindle, resulting in many active people being jobless, thus, overall, income inequality in the region. To test this model, we sub-divide the main model in equation (3.3) into specific theoretical models in line with the three study objectives before proceeding to empirical strategy. The detailed theoretical models in line with the three main objectives are stated as follows:

$$\Delta GDPperc_i = \beta\left(logGDPperc_{i,0}\right) + \varphi X_{i,0} + \lambda_1 urbshy_{i,0} + +\pi Z_{i,0} + \varepsilon_i \qquad (3.4).$$

This equation (3.4) captures the effect of urban agglomeration ($urbshy_{i,0}$) and other urban-specific factors ($Z_{i,0}$) taken care by control variables (urbanization rate, rural-urban migration, urban employment, and industrialization) on regional economic performance ($GDPperc_i$).

$$\Delta Gin_i = \beta\left(logGin_{i,0}\right) + \varphi X_{i,0} + \lambda_1 urbshy_{i,0} + \pi Z_{i,0} + \varepsilon_i \qquad (3.5).$$

Equation (3.5) captures the effect of urban agglomeration ($urbshy_{i,0}$) and other urban-specific factors ($Z_{i,0}$) taken care by control variables (regional economic performance, urbanization rate, rural-urban migration, and industrialization) on income inequality (Gin_i).

$$\Delta HDI_i = \beta\left(logHDI_{i,0}\right) + \varphi X_{i,0} + +\lambda_1 urinf_{i,0} + +\pi Z_{i,0} + \varepsilon_i \qquad (3.6).$$

This equation (3.6) captures the effect of urban infrastructural services ($urinf_{i,0}$) on regional human well-being (HDI_i). The control variables (urban governance, urbanization rate, rural-urban migration, urban employment, and institutional quality) take care of the country-specific factors. These models (3.4, 3.5, and 3.6) were estimated using a dynamic panel econometric model from a spatial dimensional framework, as discussed in the subsequent section of the empirical model and estimation strategy.

3.8 Variable Description and Basic Data Stylized Facts

This section describes study variables, their operationalization measures, and indicators. The measurements and indicators are adopted from previous studies and theoretical notions. Secondly, the section describes the data, their sources, and the time in consideration. The data's description helps pinpoint the underlying assumptions, corrective procedures, and purging techniques in preparing the data for modeling and estimating objectives. Also, the section presents the stylized facts regarding the variable indicators, measures, data, and the selected econometric model. Lastly, the section discusses the estimation techniques that the study utilizes in analyzing the data in line with the chosen empirical model.

3.8.1 Operationalization of Variables

The study focuses on five main topical issues: urban agglomeration, urban infrastructural service accessibility, income inequality, regional economic performance, and regional human well-being in the Sub-Saharan African context. From the theoretical foundations, urban agglomeration refers to the city regions' concentration of people, industries, and economic activities. Measuring urban agglomeration has evolved, with different researchers applying different indicators. In this study, urban agglomeration was measured using the urban share of population and how it contributes to human capital formation, regional economic performance, and urban infrastructural service accessibility as supported by the works of Wei et al. (2016), Thomas et al. (2012) and Castells-Quintana

(2017). Specifically, we draw reference to the studies by Castells-Quintana (2017) and Brülhart and Sbergami (2009), which used three indicators of urban agglomeration: country's share of population living in city regions with over 750,000 people, the share of urban population living in areas described by national and World Bank statistics as urban, and the share of urban population living in the largest city described as city primacy. Lastly, we computed HHI50 and HHI100 indices as more nuanced measures of urban agglomeration in the first objective as postulated by (Frick & Rodríguez-Pose, 2018).

Urban infrastructure is broadly defined as the systems that provide energy, water, sanitation, waste management, communication, transportation, public green spaces, and affordable housing services, which are vital in supporting human well-being and economic prosperity in city regions (Ramaswami et al., 2012). It was included as the independent variable influencing regional human well-being. The role of urban infrastructure, specifically accessibility of water, sanitation, and energy, has been identified to be robust among the long list of control variables and distinct specifications. Urban infrastructural service accessibility plays two key roles. First, it directly influences the living conditions and the well-being of the urban population (Lewis, 2014). For instance, according to UN-Habitat Reports, over 1 billion people globally, of whom the majority are in developing regions, live in slums with dilapidated and inadequate urban infrastructural services such as water, sanitation, and energy. Secondly, access to urban infrastructural services cements the trade-off between economic performance costs and benefits of urban agglomeration (Fay & Opal, 2000; Bloom et al., 2008). Therefore, to measure the quality of urban infrastructural service accessibility, this study considers three indicators per World Bank statistics: the share of the urban population accessing water, sanitation, and electricity (Castells-Quintana, 2017).

Income inequality refers to the economic differences resulting from an increased urban agglomeration (urban population share) (Kuznets, 1955). It also involves differences in access to social amenities, employment opportunities, and the general well-being of the urban population (Harris & Todaro, 1970; Brulhart & Sbergami, 2009). It was included in this study as the dependent variable influenced by increasing urban agglomeration, which creates a difference in regional economic performance and access to basic needs by the urban population. According to Kuznets (1955), urban agglomeration pursued by the rural-urban or within urban informal-formal and formal-informal migration processes fundamentally increases income inequality during the early stages of urban agglomeration. As urban agglomeration rises, urban economic performance and industrialization increase the per capita income gap between the formal and informal sectors (Brulhart & Sbergami, 2009). The most celebrated measure of income inequality is the Gini Index, developed by Gini (1909). This measure has been adopted by several studies that have paid attention to the linkage between urban agglomeration and income inequality (Adams & Klobodu, 2019; Arouri et al., 2017; Liddle, 2017; Sulemana et al., 2019).

Regional economic performance refers to the general well-being of a region in terms of economic activity. It was included in this study as the primary dependent variable. The variable was measured by GDP per capita growth in line with the pyramidal model fronted by Lengyel and Szakálné (2012). This signifies that regional economic performance is propelled by high labor productivity resulting from human capital formation processes such as matching, learning, and sharing of skills within the proximity of firms in the urban regions (UN, 2018; Nijkamp & Kourtit, 2012). Several previous studies have adopted the measure in their analyses, some of whom have observed supporting evidence of the positive link between urban agglomeration and GDP per capita (Henderson, 2003; Sekkat, 2013; Castells-Quintana & Royuela, 2014; Brülhart & Sbergami, 2009). Another section of studies has found supportive evidence of the negative link between urban agglomeration and GDP per capita (Davis & Henderson, 2003; Bloom et al., 2008; Gollin et al., 2014).

Regional human well-being is the last variable defined as the degree to which people in a given region have better access to social services such as water, energy, sanitation and health, economic opportunities, and safety (Zanella et al., 2015). Nevertheless, from the urbanization view, regional human well-being still lacks a universal definition and measurement due to its complex character (Zhan et al., 2018). For instance, human well-being has been interchangeably used with overlapping concepts such as sustainability, urban livability, and quality of life, which makes the definition and interpretation more difficult (Kovacs Györi et al., 2019).

Recently, Paul and Sen (2018) defined regional human well-being as the general standard of living within a city, region, or country, which can be measured subjectively or objectively. Regarding subjective measures, regional human well-being comprises life satisfaction, such as gratification with overall life, emotional well-being, hedonic well-being, and eudaimonia, which refers to the meaning and self-actualization in life (Organization for Economic Corporation and Development, 2013). However, this study adopts an objective measure of regional human well-being (Enqvist & Ziervogel, 2019). In this effect, regional human well-being is measured using the Human Development Index (HDI), an objective measure that captures different facets of indicators of better living conditions for people in a region (UNDESA, 2018; Das et al., 2022). The summary of the variable description, operationalization measures, and data sources are presented in respective analysis chapters.

3.8.4 Basic Data Stylized Facts

Before carrying out econometric modeling and analysis, a primary look at urban agglomeration, urban infrastructural services, regional economic performance, income inequality, and regional human well-being patterns worldwide in recent periods enables us to put forth some basic yet interesting stylized facts. In particular, we present the urban agglomeration indicators, such as the share of the urban population described as urban, which has been identified as around 35% in developed regions and above 43% in developing regions such as Sub-Saharan Africa (World Bank, 2018). The second fact concerns the urbanization pace in developing areas and subsequent urban agglomeration in Sub-Saharan Africa compared to its counterpart in developed regions such as the European Union. Statistical evidence shows that while the share of the urban population in Sub-Saharan Africa has been below that of the developed area such as the EU, the region has continued to maintain an average growth rate of 2% more than that of the EU between 1990 and 2000, and growth rate of 4% between 2010 and 2021 (World Bank, 2022).

The third fact concerns the heterogeneity in the relationship between urban agglomeration and regional economic performance. Whereas there has been an insignificant negative linkage between the two variables in the world sample (-0.03), the correlation by development level changes; urban agglomeration positively correlates with developed regions, not developing regions. For instance, it is positive in Asia and Europe and negative in Oceania and SSA (-0.13) (Castells-Quintana, 2017; World Bank, 2022). The fourth stylized fact relevant to the study is the condition of urban infrastructure, where significant heterogeneities across different nations have been observed. Mainly, the pace of urbanization in various developing countries is characterized by the large share of the urban population living with inadequate well-being and limited access to essential infrastructural services such as water, sanitation, and energy. Whereas access to these infrastructural services was seen as universal in developed regions in 1990, it was not the case in developing areas, with observable differences among them and, particularly, enormous inadequacies in Sub-Saharan Africa. For instance, the average access to water, sanitation, and electricity was less than 5% and 10% for the SSA region in 1990 (World Bank, 2022).

The fifth stylized fact concerns the choice of balanced panel data from 2000 to 2020. Our decision is informed by the fact that short data panels are highly variable and more efficient, helping to uncover the adjustment dynamics and allowing for easy identification of measure impacts (Baltagi, 2005). Also, the decision to use a short panel of 21 years was informed by the unavailability of urban infrastructure data for Sub-Saharan Africa before 2000. The sixth basic stylized fact is about variable inclusion and measurement. To begin with, the panel data on the urban share of the population was used to measure urban agglomeration as the concentration of people in metropolitan cities consists of rural-urban migrants and urban births (Baltagi, 2005; Harris & Todaro, 1970).

Regarding urban infrastructure, the quality (share of the urban population accessing water, sanitation, and energy infrastructural services) was considered as opposed to the quantity or share of GDP allocated to urban infrastructure. This helps point out the direct implications of the urban infrastructure to urban dwellers regarding accessibility and utilization (Martinez-Vazquez &Wu, 2020). The Human Development Index (HDI) was used to measure regional human well-being, influenced by the quality of urban infrastructural service accessibility (Ramaswami, 2020). Finally, the stylized fact is about the variability nature of the panel data, which informs the use of the dynamic panel data model, especially involving the demographic transitions from rural to urban regions (Baltagi, 2005). Thus, the model is best suited as it can uncover the dynamic trend of the data, providing robust findings in line with the anchoring theoretical assertions (Baltagi, 2005).

3.9 Study Design, Rationale, and Estimation Techniques

As mentioned in chapter one, this study follows a deductive approach; thus, the design approach is quantitative. The quantitative research approach enables the researchers to critically evaluate the interactions between the study variables under the set hypotheses and leading research questions (Creswell, 2013). The quantitative analysis technique also aids in operationalizing variable definitions and thus allows the study to be replicated in different circumstances, thereby improving and advancing the existing literature (Matveev, 2002; Creswell, 2013). This study used Pooled Ordinary Least Squares (OLS), Fixed Effects (FE), Random Effects (RE), Difference GMM, and System GMM techniques, together with all necessary estimation tests, as illustrated below.

3.9.1 Cross-sectional Dependence and Panel Unit Root Test

Conducting a stationarity test for time series for dynamic panel analysis is significant since most econometric estimation models utilize the current period based on the time series stationary theory. This is because series datasets are usually unstable; thus, if used for dynamic panel analysis in its non-stationarity state, it results in spurious regression findings characterized by insignificant t-ratios from zero. The coefficient of determination (R^2) is too high (Brooks, 2014). Stationarity exists if the dataset has a constant mean, non-varying variance, and autocovariance for each provided lag. It is subjected to different levels of difference to make non-stationary data stationary. A stationary series after differencing is said to be integrated into order one using Innovation Technique I(1). To ascertain the stationarity of the dataset in this study, we apply a combination of unit root tests developed by Breitung (1994) and Quah (1994) and formally modified by Levin, Lin, and Chu (1992, 2002) and Im, Pesaran and Shin (1997, 2003) leading to Levin, Lin and Chu Tests and Im, Pesaran and Shin Test.

The stationarity test postulated by Levin, Lin, and Chu (2002) for dynamic panel data models assumes a null hypothesis that the data series has a unit root against the alternative hypothesis that the data series has no unit root. This is stated as follows:

$$H_0: \rho_i = 0, \text{for all regions i}$$

$$H_0: \rho_i < 0$$

Levin, Lin, and Chu suggested three distinct estimation models for determining stationarity in dynamic panel analysis. The models are specified without individual effects, models with a particular specific effect but with no time trend, and the last model is a series without unique specific effects, linearity, and time trend.

Im et al. (2003) proposed the unit root test, and it recommends using the mean of the individual stationarity statistic to determine the stationarity of the heterogeneous panel datasets. The test assumes a null hypothesis, stating that every panel data series contains a unit root. An alternative idea noted that some of the series but not all the single data series have a unit root. The hypotheses are stated as follows;

$$H_0: \rho_i = 0, \text{for all regions } i$$

$$H_0: \rho_1 < 0 \ for \ i = 1,2, \dots \dots \dots N_1$$

and

$$H_0: \rho_1 = 0 \ for \ i = 1,2, \dots \dots \dots N_{1+1}, \dots, N$$

Verifying the cross-sectional dependence has become required for dynamic panel analysis. This is due to the dynamic economic occurrences such as recessions, inflation, pandemics, and financial crises, which impact the entire world economy and induce significant interdependency across nations or regions (cross-sectional units), regressors of the model, and the error term (Pesaran, 2006). Nonetheless, panel estimation techniques such as Pooled OLS, FE, RE, and generalized method of moments (GMM) estimators disregard the probable existence of the cross-section dependence among countries, regions, or cities, resulting in misleading inferential statistics.

As such, in this study, we shall check the presence of cross-sectional dependency for the panel data using the Breusch-Pagan LM test (1980), Pesaran LM test (2008), and Pesaran CD test (2004). In the presence of cross-sectional dependence in the panel dataset, the first-generation unit root test like the Augmented Dickey-Fuller (ADF) test, Philips-Perron (PP) test, Im, Pesaran, and Shin (IPS), and Levin, Lin, and Chu(LLC) may not be appropriate in testing for the stationarity. Therefore, the cross-sectional dependence is addressed by utilizing the "CIPS" unit test developed by Pesaran (2007), as it is ideal for accommodating the cross-sectional dependence in the panel dataset.

3.9.3 Pooled Ordinary Least Squares (POLS)

Dynamic panel data estimation is used to analyze cross-sectional and time-series datasets. These datasets are collected on individual items repeatedly over time. Gujarati (2003) opined that combining time series and cross-section enhances the number of the dataset and its quality, which would not be possible when using cross-sectional or time-series data. In panel analysis, the heterogeneity problem is controlled using control variables. In this accord, the unit of study, such as firms, nations, or regions, is viewed as heterogeneous.

The pooled OLS estimation model is critical when analyzing the effects of variables that change over time and determining the outcome variables within a specific region, country, or any other entity (Baltagi, 2008). Pooled OLS is appropriate for this study as it aids in identifying and measuring effect relationships that are not easily detected in a pure time series or cross-sectional data analysis. The general Pooled OLS model is stated as follows;

$$y_{it} = \alpha_i + \beta x_{1it} + e_{it} \tag{3.7}$$

where y_{it} is the dependent variable (regional economic performance and income inequality) in this study for region i over some time t, α_i is the intercept variable representing region i. The vector representing the independent variable (urban agglomeration and urban infrastructure) for region i is x_{1it}. The vector representing the unknown parameter estimates among regions is β, and e_{it} is the error term for region i and period t. This study will integrate several other conventional and dynamic panel regression analyses.

3.9.4 Dynamic Fixed Effect Model (FE) (Baseline)

The dynamic Fixed effect estimation model refers to a panel regression method whereby the group means is a fixed sample from the data population. A panel of data utilized in the fixed-effect model analysis is grouped in line with distinct observed factors, where grouped means are modeled and determined as group-spec quantity. The justification for incorporating the FE model in this study is that it accommodates the heterogeneous attribute or variability linked to individuals, countries, firms, or, in this case, regions (Greene, 2012). With the heterogeneous nature of the Sub-Saharan African economic region, many periods (T), and several country regions (N) under consideration, the FE model is suitable for this study. Another critical reason why the FE model is adopted in this study is that it helps to eliminate the omitted variable biasedness which can arise from the unobserved heterogeneity, thereby controlling for the individual time-invariant features across country regions (Edeme & Nkalu, 2019; Torres-Reyna, 2007).

One of the assumptions that must be fulfilled before using the FE model is that the error term could be correlated with the individual fixed effect. That is, the assumption of strict exogeneity and feedback effects should be held so as:

$$E(\mu_{it}) \mid X_{i1}, X_{i2}, \ldots, X_{iT}, \eta_i) = 0 \tag{3.8}$$

This assumption rules out any possible correlation between current errors and present or future values of the independent variables (feedback effect phenomenon which moves from Y to X). If present, the FE model estimates become spurious or inconsistent (Nickell, 1981). Therefore, the FE model is specified as follows:

$$y_{it} = X_{it}\beta + \alpha_i + e_{it} \qquad (3.9)$$

where y_{it} is the representation of the response variable (regional economic performance and income inequality) for region i over a time period t X_{it} represents the 1 X P time-invariant independent variables (urban agglomeration and urban infrastructure), β is the P X 1 matrix representing the coefficient estimate of the independent variables. The individual unobserved time-invariant effect is represented by α_i, and the error term for a country region i over a time period t is represented by e_{it}.

3.9.5 Dynamic Random Effect Model (RE)

Greene (2012) states that a random effect (RE) regression estimation model is a regression model bearing an arbitrary constant term. It is a regression model whereby the group means are random and can be modeled as random for every grouping. The redundant error in the RE model is addressed by assuming that the intercept is a random outcome variable. The assumption for estimating the panel data using a random-effect model is that the individual-specific effect is not correlated with the independent variables. Just like in the FE model, the assumption of strict exogeneity holds as follows:

$$E(\mu_{it}) \mid X_{i1}, X_{i2}, \dots\dots, X_{iT}, \eta_i) = 0 \qquad (3.10)$$

The random effect (RE) model is stated as follows:

$$y_{it} = \beta_{oi} + \beta_1 X_{it} + \beta_2 X_{it} + e_{it} \qquad (3.11)$$

where $\beta_{oi} = \beta_i + \mathrm{V}_i$

Therefore, the complete dynamic RE model becomes;

$$y_{it} = \beta_i + \beta_1 X_{it} + \beta_2 X_{it} + e_{it} + \mathrm{V}_i \qquad (3.12)$$

where y_{it} is the representation of the response variable (regional economic performance and income inequality) for region i over a time t, X_{it} represents the independent variables (urban agglomeration and urban infrastructure) for region i over a time t, β is the vector representing the unknown parameters that are common to areas, V_i represents the disturbance term for a specific heterogeneity for an individual country region i and is constant over a given period, and the white noise specific to a particular observation for a country region i over a time period t is represented by e_{it}.

3.9.6 Hausman Test

Hausman test is conducted mainly in panel data analysis estimation to determine if the random or fixed effect model is ideal. It also helps in testing for the misspecification of the estimation model. The Hausman test assumes a null hypothesis that the selected model has a random effect. The alternative hypothesis states that the selected model has a fixed effect, implying that the individual heterogeneity terms and exogenous variables in the model are deemed correlated. Nonetheless, suppose the null hypothesis is not rejected. In that case, the random effect model is ideal, signifying that the unique error term and the independent variables in the estimation model are not correlated.

3.9.7 Generalized Method of Moments (GMM) Model

The Generalized Method of Moment is a celebrated dynamic panel estimation method extensively used in econometric spatial literature as fronted by Arellano and Bond (1995). The technique is primarily categorized into the system generalized method of moment (Sys-GMM) and generalized method of moment first difference (Diff-GMM). Based on the reviewed literature, the system generalized method of moment (Sys-GMM) is considered effective in estimating panel data compared to Diff-GMM, Pooled OLS, RE, and FE. The system GMM estimation method is regarded as more efficient because it uses the level of the lags of the instrumental variables for the differential equations and the differences in the lags as instrumental variables for the equation levels. Also, it has more instrumental variables compared to the Diff-GMM. It is ideal when a single observation in the panel data is sufficiently large within a short period. The Sys-GMM helps address the endogeneity, heteroscedasticity, and autocorrelation problems linked to cross-sectional and time series datasets (Roodman, 2009).

To specify the two categories of GMM models, we start by stating the conventional dynamic panel model stated as:

$$Y_{it} = \alpha_0 + \alpha_1 Y_{it-1} + \beta X_{it} + \varepsilon_{it}, i = 1, \dots, N, t = 1, \dots, T \quad (3.13)$$

where Y_{it} is the response variable (regional economic performance and income inequality), α_0 is the intercept, α_1 is the coefficient estimate of the lag value of the response variable Y_{it-1}, β is the coefficient estimate of the independent variable (urban agglomeration and urban infrastructure) X_{it} and the error term represented by ε_{it} for region i and period t. From this, a Difference-GMM by Arellano and Bond (1991) population known as the Arellano-Bond estimator (Diff-GMM) is specified. This estimation procedure computes the difference of every variable about its first lag.

Thus, by rewriting equation (3.13), we have;

$$\Delta Y_{it} = \alpha_0 + \alpha_1 \Delta Y_{it-1} + \beta \Delta X_{it} + \Delta\varepsilon_{it}, i = 1, \dots, N, t = 1, \dots, T \quad (3.14).$$

This estimation procedure considers the moment condition, $E[Y_{i,t-s}\Delta\varepsilon_{it}] = 0$, with t=3, ..., T and S=2, ...,t-1, and utilizes the vector $(Y_{i1}, \dots, Y_{i,t-2})$ as the GMM instruments for ΔY_{it-1}.

The second estimation model under GMM by Blundell and Bond (1998), referred to as the System-GMM estimator (Sys-GMM), which, as mentioned under the overview of the model, is critical in enhancing the efficiency of the Diff-GMM by using more moment conditions in the level equation. The procedure regards $(\Delta Y_{i,2}, \dots, \Delta Y_{i,t-1})$ as the instruments for $(Y_{i,t-1})$ under the moment condition $E[Y_{i,t-s}\varepsilon_{it}] = 0$, with t=3, ..., T and s=1, ..., t-2 (Arellano & Bover, 1995; Blundell & Bond, 1998). Further, the system-GMM can exploit the moment condition:

$$E[\Delta X_{i,t-1} \eta_i + \mu_{it})] = 0 \quad (3.15).$$

The model is explicitly stated as follows;

$$Y_{it} = \alpha_0 + \alpha_1 Y_{it-1} + \beta X_{it} + \eta_i + \lambda_t + \mu_{it}, i = 1, \dots, N, t = 1, \dots, T \quad (3.16).$$

where the error term (ε_{it}) in equation (3.13) is decomposed into three components: unobserved heterogeneity (η_i) of the regions (i), (λ_t), which represents the time-fixed effects, and (μ_{it}) defining the model's error term.In summary, this sub-section reviewed the theoretical model for estimating the study relationships and effects derived from the theoretical notions in chapter two.

4. URBAN AGGLOMERATION AND REGIONAL ECONOMIC PERFORMANCE CONNECTEDNESS: A THIN ICE IN DEVELOPING REGIONS

This chapter contributes to the ongoing debate regarding whether urban agglomeration is a growth-augmenting or inhibiting, especially from the developing regional perspective. Also, the chapter lays bare the actual urban agglomeration evolution trends in the recent two decades and how this has affected the economic performance of developing economies. The chapter provides in-depth theoretical, empirical, and statistical modeling and deductions based on the Two-Step Instrumental Variable Generalized Method of Moments (2SIV-GMM) model of the urban agglomeration and economic performance using unbalanced 5-year interval data from 2000 to 2020 for 66 countries from SSA, Asia, and Europe regions.

4.1 Introduction

Several regions have encountered a sizable drift in the geographic relocation of their population from rural to urban areas, particularly in developing regions such as Africa and Asia, especially in recent decades. Specifically, population growth combined with rapid urbanization has compounded the increase in some cities' sizes, attenuating the population in other areas, and the birth of new urban areas has occurred (Frick and Rodríguez-Pose, 2018). The urbanizing towns and regions are where more than half the world's gross population resides (Grafakos et al., 2019; UN, 2019). By 2050, more than two-thirds of the world's population will reside in urban areas, with millions living in informal and unplanned settlements and growing cities in Sub-Saharan Africa (SSA; United Nations Department of Economics and Social Affairs, 2018). This prediction is based on recent urban agglomeration and population dynamics growth trajectories. For example, the world's population increased from 13.09 million in 2000 to 14.35 million in 2010 and more than 17.97 million in 2022 (UNDESA, 2018; World Bank, 2022).

The increasing concentration of the urban population (urban agglomeration) preceding rapid urbanization has been investigated regarding its connectedness to economic performance dynamics, namely, poverty reduction, CO_2 emissions, and income inequality (Christiaensen et al., 2013; Makido et al., 2012; Mohajeri et al., 2015; Castells-Quintana and

Royuela, 2015; Moreno, 2017; Ovyat, 2016; Sekkat, 2017). Whether increasing urban agglomeration spurs economic performance is a hot research topic in developing regions' policy agendas. An increasing amount of evidence supports the view that urban agglomeration promotes agglomeration economies and economic productivity gains owing to a pooled labor supply, knowledge spillovers, and forward and backward ties (Fujita and Thisse, 2003; Chong et al., 2016; Zheng et al., 2020). Additionally, several empirical studies have documented positive connectedness between spatially balanced economic performance and efficiencies attributed to increases in the urban agglomeration, which probably promote increases in national economic development (Sekkat, 2017; Frick and Rodríguez-Pose, 2018; Ganau and Rodríguez-Pose, 2022; Zheng et al., 2020).

However, this perceived positive urban agglomeration–economic performance nexus in the literature is built on thin ice and requires further research, particularly in developing regions such as SSA and Eastern Asia (Frick and Rodríguez-Pose, 2018). Three reasons support this assertion: First, how urban agglomeration has evolved in different regions globally remains unclear because most studies on this subject have focused on the drivers of urban agglomeration and economic performance at the country level (Camagni et al., 2015; Cottineau et al., 2019; Martinez Posada and Garcia, 2017). Notably, inadequate studies have evaluated urban agglomeration patterns from a cross-sectional, cross-country, or regional dimension (Ahrend et al., 2017; Aroca and Atienza, 2016; Behrens and Bala, 2013; Castells-Quintana et al., 2017; Li and Liu, 2018). Second, the urban primacy levels (urban population concentration) in the largest city or the share of the urban population residing in a city with a specific population size threshold (primarily urban population of approximately 750,000 or 1 million) are commonly used as measures, but have been accentuated as lacking indicators of urban agglomeration in the recent literature (Anthony, 2014; Brülhart & Sbergami 2009; Castells-Quintana, 2017; Sekkat, 2017). In this regard, Van et al. (2010) emphasize the need to measure functional urban agglomeration using a robust measure beyond the city's size as indicated by urban population share. Third, further research is necessary regarding ensuring sustainable urbanization in developing regions, where more than 50% of the urban population resides under acute proliferation without adequate access to urban infrastructural services (e.g., water, sanitation, and energy) because of governments' insufficient investment, increased social consumption and ineffective urban governance policy measures (Lawhon et al., 2018; Shi, 2019; Ulucak et al., 2020). For instance, governments in SSA only spend between USD 130 billion and 170 billion annually on essential urban infrastructural services (World Economic Forum, 2018). They are experiencing a financing shortfall between USD 68 billion and 108 billion. Notably, two-thirds of the budget for the urban infrastructure required by 2050 has not been attained (World Economic Forum, 2018).

This dissertation aims to fill the three research gaps by assembling a new dataset that allows the construction of a more nuanced measure of urban agglomeration for many economies in SSA, Asia, and Europe that has been presented in the literature. First, we evaluate how urban agglomeration has evolved from 2000 to 2020 across 22 Sub-Saharan African, 22 Asian, and 22 European countries. Second, we analyze how variations in urban agglomeration have influenced economic performance in recent decades. Third, we interrogate the role of urban infrastructural service accessibility on the urban agglomeration–economic performance relationship. Last, we apply the Driscoll-Kraay Fixed Effect and two-step instrumental variable generalized method of moments (2SIV-GMM) technique to model the relationship between urban agglomeration and economic performance across the three regions in the last two decades as they are reliable, especially in the case of autocorrelation, heteroskedasticity of unknown forms, cross-sectional dependence and endogeneity (Nguea, 2023). We also used the Two-Stage Least Squares (TSLS) technique to assess concerns regarding probable reverse causality and robustness checks.

4.2 Contextual Background Literature

The urbanized economic performance concept is introduced in the seminal works of Marshall (1890) and Lewis (1954). They explained urban agglomeration as the concentration of people, the factors of production, firms, and economic activities within one complex urban space. Similarly, proponents of urban structure base their assertions on the advantages of urban agglomeration on economic performance (Rosenthal & Strange, 2004). In line with this proposition, economic performance results from agglomeration economies of scale, urban structure, labor productivity gains via a pooled labor supply, and backward and forward linkages (Ciccone & Hall, 1996; Combes & Gobillon, 2015; He et al., 2016; Meijers, 2008). Still, proponents of urban agglomeration-economic performance positive nexus argue that the connectedness depends on the quality of urban specificities: urban infrastructure, which refers to the systems providing energy, water, sanitation, waste management, communication, public green spaces, and affordable housing services, which are vital in supporting economic prosperity in urban areas (Ramaswami et al., 2020).

New economic geography (NEG) and urban economics (UE) theories have emerged as competing theories and provide related perspectives on urban economics, contributing to a robust understanding of the dynamics, relationships, and drivers of economic performance from an urban agglomeration perspective (Duranton & Puga, 2004). NEG posits that large firm agglomerations drive increased economic performance, urban trade, and competitiveness (Fujita &Thisse, 2003). NEG is based on three assumptions: labor and production factors are mobile, economies of scale and returns are increasing, and transportation costs are incorporated into the economic growth model (Hassink &Gong, 2019). Moreover, NEG posits that urban firms are located near large labor pools and that urban residents choose to reside near firms for easy mobility to and from work (Baldwin & Krugman, 2004). This forms the foundation of urban agglomeration and increased economic activities, leading to long-run economic performance (Al-Jebouri et al., 2020).

UE theory is based on another dimension: the positive relationship between urban agglomeration and economic performance; moreover, it acknowledges that large urban agglomerations might deter sustainable economic performance in the long term (Duranton & Puga, 2004; Henderson, 2005). Similar to the views of NEG, urban economists posit that urban agglomeration promotes the external scale of economies via matching and sharing inputs, ideas, and people (Combes et al., 2022; Duranton & Puga, 2015). Before the NEG and UE theories, Williamson (1965) argued that there is an inverted U-shaped nexus between urban agglomeration and economic performance. Mainly, the U-shaped function indicates that economic performance increases as urban agglomeration levels increase and then decreases beyond a specific threshold. Supporting Williamson (1965), Frick and Rodríguez-Pose (2018) suggest that cities with large agglomerations will likely experience inadequate urban infrastructural services (e.g., sanitation, water, and energy) and urban economic opportunities at later development stages. This phenomenon is attributable to the pressure on municipal governments to manage and allocate resources necessary for urbanization while aiming to prevent urban poverty and vast income inequalities, which increase faster than the economic growth rate in developing regions (Rodríguez-Pose & Griffiths, 2021). Empirically, some studies have observed a negative link between urban agglomeration and economic performance, especially in developing areas (Chauvin et al., 2017; Castells-Quintana & Royuela, 2015).

In this context, an intriguing debate is incorporating the role of urban infrastructure in urban agglomeration–economic performance analysis in developing economies (Marx et al., 2013). The literature has argued that because of increasing urbanization and limited government infrastructural provision, a slum-common feature in poor developing economies is negatively linked to economic performance (Fay & Opal, 2000; Bloom et al., 2008). For the residents of slums, their living standards are unlikely to improve; thus, slums are a form of poverty trap, described as a *Malthusian Trap* in developing regions (Jedweb et al., 2014). Approximately 30% of the urban population in developing regions such as SSA resides in slums, with a large share of that 30% living in large agglomerations (UN, 2015). Indirectly, an increase in slum population indicates increased agricultural population migration into urban from rural regions, posing a disastrous threat to environmental degradation and excessive government consumption that hamper economic performance (Castells-Quintana & Royuela, 2015; Ulucak et al., 2020).

In line with these theories, a growing body of empirical literature has focused on the role of urban infrastructural services (e.g., sanitation, water, and energy) in determining the link between urban agglomeration and economic performance. For example, Field and Kremer (2006) observed a significant effect of urban infrastructure on improving the link between urban agglomeration and economic performance. Similarly, Lewis (2014) observed an important role played by the Indonesian local government in urban infrastructure investment: it improved its management of the negative impacts of urban agglomeration on economic performance. Subsequently, Castells-Quintana (2017) observed the robust effect of the quality of urban infrastructural service accessibility on the link between urban agglomeration and economic performance in developed and developing world economies. Moreover, Ganau and Rodríguez-Pose (2022) observed that despite the positive association between urban agglomeration and economic performance, urban infrastructure is paramount in lower-income countries with large agglomerations. Using the same connection, Kyriacou et al. (2019) provided evidence that the quality of urban infrastructure would likely enhance the outcomes of decentralized urban infrastructure, reinforcing the urban agglomeration–economic performance linkage. Furthermore, Alvarado et al. (2020) concluded that government ineffectiveness and inefficient use of urban resources through imprudent urban infrastructural investment deter agglomeration economies, curtailing sustained long-term economic performance in developing regions.

The literature review indicates a significant link between urban agglomeration and economic performance. However, there are gaps in the empirical literature. The first group of empirical literature has focused on the links between urban agglomeration and economic performance by using country-level panel data as the unit of analysis (Brülhart &Sbergami, 2009; Castells-Quintana &Royuela, 2015; Fang &Yu, 2017; Hasan et al., 2017; Liu & Du, 2021; Yao et al., 2022). These studies have used a primacy indicator—the urban population in the largest city and the urban population above a certain threshold—as measures of urban agglomeration and observed a significant positive relationship between urban agglomeration and economic performance. However, their deduction is nuanced because of a probable negative sign on the interaction term with the gross domestic product (GDP) per capita in developing economies. Thus, urban agglomeration may be advantageous in the first economic performance stages but become deleterious at later stages of urbanization-driven development (Kuznets, 1955; Ha et al., 2019).

Based on a country's income level, the second category of empirical literature has demonstrated the differences in the magnitude of the association between urban agglomeration and economic performance, implying that the relationship is not a one-fits-all case. In line with this conjunction, Castells-Quintana (2017) and Nkalu et al. (2019) have concluded that urban agglomeration has a potentially detrimental implication on the economic performance of African economies. By contrast, Pholo-Bala (2009) and Mikhaylova and Gorochnaya (2022) have observed a significant positive relationship between urban agglomeration and economic performance in European and Russian contexts. Nevertheless, the authors observed that a growth trap at the medium level of urban agglomeration was held for developing countries in Asia and Latin America. Similarly, Frick and Rodríguez-Pose (2018) observed a positive association between urban agglomeration and economic performance in high-income countries and the detrimental effects of urban agglomeration for low-income and medium-income countries in SSA, Europe, and Latin America. However, Ganau and Rodríguez-Pose (2022) observed mixed results in a more recent study. First, the authors observed that the economic returns of urban agglomeration differ in the short run and long run as agglomeration enlarges. Thus, the link between urban agglomeration and economic performance is not universal across economies with different income levels and quality of urban infrastructure.

Last, based on the reviewed theoretical and empirical literature, this dissertation aims to uncover and fill several research gaps. First, this study aims to compute a more nuanced indicator for urban agglomeration than has been presented in the literature by using conventional measures, such as urban share of the population, which do not point out the actual urban structure and thus may not produce robust agglomeration effects (Frick & Rodríguez-Pose, 2018; Ganau &Rodríguez-Pose, 2022). Empirically, studies have argued that using a more nuanced measure of urban agglomeration offers not only higher estimation efficiency but also overs the urban morphological attributes rather than city size as measured by urban population in primate city or urban population share above 750 000 or 1 million thresholds (Brezzi &Veneri, 2015; Meijers & Burger, 2010; Li et al., 2019). Second, to our knowledge, only Castells-Quintana (2017) has conducted the link between urban agglomeration and economic performance from the quality perspective of urban infrastructure in line with cross-country analysis. Third, we aim to disabuse the suggestion in the literature that measuring urban agglomeration by using the urban share of the population shows that large urban agglomerations benefit from a pro-economic performance up to a certain level by pointing out differences across countries based on their income level (World Bank, 2023). Last, our focus is the developing economies in SSA and East and Central Asia. Still, we refer to the literature on European developed economies because of the limited availability of empirical evidence in developing economies.

4.3 Data and Methodology

This dissertation chapter explores the link between urban agglomeration and regional economic performance by comparing the development trajectories of 66 countries: 22 each in SSA, Asia, and Europe (Appendix XII). We use balanced panel data from 2000 to 2020 measured as a census from various selected world countries' urban areas at intervals of 5 years to fulfill the research objective. Regional economic performance measured by real GDP growth was applied as the primary dependent variable. On the other hand, urban agglomeration indicators are used as the independent variable to explain the variation in the economic performance of the selected countries from 2000 to 2020. As aforementioned, the urban agglomeration has been widely measured by the urban share of the population in the largest city and the urban share of the population above a certain threshold (e.g., 750, 0000, or 1 million inhabitants) but has been criticized as a poor indicator of urban agglomeration (Anthony, 2014; Brülhart & Sbergami, 2009; Sekkat, 2017). Although the measures are ideal for studies exclusively investigating the link between urban agglomeration and economic performance because of their data availability for many countries and over a long period, they have been criticized because of their inability to depict the relative distribution of urban population as well as the urban structural and agglomeration effect on economic performance. Due to the abovementioned limitations, the literature has increasingly adopted new nuanced indicators such as the Herfindahl-Hirschman Index (HHI). However, only a few available samples are restricted to developed regions such as Europe (e.g., Frick &Rodríguez-Pose, 2018; Ganau & Rodríguez-Pose, 2022).

The dissertation also controlled for different structural variables influencing the connectedness between urban agglomeration and regional economic performance. The first category of control variables comprises those integrated into cross-economy growth regressions: a) a log of initial GDP per capita at the beginning period (2000) to control for conditional convergence; b) private investment, touted as the key driver of economic performance owing to its contribution to the economy's capital stock formation; c) government consumption measured as the share of GDP, owing to its probable crowding-out effect on the private investment; and e) average years of schooling, referring to Brülhart and Sbergami (2009) and Henderson (2003).

The second category of control variables comprises variables directly linked to the economy's economic performance trends. We controlled the economy's urbanization rate, governance effectiveness, and fertility rates. In addition, an economy's population size affects potential investment attractiveness, benefiting economic performance in large states (Alesina et al., 2005). Specifically, governance effectiveness is included because it reflects the local government, central government, and other stakeholders' effectiveness in implementing policies that enable the provision of urban infrastructural services to the urban population necessary for economic productivity (Castells-Quintana, 2017). Therefore, government ineffectiveness and inefficient use of urban resources through imprudent urban infrastructural investment deter agglomeration economies (Alvarado et al.,2020). Last, our estimation includes second-order polynomials to account for the probable nonlinear relationship between urban agglomeration and economic performance under the robustness checks section. Table 1 lists all variables, briefly defining the operationalization measures and data sources.

Table 1:Variable List, Measurement, and Data Source

Variable name	Measurement and Description	Data source
Economic Performance	Annual average GDP per capita growth rate (% into ratio form)	World Penn Tables (PWT 10.1)
Urban Agglomeration	Computed HHI50 and HHI100 indices by summing ratios of $p \geq 50\,000$ and $\geq 100\,000$ to the total urban population.	World Bank-Development Indicators/GHSL/Africapolis /UN/Population.de
Urban Infrastructure	% composite urban population accessing water, sanitation, and energy	World Bank-Development Indicators
Governance	Governance Effectiveness Index	World Bank-Governance
Log Initial GDP per capita	Measured in the logarithm of Real GDP at constant 2017 divided by 10	Computed using data from World Penn Tables (PWT
Private Investment	Gross capital formation at the current PPP	World Penn Tables (PWT
Fertility Rate	total (births per woman)/10	WDI
Schooling	Average years of schooling in all levels of the active population (15-64 years)	Barro and Lee dataset
Government Consumption	Share of government consumption at current PPPs	World Penn Tables (PWT 10.1)
Urbanization Rate	% of the population living in urban regions (% into ratio)	World Bank-Development Indicators
Log Land Area	The logarithm of the size of the economy's land area measured in square kilometers	World Bank-Development Indicators

Source: Own Construction (2023)

4.4 Theoretical Model

The dissertation explores the relationship between urban agglomeration and economic performance using a neoclassical framework of economic performance foundation for ordinary cross-country growth regression. By referring to Brülhart and Sbergami (2009); Castells-Quintana (2017); Frick and Rodríguez-Pose (2018), and Ganau and Rodríguez-Pose (2022), we base our empirical analysis on a GDP per capita growth rate, enabling us to determine the effect of urban agglomeration in a more simplistic manner. Starting at a cross-sectional regression setting, where the average GDP per capita growth of economy e over a period t, $\Delta Y_{e,t}$, is estimated as a function of the initial log GDP per capita, $log(Y_{e,0})$, to capture the conditional convergence of income levels (Barro, 1991), an initial urban agglomeration growth variable HHI_{e0}, and a host of control variables represented by the vector X_e^n, based on Sala-i-Martin et al. (2004). Our estimation equation is thus stated as follows:

$$\Delta Y_{e,t} = \alpha + \beta \log(\mathrm{Y}_{e,0}) + \gamma \mathrm{HHI}_{e,0} + \sum_{n=1}^{N} \delta_n X_e^n + \varepsilon_e \quad (4.1)$$

where average GDP per capita growth rate is the dependent variable denoted as $\Delta Y_{e,o} = \frac{1}{T-t}[\log(Y_e^T) - \log(Y_e^t)]$ from $t = 2000$ to $T = 2020$ for economy $e = 1, \dots, 66$. The constant term is denoted by α, and the well-behaved error term is denoted by ε_{et}. Nevertheless, as discussed in the introduction, the extent to which urban agglomeration influences economic performance efficiency relies on the urban process specificities. Specifically, urban infrastructure defines the urban environment, resulting in distinct cities' capacities to benefit from agglomeration economies and regulate congestion diseconomies regarding production efficiencies such as knowledge spillovers (Henderson, 2005). In line with this argument, we follow the stylized UE model of Bertinelli and Black (2004) and pose an empirically testable prediction that the quality of urban infrastructure significantly influences economic performance-augmenting benefits of urban agglomeration. Thus, we rewrite equations 4.1 to 4.2 as follows:

$$\Delta Y_{e,t} = \alpha + \beta \log(\mathrm{Y}_{e,0}) + \gamma_1 \mathrm{HHI}_{e,0} + \gamma_2 \mathrm{UI}_{e,0} + \sum_{n=1}^{N} \delta_n X_{e,t}^n + \varepsilon_{e,t} \quad (4.2)$$

where $U\mathrm{I}_{e,0}$ denotes the urban specificities as the quality of urban infrastructure.

Although cross-national regression analysis following equation 4.2 is conducted using pooled OLS, the main focus in this study is panel dynamic model regression estimated using system GMM, as Arellano and Bover (1995) suggest. Therefore, we rewrite equation 2 in dynamic panel format:

$$\Delta Y_{e,t} = \alpha + \beta \log \mathrm{Y}_{e,t-1} + \gamma_1 \mathrm{HHI}_{e,t-1} + \gamma_2 \mathrm{UI}_{e,t-1} + \rho \sum_{n=1}^{N} \delta_n X_{e,t}^{n} + \mu_e + \tau_t + \varepsilon_{e,t} \qquad (4.3)$$

where t denotes the 5-year interval period and μ, τ, and ε are well-behaved error terms. Moreover, equation 4.3 is presented in simple AR (1) specification, containing the interaction term between urban agglomeration and urban infrastructure, as follows:

$$\begin{aligned} Y_{e,t} = \alpha + \beta' \log \mathrm{Y}_{e,t-1} + \gamma_1 \mathrm{HHI}_{e,t-1} + \gamma_2 \mathrm{UI}_{e,t-1} + \gamma_3 (\mathrm{HHI} * \mathrm{UI})_{e,t-1} \\ + \rho \sum_{n=1}^{N} \delta_n X_{e,t}^{n} + \mu_e + \tau_t + \varepsilon_{e,t} \end{aligned} \qquad (4.4)$$

where $\beta' = (\beta + 1)$. The interaction between urban agglomeration and urban infrastructure is denoted by $\mathrm{HHI}_{e,t-1} * \mathrm{UI}_{e,t-1}$. A country-specific effect denoted by τ_t, representing time-invariant determinants of GDP per capita that may either be correlated with urban agglomeration or not is the specification motivating panel regression estimation. If such effects are present and essential, any cross-sectional estimate of $\gamma_1, \gamma_2, \gamma_3, \beta', \rho,$ and α based on the same variables' lags as instruments are likely to be biased. We estimate the dynamic panel model specified in equation 3 by using the system GMM method of Arellano and Bover (1995) because Blundell and Bond (1998) show that it is better than the Arellano-Bond difference GMM technique, which can produce inaccurate results, especially in cases of short panels when β' approaches one or when the variance of μ_e is large relative to that of $\varepsilon_{e,t}$.

System GMM consistently has the smallest bias of estimators because it is a weighted average of the difference GMM (Arellano-Bond) and GMM levels, and the biases of those two estimators contain opposite signs (with system GMM being of large extent) (Bun &Windmeijer, 2007). System GMM consists of first differences instrumented in the lagged level and levels of instrumented lagged first differences; for it to hold, the following assumption must be fulfilled:

$$\mathrm{E}[\Delta \mathrm{HHI}_{et} \mu_e] = E\left[\Delta X_{e,t}^{n} \mu_e\right] = E[\Delta Y_{e2} \mu_e] = 0 \qquad (4.5)$$

The main reason for using the system GMM is to minimize simultaneity and the feedback effect that runs directly from urban agglomeration to economic performance. Thus, for assumption 5 to hold, a sufficient dynamic condition is that $\text{HHI}_{et}, X^{n}_{e,t},$ and Y_{et} are mean free from unit root traits. Nevertheless, the addition of the time effect component τ_t enables common trends in GDP per capita without violating assumption 4.5; hence, the stationarity assumption reduces relative income levels across economies. Although the stationarity assumption may still be constraining, we base our analysis on the condition that the error term ($\varepsilon_{e,t}$) and country-specific effects (μ_e) are uncorrelated (Blundell & Bond, 1998). Last, to contain overfitting bias, we run the overidentifying restriction tests after dynamic panel GMM estimation, such as the Hansen J statistic, and further limit the maximum lag length of the instruments to 3 throughout to maximize the Hansen J statistic test power (Browser, 2002). The vector $X^{n}_{e,t}$ denoting the country-specific control variables in two categories.

4.5 Data Description and Stylized Facts

Next, we present stylized facts on the variation in urban agglomeration from 2000 to 2020 using more robust indicators than those in the literature. The HHI has emerged as a frequently used measure for various urbanization aspects because it describes the total size of the city distribution (Shen et al., 2019). It is also easy to compute for a large set of countries and over long periods (Ganau & Rodríguez-Pose, 2022). It is defined as the sum of the squared population shares of every city's contribution to the gross urban share of the population at the start of period t (Frick & Rodríguez-Pose, 2018). The HHI takes on values ranging between $\frac{1}{n}$ and 1, where a value of 1 shows complete spatial concentration (Frick & Rodríguez-Pose, 2018). Regardless of its desirability, few studies on urban agglomeration have used it because of the data requirements for calculating it, especially for many countries with incomplete datasets (Wheaton & Shishido, 1981).

HHI is calculated as follows in urban contexts:

$$HHI_{i,t} = \sum_{y=1}^{nt} \left(\frac{X_{yit}}{X_{it}}\right)^2 \quad (4.6)$$

By normalizing the $HHI_{i,t}$ in equation (4.6),

$$Normalised\ HHI_{i,t} = \left\{ \frac{\left(\sum_{y=1}^{nt} \left(\frac{X_{yit}}{X_{it}} \right)^2 \right) - \frac{1}{n}}{1 - \frac{1}{n}} \right\};\ \epsilon[0,1] \tag{4.7}$$

where, X_{yit} is the population of city Y in country i at the start of period t.

X_{it} is the total urban population in country i at the start of period t.

n is the total number of cities in the country i at the start of period t.

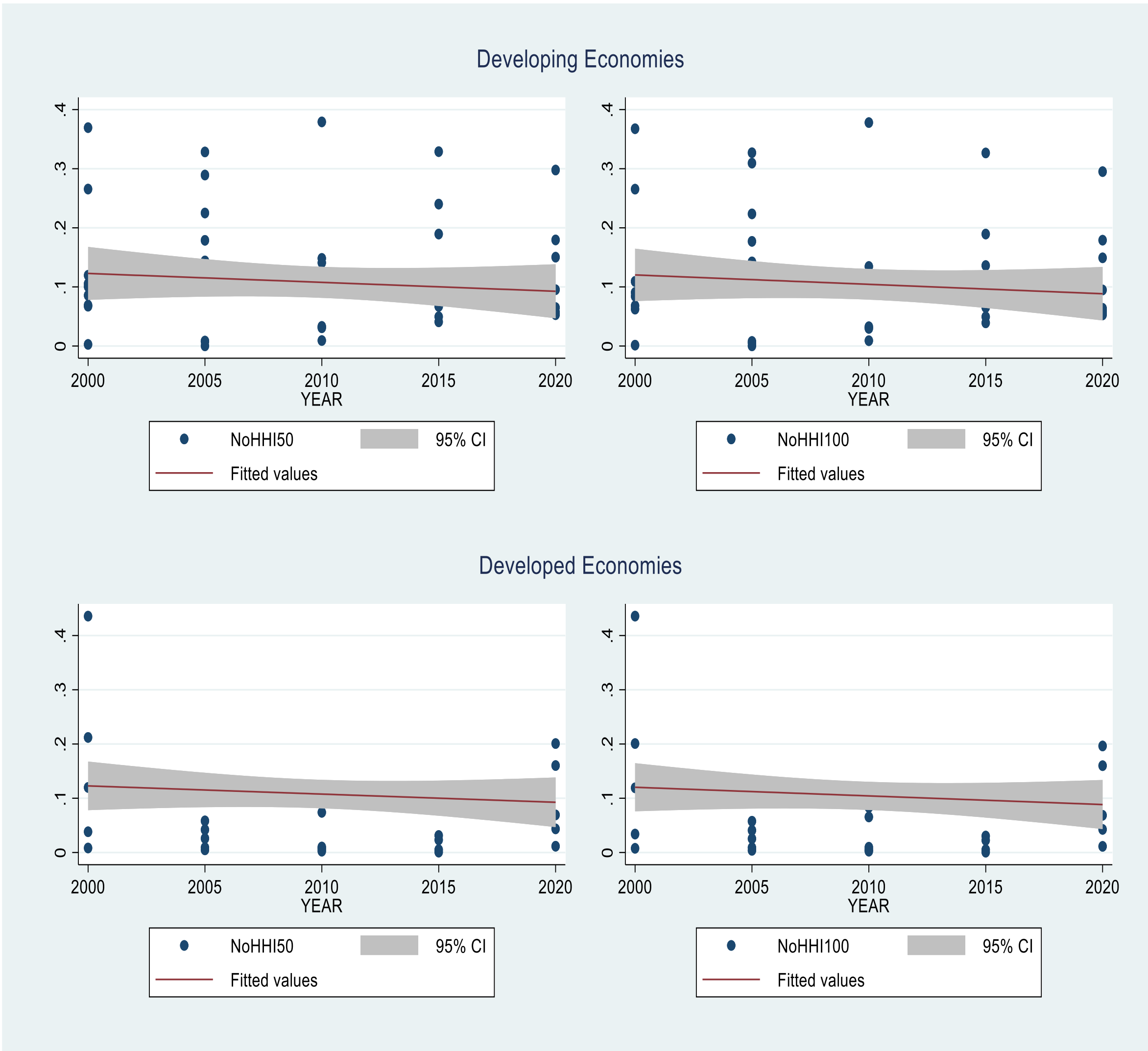
In this dissertation, HHI is calculated using new city population datasets for 66 countries with equal distribution of a $\frac{1}{3}$ representation for SSA, Asia, and Europe. We use the census data available for each economy from citypopulation.de (Brinkoff, 2013), Africapolis (for SSA), and the 2014 edition of the World Urbanization Prospects websites (UN, 2014). The census data differ across countries, giving the potential of a balanced dataset collected at 5-year intervals. Because this study considers the developing regions where city population data is unreliable owing to incomplete city boundaries and no universal definition of urban region, the population data were adjusted to ensure the proper agglomeration size, especially for countries without complete agglomeration data (Li &Liu, 2018). Further, similar to other indicators measuring urbanization and city sizes, HHI is susceptible to aggregation bias regarding the number of cities in the calculation (Frick & Rodríguez-Pose, 2018; Ganau &Rodríguez-Pose, 2022; Li & Liu, 2018; Shen et al., 2019).

Thus, this dissertation follows the approaches recommended by Cheshire and Hay (2017), Turok (1999), and Rosen and Resnick (1980) by calculating the HHI based on a cutoff size of 50,000 people at the beginning of 2000 and a specified number of cities within this threshold, independent of size, and boundaries. The two approaches help assess small countries with few cities within the set population threshold (Parr, 2007). In line with experimental data developed by Ganau and Rodríguez-Pose (2022) and Frick and Rodríguez-Pose (2018), we develop the HHI50 index, comprising all a country's cities that have 50,000 or more dwellers and an HHI100 index, that is, all cities of 100,000 or more residents. Because of controversies about threshold cities' inclusion, this study regards normalized HHI50 and HHI100 indices calculated based on cutoffs of 50,000 and 100,000 people of all cities falling in this threshold. The practical thought of data availability and the need to reflect each country's urban agglomeration structure as wholly as possible drove the decision of threshold selection.

Having calculated HHI50 and HHI100 indices, the next step is analyzing the evolution of urban agglomeration from 2000 to 2020 to provide stylized data facts. We depict this by plotting the average HHI50 and HHI100 indices by region (Asia, Europe, and SSA) and dividing the sample into developed and developing economies based on income levels. Figure 9 shows three insights into the evolution of urban agglomeration, as the calculated indices describe. First, there are marked differences in evolution, whereby developing nations' agglomerations are larger than developed nations'. Second, the average level of agglomerations declined dynamically for developed economies but is below that of developing economies, which remained relatively stable, especially in cities with a population of ≥50,000, and declined gradually in towns with a population above 100,000. For instance, the average HHI50 and HHI100 in developed economies fell sharply, below that of developing economies. Third, although the urban agglomeration declined in developed and developing countries, the relatively stable and constant trend of HHI50 in developing economies can be attributed to the number of people residing in urban regions, which doubled in developing economies, leading to the birth of new cities fulfilling the functional urban areas threshold (UNDESA, 2008; Ganau & Rodríguez-Pose, 2022).

Another distinctive feature relates the calculated HHI to the country's primacy level. The evaluation of HHI by country shows that countries with few primate cities tend to have high urban population concentrations compared to countries with several cities within the functional urban threshold. For instance, countries such as Kenya, Liberia, Mongolia, Qatar, Iceland, and Estonia, where a large share of the urban population is concentrated in one large city, tend to have a higher urban agglomerations level than that of long-perceived countries such as Ethiopia, Nigeria, Germany, Italy, India, and China with multiple large primate cities with more than 1 million people. In scrutinizing these case scenarios, primacy level appears to underrate the concentration of the urban population in nations where there are one or too few large cities at the top of urban structure, with several small, or in some cases, nonexistent satellite cities such as Iceland, Mongolia, Kenya, or Qatar (Rodríguez-Pose & Storper, 2020). A potential deduction of these case scenarios can be attributed to primacy population numbers often considering agglomeration boundaries (Bloom et al., 2008). Thus, using HHI indices provides a significant advantage—how it is computed—differentiating it from other indicators of comparable economies (Ganau & Rodríguez-Pose, 2022).

*Figure 9:*Evolution of Urban Agglomeration by Country Income Level, 2000-2020

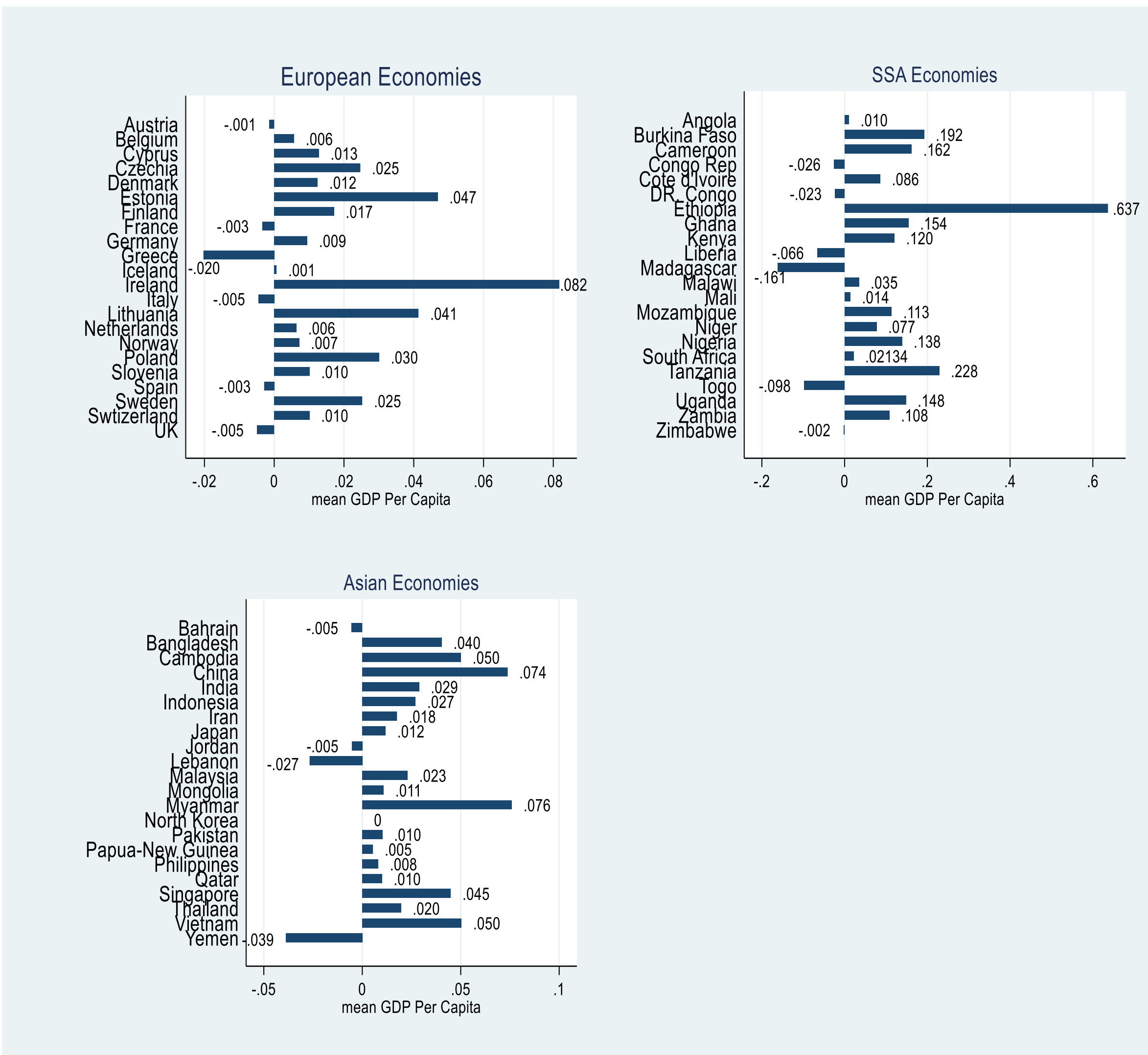


Source: Own Construction (2023)

Figure 10 presents the average GDP per capita growth across the selected continental economies. as indicated, the growth varies from country to country and region. for instance, significant GDP per capita growth happened in SSA economies compared to European and Asian economies. Looking at the country differences, Ethiopia exhibited substantial GDP per capita growth at 63.7%, followed by Tanzania at 22.8%, Burkina Faso at 19.2%, and Cameroon at 16.2%. However, the GDP per capita growth declined considerably in

Madagascar at 16.1%, followed by Togo at 9.8% and Congo republic at 6.6%. Ireland experienced significant GDP per capita growth in Europe at 8.2%, followed by Estonia at 4.7% and Lithuania at 4.1%. On the other hand, GDP per capita growth declined considerably by 0.5% in the UK and Italy, followed by Spain and France, which experienced a 0.3% decline. The Asian economies exhibited average GDP growth rates. For instance, Myanmar experienced a positive growth of 7.6%, followed by china at 7.4% and Cambodia at 5.0%. However, Yemen experienced the greatest declining growth rate of 3.9%, followed by Lebanon at 2.7% and Jordan and Bahrain at 0.5%.

Figure 10: Average GDP Per Capita Growth Across Continental Regions for 2000-2020



Source: Own Construction (2023)

Table 2 presents the additional stylized facts in descriptive statistics of urban agglomeration, economic performance, and urban infrastructure in the last two decades. The average economic performance in the world sample is 0.04, below the developing region's growth rate of 0.054. The economic performance in developed economies grew by 1.5%, below that of Asia at 2.0% and that of SSA at 8.5%. Regarding urban agglomeration (HHI50), Sub-Saharan Africa ranks high at 0.162, way above Asia and Europe at 0.089 and 0.068, respectively. Also, large urban agglomerations (HHI50 and HHI100) with a mean value of 0.13 are in developing economies compared to an average value of 0.1 in developed economies. Regarding urban infrastructure (composite value of a share of the urban population accessing water, sanitation, and electricity), European economies have an average accessibility of 99.4% ahead of developing SSA with a paltry 15.9%, and Asian economies at 89.6%.

Table 2:Descriptive Statistics by Region, Income Level, and World Sample

Variable Name	GDP Per Capita growth		HHI50		HHI100		Infrastructure		
Region	Mean	St.Div	Mean	St.Div	Mean	St.Div	Mean	St.D	N
World	0.040	0.262	0.106	0.114	0.105	0.114	0.68	.384	330
Developed	0.015	0.046	0.069	0.100	0.067	0.097	0.99	0.01	125
Developing	0.054	0.329	0.129	0.117	0.128	0.117	0.49	0.38	205
Asia	0.020	0.059	0. 089	0.097	0.086	0.096	0.90	0.10	110
Europe	0.014	0.045	0.068	0.099	0.066	0.098	0.99	0.01	110
SSA	0.085	0.445	0.162	0.122	0.162	0.122	0.16	0.12	110

Source: Author's Own Construction (2023)

Another distinctive feature relates the calculated HHI to the country's primacy level. From the evaluation of HHI by countries, it is evident that countries with few primate cities tend to have higher urban population concentrations. For instance, countries like Kenya, Liberia, Mongolia, Qatar, Iceland, and Estonia, where a large share of the urban population is concentrated in one larger city, tend to have higher urban agglomeration levels than long-perceived countries like Ethiopia, Nigeria, Germany, Italy, Indonesia, India, and China with multiple large primate cities with more than 1 million people. While scrutinizing these case scenarios, primacy level appears to underrate urban agglomerations or concentration of urban population in nations where there are one or too few large cities at the top of urban structure, with supposedly several smaller, or in some cases, non-existent satellite cities such as Iceland, Mongolia, Kenya or Qatar (Rodríguez-Pose & Storper, 2020). A potential deduction of these case scenarios can be attributed to primacy population numbers often considering agglomeration boundaries (Bloom et al., 2008). Thus, using HHI indices provides an essential advantage over which it is computed, differentiating it from other indicators of comparable economies (Ganau & Rodríguez-Pose, 2022).

Table 3 presents the correlation test results. As indicated, there is an insignificant positive correlation between the regional economic performance measured by GDP per capita growth and the urban agglomeration measure variables (NoHHI50 and NoHHI100). On the other hand, a weak negative correlation exists between regional economic performance and the initial GDP per capita (GDPpc) and the quality of access to urban infrastructural services. In addition, there is a weak negative correlation between regional economic performance and urbanization rate, schooling, governance effectiveness, and consumption. In contrast, there is a weak positive correlation between the regional economic performance and fertility rate. Although there is an insignificant correlation between urban agglomeration indicators and the GDP per capita growth variables, as well as a weak significant correlation between explained and the control variables indicate ideal regression results, it is essential to check for a multicollinearity problem as its presence results in overestimation of coefficient estimate standard errors. This dissertation relied on the variance inflation factor (VIF) test to detect the presence of multicollinearity. Studenmund (2011) posited that the rule of thumb for the VIF test is that VIF values greater than 5 and tolerance values less than 0.1 (Miles, 2014) indicate the presence of a multicollinearity problem, and the converse is true. The results shown in Appendix I show that the VIF and tolerance values for all selected variables are less than 5 and more significant than 0.1, respectively. These collaboratively signify that including the explanatory variables together doesn’t result in strong multicollinearity in the subsequent regression models.

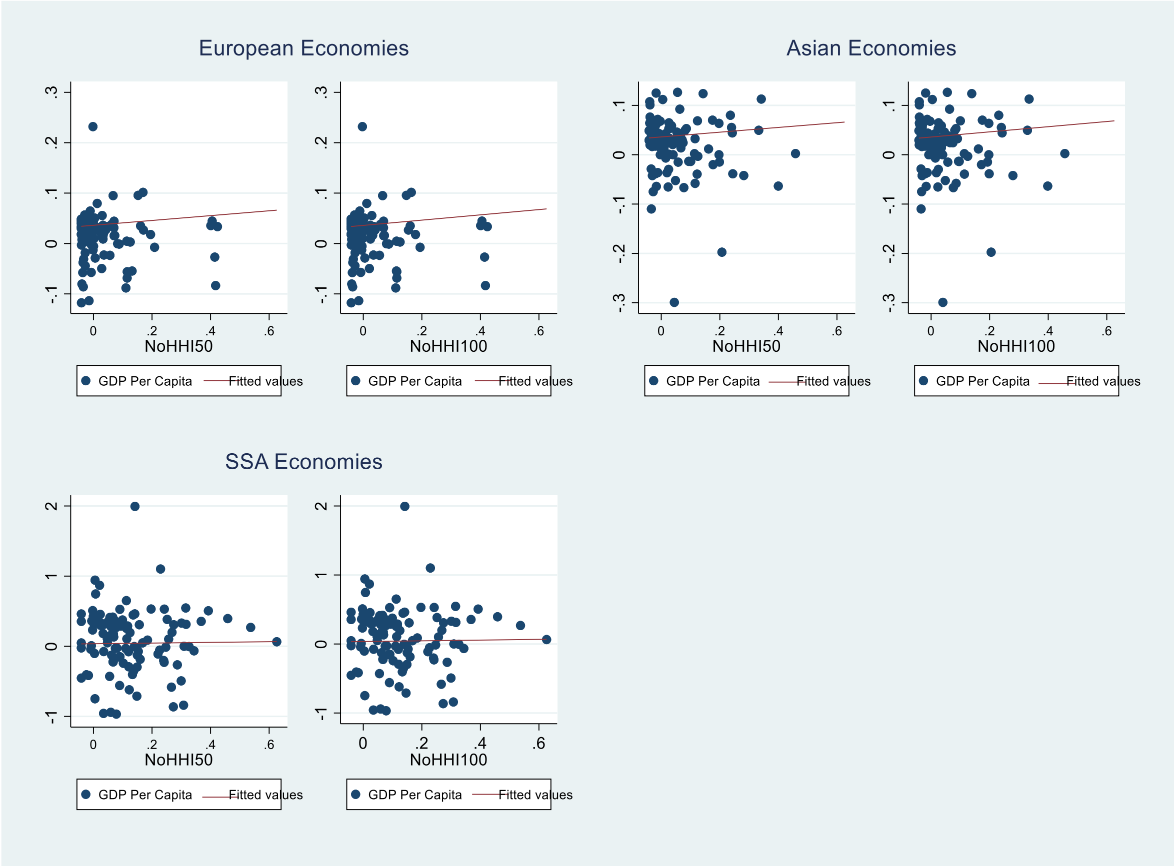
Table 3:Correlation Matrix

Variable	1	*2*	3	4	5	6	7	8	9	10	11
Gdppcg	1.0										
Initial GDPpc	-0.1*	1.0									
NoHHI 50	0.0	-0.30*	1.0								
NoHHI 100	0.0	-0.3*	0.1*	1.0							
Infrastructure	-0.1	0.8*	-0.2*	-0.3*	1.0						
Urbanisation	-0.2	-0.8*	-0.1*	-0.1*	0.6*	1.0					
Schooling	-0.2*	0.8*	-0.3*	-0.3*	0.7*	0.7*	1.0				
Governance	-0.0	0.9*	-0.3*	-0.4*	0.7*	0.7*	0.8*	1.0			
Fertility Rate	0.2*	-0.8*	0.3*	0.3*	-0.9*	-0.6*	-0.8*	-0.7	1.0		
Consumption	-0.2*	0.3*	0.1	0.1	0.3*	0.4*	0.4*	0.2	-0.3	1.0	
Investment	-0.0	0.4*	-0.1*	-0.1*	0.3*	0.4*	0.4*	0.4	-0.4	0.2	1.0

Source: Own Construction (2023); ***p<0.05, ***p<0.01, *p<0.10*

Figure 11 presents correlation plots between regional economic performance and urban agglomeration measures. Specifically, Figure 10 depicts an increasing relationship between GDP per capita growth and HHI50 and HHI100. The findings indicate a sharp increasing relationship in European and Asian economies but a constant relationship in SSA countries.

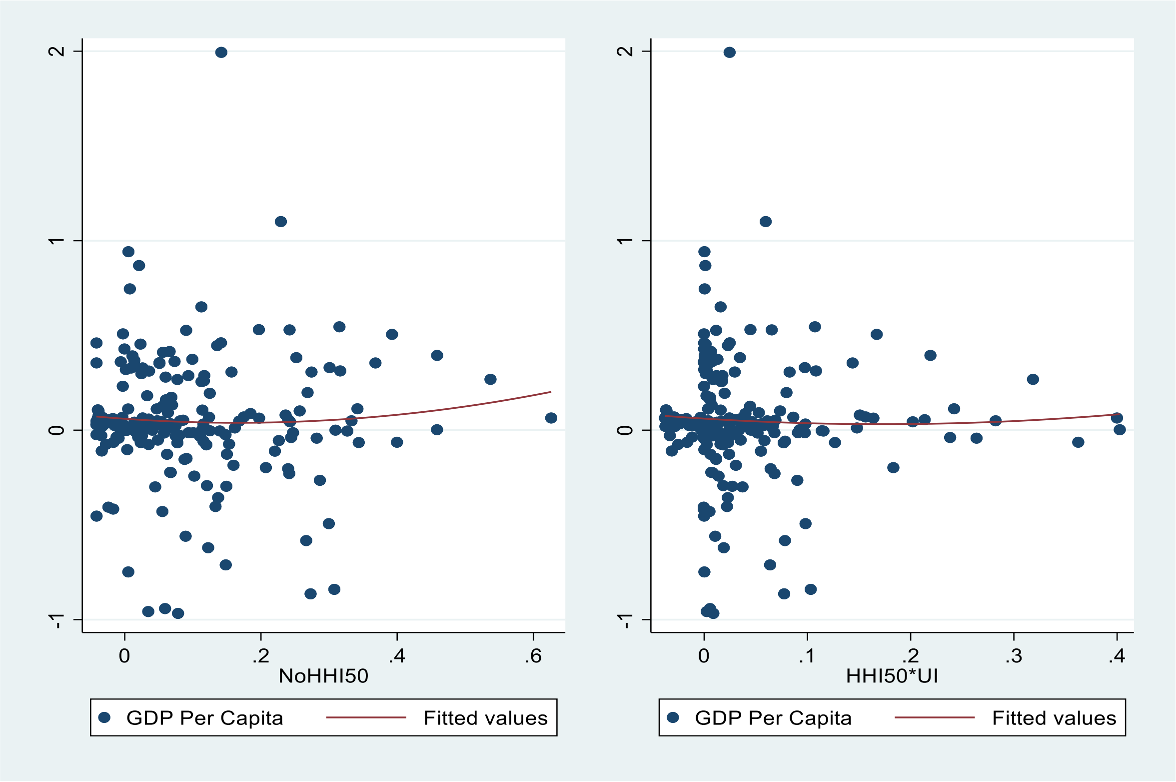
Figure 11: Correlation Between Regional Economic Performance and Urban Agglomeration



Source: Own Construction (2023)

Additionally, the correlation between regional economic performance and interaction between urban agglomeration and urban infrastructure is presented in Figure 12. Based on the findings, there is a gradually increasing relationship between urban agglomeration and urban agglomeration. This relationship is sustained if we include the interaction term between urban agglomeration and urban infrastructure (HHI50*UI). Intuitively, there is a decreasing relationship between regional economic performance and urban agglomeration in the first stages of urbanization before increasing beyond a turning point. This holds if the interaction between urban agglomeration and urban infrastructure (HHI50*UI) correlates with regional economic performance in developing economies. Of great importance is the role played by urban agglomeration in fastening the speed of bringing the turning point much earlier, as shown in panel 2 in Figure 12. Comparatively, urban infrastructure augments the effect of urban agglomeration on regional economic performance.

Figure 12: Correlation between GDP per capita growth and HHI50 and HHI50*UI



Source: Author's Computation (2023)

4.6 Empirical Estimation Strategy

This dissertation's starting point of estimation is checking the presence of cross-sectional dependence (CD) between the cross-sectional units of analysis (countries). Due to urbanization resulting from rural-urban migration, attributed mainly to political instability, forced displacement, trading activities, and industrial establishments in most developing countries, the effect can spillover to the neighboring countries (Duda et al., 2018). Additionally, most regional countries are highly connected, resulting in dependence problems, mainly if applied to panel data modeling (Agergaard et al., 2019). As indicated in Table 4, most variables are cross-sectionally dependent, thus rejecting the null hypothesis of panel homogeneity. However, urban agglomeration measures (NoHHI50 and NoHHI100), urban infrastructural services, and urbanization rate are cross-sectionally independent; the null hypothesis of panel heterogeneity is accepted at a 5% significance level.

Table 4: Cross-sectional Dependence Test Results

Variable	CD-Test	P-value	Abs(Corr)
GDP Per Capita Growth	0.000**	0.000	0.006
Initial GDP Per Capita	0.014**	0.000	0.109
NoHHI50	0.370	0.710	0.482
NoHHI100	0.160	0.871	0.494
Urban Infrastructure	0.013	0.075	0.232
Urbanisation Rate	0.164	0.059	0.177
Schooling	1.250**	0.000	0.793
Governance	-0.450	0.654	0.486
Fertility Rate	3.711**	0.000	0.640
Consumption	2.234**	0.002	0.558
Investment	7.830**	0.000	0.528
Land area	1.112**	0.004	0.777

Note: In the null hypothesis of cross-sectional independence. **$p<0.05$, ***$p<0.01$, *$p<0.10$

Source: Own Construction (2023).

In line with the evidence of cross-sectional dependence among most of the selected variables, the next step is checking the stationarity or order of integration by carrying out second-generation unit root tests, which are ideal in addressing the presence of cross-sectional dependence in the estimated models. The study combined several panel unit root tests such as Levin et al. (2002), knowns as (LLC), Im et al. (2003), and known as the IPS test. These stationarity tests perform well in short panels with a small T. The validation for using panel unit root tests (IPS and LLC) instead of first-generation unit root tests (ADF and PP) is the robustness of the test, especially for short panels as it is in this study. Also, we employed augmented cross-sectional IPS (CIPS) by Pesaran (2007) to account for the possibility of cross-sectional dependence in our panel data. The stationarity test findings of variables follow the underlying null hypothesis of the presence of unit root. Based on the results in Table 5, the null hypothesis is rejected under all tests for all variables at level form, $I(0)$, except for schooling and fertility rate, whereby the null hypothesis was rejected at the first difference, that's, $I(1)$, implying the absence of non-stationarity traits.

Table 5:Panel Stationarity Unit Root Test Results

Variable	CIPS	IPS	LLC	Status
GDP Per Capita Growth	-0.672**	-3.123**	-3.3e+2**	I(0)
Initial GDP Per Capita	-2.014**	-2.543**	-4.8e+2**	I(0)
NoHHI50	0.370**	-3.868**	-37.835**	I(0)
NoHHI100	0.960**	-3.451**	-75.415**	I(0)
Urban Infrastructure	0.813**	-2.287**	-25.158**	I(0)
Urbanisation Rate	0.164**	-4.981**	-23.423**	I(0)
Schooling	7.250**	-8.025**	-35.208**	I(1)
Governance	-10.433*	-1.988**	-50.567**	I(0)
Fertility Rate	-16.715**	-2.215**	-15.592**	I(1)
Consumption	3.110**	-1.947**	-29.775**	I(0)
Investment	-7.830**	-1.956**	-6.888**	I(0)
Land area	1.112**	-2.889**	-1.1e+3**	I(0)

Note: Null hypothesis of cross-sectional independence. ***p<0.05, ***p<0.01, *p<0.10*

4.6.1 Dynamic Panel Model Estimation

This dissertation chapter aims to determine the connectedness between urban agglomeration and regional economic performance in 22 SSA, 22 Asian, and 22 European countries from 2000 to 2020. The beginning is to discuss the results per the estimation of the dynamic panel data model in equation (4.3) using cross-country Pooled OLS as a benchmark model and system GMM as the preliminary technique. All deductions and explanations of the results are based on the system GMM technique. The number of countries in the sample varies from 22 to 66, depending on the independent and control variables in the regression analyses. Table 6 reports the findings with HHI50 and HHI100 as measures of urban agglomeration and GDP per capita growth as a measure of the regional economic performance. In columns 1, 3, 5, and 7, we indicate estimates of internally adjusted parsimonious and fully pooled OLS models. Columns 2, 4, 6, and 8 show the internally fully adjusted system GMM model findings. A panel regression following system GMM is conducted to mitigate concerns regarding the effect of unmeasured time-invariant country-specific impacts that can be correlated with the explanatory variables, leading to spurious results. The panel regression using the system GMM approach included all variables taken as deviations from their respective years, implying controlling for τ_t in equation (4.3). For system GMM to produce reliable estimates, we ensure that our vital explanatory variables (urban agglomeration and urban infrastructure) have valid, reliable lagged first differences, and lagged levels are accurate and reliable for the first difference and instruments. Specifically, all time-dependent explanatory variables are treated as probable endogenous; thus, we considered the first difference with a past level from $t - 1$ and backward for all variables measured at 5-year intervals and their values in the level equation and the lagged first differences.

Based on the findings in Table 6, the System GMM estimates provide distinctive regional findings regarding the influence of urban agglomeration on regional economic performance. For instance, the findings show no significance of urban agglomeration on regional economic performance for the world sample (column 2). However, a significant negative effect of urban agglomeration (HHI50) across all regional economies is observed at 5% and 10% confidence intervals, respectively (columns 4, 6, and 8). The complete System GMM findings also show that the effect moves from negative to positive as the agglomeration rises from HHI50 to HHI10 at 1% and 5% confidence intervals in European and SSA economies (columns 6 and 8), respectively. However, it is insignificant for the world and Asian economic samples.

The findings also show urban infrastructure's significant negative role in Asian and European economies at a 5% confidence interval (columns 4 and 6). However, the effect of urban infrastructure on regional economic performance in SSA is not significant (column 8). Last, concerning the control variables, the system GMM estimates significantly negatively affect the urbanization rate in SSA economies. However, an insignificant effect is observed for Asian and European economies. Average years of schooling significantly negatively affect regional economic performance in European economies but has an insignificant impact on world, Asian, and SSA economies. Government effectiveness plays a significant positive role in implementing prudent urban infrastructure developments that foster the economic performance of the urban population for the world and European samples (columns 2 and 6).

Moreover, the fertility rate significantly positively affects regional economic performance, and SSA economies mimic it. However, investment significantly negatively affects economic performance for world and SSA samples. Also, we conducted Arellano serial correlation (AR1 and AR2) and overidentifying (Hansen J-statistic) tests, and both were insignificant, depicting correct model specification and valid instruments (Chao et al., 2014; Maket, 2023b). Lastly, we conducted post-estimation tests using world sample pooled OLS. The statistically significant Jarque-Bera statistic, Breusch–Pagan and Wooldridge F-statistic indicated the non-normal distribution, presence of heteroscedasticity, and first-order autocorrelation.

Although the system GMM technique has been regarded as efficient in regression analysis, Nguea (2023) and Sarafidis and Robertson (2006) argue that in the presence of cross-sectional dependence, as it is in this study, system GMM and pooled OLS estimation techniques are inconsistent. Thus, the results may not be relied upon in making economic deductions. In addition, given that we have $N>T$ ($N = 22$ and $T = 21$) and social welfare variables such as urban agglomeration, urban infrastructural service accessibility, fertility, and schooling that are hard to measure, it signifies that biased estimates can be obtained. However, applying dynamic panel data models such as the two-step instrumental variable generalized method of moments (GMM) technique (2SIV-GMM) helps to control state and time-invariant variables and tackle endogeneity issues (Banerjee & Duflo, 2003; Fotio & Nguea, 2022). In addition, applying Driscoll-Kraay standard errors in the 2SIV-GMM setup deals with probable heteroscedasticity and cross-sectional dependence problems, which automatically exist in variables measured in panel form (Nguea, 2023). Additionally, since the 2SIV-GMM utilize instrumental variables as part of the regressors, they enhance the performance of dynamic panel models with small N and T, as in this study (Berg et al., 2018). Using Driscoll-Kraay standard errors helps robustly account for cross-sectional dependence (Driscoll & Kraay, 1998). It accounts for spatial and other forms of cross-sectional correlation results in a significant complication of empirical studies. Failure to care for spatial dependence results in spurious standard error estimates (Maket et al., 2023b). Furthermore, the Driscoll-Kraay estimator allows for autocorrelation, heteroscedasticity, and temporal and spatial dependence (Berg et al., 2018; Hoechle, 2007; Nguea, 2023).

Table 6:Urban Agglomeration and Economic Performance by Regional Panels

Sample	World		Asia		Europe		SSA	
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP per	0.111	0.49*	0.029	0.324	-0.166	-0.7**	0.043	0.36**
Capita (-1)	(0.154)	(0.1)	(0.131)	(0.288)	(0.253)	(0.291)	(0.154)	(0.102)
Constant	0.002	-0.3*	0.25**	0.36**	3.25**	4.26**	0.189	-0.321
	(0.196)	(0.2)	(0.100)	(0.154)	(1.219)	(0.868)	(1.042)	(0.457)
LN(initial	0.041	0.20	0.005	0.065	-0.908	-1.01*	-0.173	1.382
GDP pc)	(0.113)	(0.2)	(0.105)	(0.085)	(0.238)	(0.385)	(1.236)	(1.528)
HHI50	-0.713	0.99	-0.144	-0.90*	-0.879	-1.4**	-1.52*	-3.29*
	(1.179)	(1.3)	(0.050)	(0.775)	(1.157)	(1.664)	(117.0)	(59.22)
HHI100	0.728	-1.18	0.150	1.074	0.859	1.39**	0.97**	2.315*
	(1.250)	(1.4)	(0.881)	(0.832)	(1.173)	(1.67)	(116.6)	(59.14)
Infrastructur	0.118	0.3**	-0.3**	-0.5**	-2.280	-3.1**	1.96**	0.474
e	(0.151)	(0.1)	(0.130)	(0.191)	(1.186)	(0.731)	(0.683)	(0.389)
Urbanisation	-0.19*	-0.10	-0.08*	-0.031	-0.077	-0.104	-0.359	-0.45*
	(0.092)	(0.1)	(0.036)	(0.069)	(0.053)	(0.088)	(0.328)	(0.217)
Schooling	-0.009	0.000	0.006	0.005	-0.005	-0.0**	-0.006	0.023
	(0.013)	(0.0)	(0.005)	(0.008)	(0.006)	(0.005)	(0.025)	(0.021)
Governance	0.08**	0.03*	0.009	0.012	0.04**	0.1***	0.200	-0.026
	(0.032)	(0.0)	(0.013)	(0.024)	(0.012)	(0.018)	(0.206)	(0.137)
Fertility	0.64**	0.93*	-0.056	-0.006	0.271	0.450	1.249	1.669*
	(0.292)	(0.2)	(0.194)	(0.102)	(0.276)	(0.350)	(0.767)	(0.594)
Consumptio	-0.6**	-0.64	-0.266	0.269	-0.163	-0.201	-2.1**	-1.597
n	(0.279)	(0.4)	(0.194)	(0.334)	(0.142)	(0.158)	(0.986)	(1.488)
Investment	-0.061	-0.8*	0.23**	0.056	0.147	0.105	-0.200	-1.0**
	(0.274)	(0.3)	(0.10)	(0.210)	(0.094)	(0.075)	(0.407)	(0.350)
Time effects	YES	YES	YES	YES	YES	YES	YES	YES
AR1 *p*-value		0.116		0.131		0.435		0.100
AR2 *p*-value		0.063		0.626		0.524		0.471
Hansen J *p*-value		0.793		0.013		0.016		0.854
Wald /F-stat	5.00**	126.*	3.18**	23.1**	4.68**	226.**	50.2**	119.4*
Jarque-Bera stat 3925**								
Breusch–Pagan 7.99**								
Wooldridge F-stat 7.52**								
N	264	264	88	88	88	88	88	88
Countries	66	66	22	22	22	22	22	22

Note: Columns 1, 3, 5, and 7 show Pooled OLS estimates, and columns 2, 4, 6, and 8 show System GMM estimates. All variables are measured beginning with a 5-year interval from 2000-2020. Robust standard errors in parenthesis. ***p<0.05, ***p<0.01, *p<0.10.*

As a corrective robust measure of the cross-sectional dependence, endogeneity bias, autocorrelation, and heteroscedasticity, the model specified in equation (4.3) was re-estimated using the Two-step Instrumental Variable-Generalized Method of Moments (2SIV-GMM) estimation technique (with the Discroll-Kraay standard errors) (Nguea, 2023). The 2SIV-GMM utilizes the orthogonality condition to produce efficient coefficient estimates in the presence of autocorrelation, cross-sectional dependence, variable omission, measurement error, endogeneity, and heteroskedasticity of unknown form (Boateng et al., 2021; Nguea, 2023). Conceptually, we anticipated the existence of the correlation between explained, explanatory, and instruments (Ahmed et al., 2021; Wooldridge, 2012). This dissertation assumed that the measures of urban agglomeration (main regressors) are endogenous except for the year. Thus, we utilized a maximum of three-year lags of the main regressors as instruments and included consumption, private investment, and initial GDP per capita as external instruments of the estimation. Using lag structure enables the instruments and endogenous explanatory variables to be strongly associated (Scholl & Klasen, 2018). Additionally, by following Amponsah et al. (2023) and Sovey and Green (2011), we tested the statistical validity of the selected instruments' validity to minimize the probable bias, especially in the case of heteroscedasticity presence. We considered standard errors and Kernel (Bartlett) band-with to account for the potential heteroscedasticity in the model estimations (Amponsah et al., 2023; Nguea, 2023). Moreover, we performed instruments' validity, under-identification, over-identification, and weak identification tests using the Hansen J test, Kleibergen-Paap rk LM tests, and Cragg-Donald Wald F-statistics.

Table 7 provides the 2SIV-GMM regression estimated results. Before delving into explaining the results, it is essential to mention that Discroll-Kraay estimation was used as a preliminary estimator, and all explanations and deductions were based on 2SIV-GMM estimation based on Discroll-Kraay standard error model setup. Looking at the model reliability tests, the findings show a significant Kleibergen-Paap rk LM ($p<0.05$) and an insignificant Hansen *J*-statistic ($p>0.05$) across all samples. Empirically, a significant Kleibergen-Paap rk LM test (Kleibergen &Paap, 2006) resulted in the rejection of the null hypothesis of under-identification and weak instruments, signifying the appropriateness of the instruments in 2SIV-GMM estimation. Additionally, an insignificant Hansen *J*-statistic value indicated that we do not reject the null hypothesis (instruments are valid) and deduce that the selected instruments are valid. This further implies that the instruments excluded are independently distributed in the error process (Ahamed et al., 2021). It is also important to mention that 2SIV-GMM corrects for the endogeneity problem by including regressors as both exogenous and endogenous variables in the model estimation (Ahamed et al., 2021; Amponsah et al.,2023; Boateng et al., 2021; Nguea, 2023).

The findings in Table 7 show the coefficient of urban agglomeration measured by HHI50 to significantly and negatively influence regional economic performance in world, European, and SSA economies but significantly beneficial in Asian economies sample at 1% and 5% significance levels. This signifies that holding all other factors constant, as the urban agglomeration increases in small and large cities, the regional economic performance in the world, European, and SSA economies declines through dwindling GPD per capita growth. These findings contradict the observations made by previous studies (Ganau & Rodríguez-Pose, 2022; Melo et al., 2009; Rosenthal & Strange, 2004) that an increase in urban agglomeration increases the GDP per capita growth. However, an increase in urban agglomeration benefits economic performance by increasing GDP per capita growth in Asian economies, holding all other factors constant. This confirms the observation made by Li et al. (2019), who deduced that large agglomerations benefit economic performance in monocentric China. In addition, sizeable urban agglomeration (HHI100) has a significant positive effect on regional economic performance in the world and European economies, negative for Asian economies, but insignificant for the SSA economies (see columns 2, 4, and 6). These findings align with the findings observed by previous studies (Brückner, 2013; Castells-Quintana, 2017; Frick and Rodríguez-Pose, 2016; Frick and Rodríguez-Pose, 2018), which deduced that urban agglomeration has a significant positive effect on economic performance in developed economies only. In addition, our observation regarding the insignificant effect in the SSA sample collaborates with Bloom et al. (2008), who observed no significant impact. Given the conflicting effects of urban agglomeration, we agree with the previous studies, which concluded that the link between urban agglomeration and regional economic performance is significantly context-specific (Brückner, 2013; Castells-Quintana, 2017; Frick & Rodríguez-Pose, 2018; Henderson, 2003).

Regarding the role of accessing urban infrastructural services, the findings indicate a significant positive effect on economic performance for European and SSA economies but an insignificant for the Asian economies. These findings align with the previous studies, which observed that increased accessibility of sanitation services such as sludge management, emptying of solid waste, and electrification services improves the welfare of the people by reducing environmental pollution, diarrheal disease, infant mortality rate and enhances their economic productivity (Antunes & Martins, 2020; Gaffan et al., 2023; Enyew et al., 2021; Nano, 2021; Shobande, 2020). Additionally, improving the quality of access to urban sanitation improves human well-being by reducing air pollution and enhancing human productivity and economic well-being (Satterthwaite et al., 2019).

Regarding the control variables in Table 7, the urbanization rate is significantly and negatively linked with regional economic performance in the world sample (see column 2). Indeed, given that many sampled countries are from developing regions such as SSA and East and Central Asia regions, which are characterized by rapid urbanization, which presents governance pressure of managing large agglomerations and providing vital social amenities such as water, sanitation, and electricity services, which are crucial to the economic well-being of the urban population (Castells-Quintana & Wenban-Smith, 2020; de Bruin et al., 2021; Maket et al., 2023; van Vliet et al., 2020). Regarding the effect of governance on the effectiveness of incepting, implementing, and monitoring urban social welfare policies, the findings indicate governance has a significant positive impact on economic performance in European economies but is insignificant in Asian and SSA economies (Lahouji, 2017; Fagbemi et al., 2021). On the other hand, European economies have fair governance effectiveness in implementing pro-poor policies and promoting smart city agendas that catalyze economic performance (Li and Du, 2021; Inglesi-Lotz, 2016).

Other control variables, such as schooling, had a significant positive influence on economic performance in Asian economies but were insignificant in SSA and European economies. Fertility was significantly and positively linked to regional economic performance in world and European samples. Consumption was observed to have a deleterious effect on economic performance in world and SSA economies (Rijnks et al., 2018; Dabla-Norris et al., 2014). Lastly, investment remained significantly and positively linked to economic performance in SSA and world samples. Indeed, increased investment in clean urban infrastructural development reduces waste disposal costs (Zhang, 2022).

Table 7:Urban Agglomeration and Economic Performance: 2SIV-GMM Regression Results

DV:	World		Asia		Europe		SSA	
GDP per Capita growth	Drisc Kraay FE (1)	2SIV-GMM (2)	Drisc-Kraay FE (3)	2SIV-GMM (4)	Drisc-Kraay FE (5)	2SIV-GMM (6)	Drisc-Kraay FE (7)	2SIV-GMM (8)
Constant	0.744	-0.301	0.51**	0.080	-1.151	3.70**	-0.843	3.7***
	(0.417)	(0.198)	(0.098)	(0.103)	(1.242)	(1.066)	(1.915)	(1.045)
GDP per	0.087	-0.081	-0.319	0.068	-0.676	-0.250	0.082	0.017
Capita (-1)	(0.102)	(0.111)	(0.135)	(0.111)	(0.224)	(0.259)	(0.123)	(0.175)
LN(initial	-0.99*	-0.6**	-0.545	0.021	-0.961	-1.0**	4.646	-4.0**
GDP pc)	(0.272)	(0.234)	(0.227)	(0.046)	(0.664)	(0.271)	(2.399)	(1.340)
HHI50	-1.490	-4.5**	1.50**	0.75**	-3.7**	-2.7**	-3.79*	-2.8**
	(1.805)	(2.088)	(0.267)	(0.378)	(0.841)	(0.951)	(70.28)	(0.801)
HHI100	0.728	4.59**	-1.9**	-1.1**	3.91**	2.92**	2.68**	3.445
	(2.336)	(2.102)	(0.415)	(0.452)	(0.900)	(1.031)	(69.99)	(0.125)
Infrastructu	0.048	0.162	-0.212	-0.134	3.022	2.70**	0.368	3.5***
re	(0.710)	(0.142)	(0.082)	(0.149)	(2.121)	(0.942)	(0.456)	(0.908)
Urbanisatio	-1.4**	-3.4**	-0.072	-0.1**	-0.845	0.019	-0.359	0.446
n	(0.139)	(1.423)	(0.181)	(0.026)	(0.341)	(0.056)	(0.328)	(0.359)
Schooling	-0.007	0.028	0.01**	0.02**	-0.02*	-0.008	-6.07*	0.014
	(0.006)	(0.015)	(0.003)	(0.004)	(0.002)	(0.005)	(1.456)	(0.037)
Governanc	-0.266	-0.008	-0.1**	0.082	0.034	0.09**	-0.6**	0.230
e	(0.119)	(0.082)	(0.017)	(0.049)	(0.024)	(0.026)	(0.166)	(0.199)
Fertility	2.85**	0.99**	0.598	0.103	-0.117	0.77**	1.485	-0.355
	(0.513)	(0.310)	(0.206)	(0.311)	(0.082)	(0.277)	(0.931)	(0.789)
Consumpti	-1.074	-1.4**	-0.545	0.351	-0.022	-0.5**	-0.921	-5.9**
on	(0.358)	(0.572)	(0.174)	(0.184)	(0.135)	(0.151)	(0.869)	(2.326)
Investment	1.35**	2.12**	0.17**	0.029	0.32**	0.159	2.17**	2.89**
	(0.343)	(0.524)	(0.026)	(0.102)	(0.076)	(0.187)	(0.460)	(1.371)
AR1 *p*-value		0.256		0.3760		0.5883		0.3903
AR2 *p*-value		0.2842		0.3742		0.8030		0.7970
Hansen J *p*-value		0.3127		0.2575		0.1020		0.7569
Kleibergen-Paap rk LM *p*-value		0.000		0.0164		0.0140		0.0256
Wald F-stat	76.9**	5.93**	14.2**	3.95**	6.e8**	5.47**	3.+9**	6.11**

Note: The Driscoll-Kraay nonparametric covariance matrix estimator is used to produce the standard errors enclosed in parentheses. Dummies for year and country are included to control fixed effects. ***p<0.05, ***p<0.01, *p<0.10*

4.6.2 The Role of Urban Infrastructural Accessibility and Income Differences

As indicated in the introductory literature, the quality of urban infrastructure may be critical in unpacking the positive synergies from urban glomeration economies or exacerbating congestion costs, and both influence economic performance (Castells-Quintana, 2017). Therefore, differences in the quality of urban infrastructure can help explain why different effects of urban agglomeration appear by income level and urban specificities. Specifically, the impact of urban agglomeration would differ depending on the size of the urban share of the population, social policies, and income level of the sampled countries (Ahrend et al., 2017). For instance, the bi-cephalic economies have one or a few primate cities hosting more than 50% of the entire urban population structure (Castells-Quintana, 2017). In Table 8, we present the estimates of equation (4.4), where urban agglomeration's effect relies on the direct impact of the quality of urban infrastructure and its interaction with urban agglomeration, otherwise treated as an interactive effect on economic performance. We use the composite measure (UI) computed by summing the shares of the urban population accessing essential water, energy, and sanitation and dividing it by three, as it has been identified to be more robust than just using one of either share of the urban population accessing water, electricity or sanitation infrastructural services (Castells-Quintana, 2017). Additionally, we further scale down the analysis by income levels of countries categorized as developing and developed economies using Discroll-Kraay estimation technique as a preliminary analysis, out of which 2SIV-GMM was utilized in a Discroll-Kraay standard error setup to produce efficient coefficient estimates in the presence of autocorrelation, cross-sectional dependence, endogeneity, and heteroskedasticity of unknown form as it is in this study (Amponsah et al.,2023; Castells-Quintana, 2017).

The 2SIV-GMM findings show a significant negative effect of urban agglomeration on economic performance for developing economies and a positive impact on developed economies in the short run. However, the findings depict a highly significant positive direct effect as urban agglomeration enlarges (HHI100) on economic performance in developing economies and a negative impact on developed economies. These findings align with the observation made by Ganau and Rodríguez-Pose (2022), who alluded that negative returns of large agglomerations in developed economies are because most have already reached the turning point. By contrast, growing regions such as Asia and SSA are experiencing "newer" megacities that benefit from the rising agglomeration economies, with agglomeration diseconomies playing limited or no role (Brülhart & Sbergami, 2009).

Additionally, the findings depict a non-significant interactive effect between urban agglomeration measures and urban infrastructure on economic performance in developing and developed economies. Intuitively, the role of urban agglomeration mimics the level of urban specificities in terms of the quality level of urban infrastructure. Though the findings are insignificant, they align with the observations made by Castells-Quintana (2017) that urban infrastructure enhances urban agglomeration's economic returns, as indicated by the outcomes above. Based on the findings above, we deduce that higher urban agglomeration becomes more beneficial when population concentration increases with the quality of accessing urban infrastructural services. This phenomenon is depicted by the change from a negative to a positive effect for the case of developing economies, where the fair accessibility of services is in large agglomeration (cities with ≥HHI100), and the worst accessibility is in satellite cities (HHI50). Thus, the findings imply that economic performance-augmenting benefits of urban agglomeration prevail because essential urban infrastructural services spread fairly to a large share of the urban population, especially in developing regions of Asia and SSA, where urbanization is rapid (Castells-Quintana, 2017). Moreover, the findings show a significant negative effect of government consumption on economic performance for developing and an insignificant effect on developed economies. Urban infrastructure and schooling significantly negatively affect the developed economies' economic performance. On the other hand, governance indicates a significant positive impact on economic performance in developed economies but an insignificant effect on economic performance in developing economies.

Table 8:Urban Agglomeration-Economic Performance by Urban Infrastructure and Income

DV: GDP per Capita Growth	Developing		Developed	
	Drisc-Kraay-FE (1)	2SIV-GMM (2)	Drisc-Kraay-FE (3)	2SIV-GMM (4)
Constant	0.979	0.030	1.972	3.517**
	(0.624)	(0.349)	(1.011)	(1.161)
GDP per Capita Growth (-1)	-0.013	-0.089	-0.518	-0.252
	(0.185)	(0.202)	(0.220)	(0.218)
LN(initial GDP per Capita)	1.052	-0.595	-0.359	0.299
	(1.472)	(0.398)	(0.572)	(0.601)
HHI50	-2.488	-1.527**	-1.392	2.244**
	(1.394)	(0.762)	(1.087)	(0.880)
HHI100	0.678	0.839**	1.453	-2.189**
	(0.484)	(0.381)	(1.192)	(0.953)
Infrastructure	-0.329	-0.114	-0.961	-3.648**
	(1.233)	(0.240)	(1.609)	(1.105)
Urbanisation	-3.567**	0.007	-0.482	-0.039
	(0.579)	(0.236)	(0.519)	(0.053)
Schooling	-0.015	0.020	-0.022*	-0.020**
	(0.010)	(0.031)	(0.002)	(0.007)
Governance	0.242**	-0.080	0.044***	0.034**
	(0.071)	(0.101)	(0.007)	(0.014)
Fertility	0.775	0.608	-0.085	-0.229
	(1.025)	(0.454)	(0.237)	(0.416)
Consumption	-1.335**	-4.359***	-0.334	0.361
	(0.190)	(1.865)	(0.232)	(0.317)
Investment	-0.378	3.413	0.172***	-0.063
	(0.818)	(1.796)	(0.010)	(0.201)
HHI50 × Infrastructure	0.4100	11.229	-3.318**	1.391
	(4.971)	(7.671)	(0.774)	(1.520)
HHI10× Infrastructure	2.789	-9.280	3.303**	-1.576
	(3.398)	(7.600)	(0.766)	(1.595)
AR1 *p*-value		0.0673		0.5089
AR2 *p*-value		0.7988		0.4205
Hansen J *p*-value		0.8952		0.2651
Kleibergen-Paap rk LM *p*-value		0.0050		0.0215
Wald F-statistic	4.300	2.1800**	5.42e+8**	5.0100**
Countries	41	41	25	25

Note: The Driscoll-Kraay nonparametric covariance matrix estimator is used to produce the standard errors. Dummies for year/country controlled FE; $**p<0.05$, $***p<0.01$, $*p<0.10$

4.6.3 Robustness Checks: Urban Agglomeration and Economic Performance in Developing Regions

By referring to Brückner (2013) and Castells-Quintana (2017), we exploit the exogenous difference contributed by the government consumption and investment in constructing instrumental variables that enable us to interrogate the probable effect of economic performance on urban agglomeration and urban infrastructure, otherwise known as reverse causality. Literature has highlighted that government consumption and private investment directly influence urban agglomeration and economic performance (Yu et al., 2020). For instance, an increase in urban population heightens government consumption in terms of providing social protection services such as free monthly transfers for vulnerable groups (elderly, persons living with disabilities, and internally displaced persons) (Ulucak et al., 2020; Maket, 2021; Maket, 2023a). On the other hand, following an increase in environmental degradation following rapid urbanization, large segments of urban infrastructural development have attracted foreign direct private investments, which not only contain urban agglomeration challenges but also act as development catalysts (Li et al., 2019). We employ a Two-Stage Least Squares (TSLS) estimator in addressing the endogeneity issue in our robustness checks by using consumption and investment as instruments for economic performance by regressing urban agglomeration (HHI50) and urban infrastructure (UI) on lagged economic performance as follows:

$$\mathrm{HHI50}_{e,t} = \beta_1(\mathrm{Y}_{e,t-1,t}) + \alpha_e + b_t + \varepsilon_{e,t} \tag{4.8}$$

$$\mathrm{UI}_{e,t} = \beta_3\,(\mathrm{Y}_{e,t-1,t}) + \alpha_e + b_t + \varepsilon_{e,t} \tag{4.9}$$

where α_e is the economy fixed effects, and b_t represents year-fixed effects. The economy-fixed effects enable controlling for time-invariant specific mislaid variables, and year-fixed effects help control worldwide shocks.

Appendix II indicates the First-Stage Least Squares regression of economic performance on government consumption and investment measured at current PPPs. The dynamic panel equations' estimations for 4.8 and 4.9 are shown in columns 2, 3, and 4. Consumption has a significant negative explanatory power for the dissimilarity in economic performance, as outlined in the literature. Although the investment appears not positively effective, the validity test allows us to take them as instruments because of the F-stat p value <0.05, indicating the relevance and exogeneity of the selected instruments. Table 10 shows the robustness checks using consumption and investment as the instruments validated using first-stage least squares estimation in Appendix II. Before delving into the robustness checks results, it is worth noting that we considered several arguments in the literature in setting up the dynamic panel model used in robustness checks analysis.

First, we argued that the effect of urban agglomeration would differ depending on the population size of the metropolitan area or city. For instance, the bi-cephalic economies have one or a few primate cities hosting more than 50% of the entire urban population structure (Castells-Quintana, 2017). For this case, the economic returns of urban agglomeration could differ depending on HHI50 calculated based on the population in all cities with a population of ≥50,000 or HHI100, which considers few cities or, in some cases, none with a population threshold of ≥100,000. We also include its squared term for probable nonlinear relationships by referring to the Williamson-Hansen Hypothesis (Williamson, 1965; Hansen, 1990; Henderson, 2003). In addition, Henderson (2003) noted that the degree of economic performance varies with the economy's land area. Thus, we include an interaction term between urban agglomeration and land size in logarithm form. Secondly, we consider the positive interaction between urban agglomeration (HHI50) and urban infrastructure on economic performance because access to urban infrastructure is correlated with an economy's income level (Castells-Quintana, 2017). Therefore, we include an interaction term between urban agglomeration and the initial GDP per capita (in log form). Moreover, we include the interaction between urban infrastructure and urban agglomeration because it is significantly positive for developing economies and respective regional economies. We estimate equation (4) using system TSLS with different specifications and variable inclusion to control for endogeneity issues and ensure estimation consistency.

As indicated in Table 9, the panel TSLS estimated findings show a significant negative effect of urban agglomeration on economic performance in developing economies in the short-run but turns out beneficial as agglomeration enlarges from HHI50 to HHI100 (column 1), similar to those obtained in Table 8. The findings align with the findings observed by Brückner (2013), Castells-Quintana (2017), and Frick and Rodríguez-Pose (2018). Concerning the role of the quality of urban infrastructure, the panel TSLS findings confirm the findings of developing economies in Table 8. Specifically, the results show a non-significant negative effect of urban infrastructure on economic performance. In addition, the findings indicate a non-significant positive interactive effect between urban infrastructure and urban agglomeration on economic performance in the short-run but turn out insignificantly negative as agglomeration enlarges from HHI50 to HHI100. It can be argued that the quality of urban infrastructure can enhance the positive economic returns of urban agglomeration in the short run. Still, as urban agglomeration enlarges, the government undergoes financial and management challenges in providing quality urban infrastructure, resulting in negative long-term economic returns (de Bruin et al., 2021; van Vliet et al., 2020). These findings align with the conclusions made by Henderson (2003) and Barca et al. (2012) that the optimal urban agglomeration level is anticipated to fall with the level of economic performance as institutional environments are overwhelmed by surging urban populations in later urbanization phases.

In column 2, we included the interaction term with the initial GDP per capita (in log form) and urban agglomeration measures. Although the significant effect of urban agglomeration is sustained, the interaction effect with urban infrastructure is not substantial (column 2). In column 3, we introduce the nonlinear relationship in line with Henderson (2003), Brülhart and Sbergami (2009), and Castells-Quintana (2017), using the quadratic term of urban agglomeration (HHI50.square and HHI100.square) in Williamson-Hansen hypothesis (Williamson, 1965; Hansen, 1990). The findings show that the nonlinear relationship is insignificant, and the positive interactive coefficient between urban agglomeration and urban infrastructure remains insignificant. Moreover, urban agglomeration's significant direct negative short-run and positive long-run effects remain unaltered in developing economies. Column 4 introduces the interaction between urban agglomeration indicators and the country's land area of the selected developing economies. Correspondingly, the significant negative short-run effect (HHI50) of urban agglomeration on economic performance remains stable, as well as that of the long-run positive effect (HHI100). However, the findings indicate a significantly positive interaction effect between urban agglomeration and land area on short-term economic performance. These findings align with the assertions by Henderson (2003) and Castells-Quintana (2017).

Table 9:Robustness Checks: TSLS Results in Developing Economies

Dependent Variable: GDP per capita growth	TSLS (1)	TSLS (2)	TSLS (3)	TSLS (4)
Constant	0.045	-0.382	-0.404	-0.560
	(0.329)	(0.374)	(0.386)	(0.420)
GDP per capita (-1)	-0.086	-0.013	-0.016	-0.013
	(0.355)	(0.306)	(0.310)	(0.309)
HHI50	-1.493**	-2.136**	-2.092**	-1.840
	(0.698)	(0.769)	(0.794)	(0.799)
HHI100	0.823*	7.681**	7.837**	7.167
	(0.413)	(3.293)	(3.383)	(3.010)
Urban infrastructure (UI)	-0.117	-0.102	-0.101	0.098
	(0.299)	(0.293)	(0.287)	(0.258)
HHI50 × Infrastructure	11.460	15.520	16.006	14.245
	(10.243)	(11.919)	(11.807)	(10.471)
HHI100 × Infrastructure	-9.542	-12.467	-12.996	-11.740
	(10.124)	(11.358)	(11.282)	(10.179)
HHI50×log (initial GDP per capita)		-2.264	-9.470	-7.660
		(3.080)	(9.912)	(9.188)
HHI100×log (initial GDP per capita)		-6.049	0.989	0.064
		(4.458)	(8.526)	(8.368)
HHI50.square			22.846	19.681
			(25.279)	(24.026)
HHI100.square			-23.063	-19.945
			(25.070)	(23.680)
HHI50×log (Land Area)				0.0001**
				(7.70e-6)
Countries	41	41	41	41
Wald F-stat *p*-value	0.0026	0.0007	0.0019	0.0021

Note: Standard errors are enclosed in parentheses. Controls and dummies for year and country effects are included to control fixed effects. ***p<0.05, ***p<0.01, *p<0.10*

4.7 Discussion of Findings

The detailed empirical analysis presented in the previous section corroborates various existing literature on the economic performance returns of urban agglomeration while unraveling insights into the connectedness between urban agglomeration and its interaction with urban infrastructure on economic performance. Our analysis comprehensively evaluates whether highly concentrated urban structures are critical drivers of economic performance in three key purviews. First, this dissertation unpacks the cross-regional analysis evaluation of urban agglomeration in the last two decades. In this domain, we observed that there has been a declining urban agglomeration in recent decades, against the long-held notion of increasing urban agglomerations, especially in developing economies. This analysis complements the observations made by recent studies that focused predominantly on cross-country/regional analysis (Frick & Rodríguez-Pose, 2018; Ganau & Rodríguez-Pose, 2022).

Secondly, aligning with the most recent literature (e.g. Castells-Quintana, 2017; Frick & Rodríguez-Pose, 2018; Ganau & Rodríguez-Pose, 2022), we disaggregated the urban agglomeration-economic performance connectedness analysis by income level and quality of urban specificities—urban infrastructure service accessibility quality to account for growth heterogeneities in developed and developing economies and urbanization disparities in the short-run and long-run (Henderson, 2003; UN, 2019; Li et al., 2019). In this accord, we observed distinct economic effects of urban agglomeration in the world's sampled Asian, European, and SSA economies. Particularly, we observe that urban agglomeration measures computed based on the size of the urban population have opposing economic effects that depend on income levels and urban specificities of countries. For instance, urban agglomeration significantly deleteriously affects the economic performance of world, European, and SSA economies but significantly benefits Asian economies in the short run. Further, scaling down to specific developed and developing economies, we observed intriguing findings. Specifically, we observed deleterious economic effects of urban agglomeration in developing economies but significantly beneficial effects only for developed economies. Our results corroborate previous evidence according to which urban agglomeration has a significant negative impact in developing (low-income) and significantly positive for developed (high-income countries) only (e.g., Castells- Quintana, 2017; Brülhart & Sbergami, 2009; Henderson, 2003; Frick & Rodríguez-Pose, 2018; Ganau & Rodríguez-Pose, 2022). However, as agglomeration enlarges from satellite cities (HHI50) to large primate cities (HHI100), the findings reveal a significant positive effect on economic performance by increasing GDP per capita growth in developing economies. Still, it turns out deleterious in developed economies. These findings align with Ganau and Rodríguez-Pose (2022) and Li et al. (2019) that low-income economies also benefit from urban agglomeration regarding wealth growth. However, this only occurs in the long run.

In our third purview, we explored the growth-enhancing effects of urban infrastructural service quality in terms of the share of the urban population accessing essential drinking water, sanitation, and electricity services. Although an insignificant positive interaction between urban agglomeration and urban infrastructure exists, it augments the long-term beneficial economic returns of urban agglomeration in developing economies. Our findings corroborate the findings observed by Castells-Quintana (2017) that low- and high-income economies can benefit from urban agglomeration depending on the urban infrastructure. In this case, we shed light on the need to include urban infrastructural service accessibility in analyzing the link between urban agglomeration and economic performance. In general, the growth returns of urban agglomeration are positive for developed economies and negative for developing economies in the short run. However, this dissertation delinks from the assertions made in the recent literature (e.g., Ganau & Rodríguez-Pose, 2022) that the economic benefits of urban agglomeration in developing economies are a short-run phenomenon. In this accord, we argue that including a composite measure of urban infrastructure rather than one augments the economic performance benefits of urban agglomeration in low-income countries in the long run. Last, our unique findings highlight the significant role of urban infrastructure in analyzing the effect of urban agglomeration on economic performance. Although empirical studies such as Frick and Rodríguez-Pose (2018) suggest the subordinate role of urban infrastructure in promoting economic performance, we illustrate the need for improved urban infrastructure in economies in Asia and SSA. This is depicted by the interactive effect of urban agglomeration with urban infrastructure, implying the importance of urban infrastructure in driving economic performance. We also justify urban governance's significant role in policy implementation effectiveness because this will augment the needed positive synergistic impact of urban infrastructure. These findings point out that negative and positive cross-country-level economic performance returns from urban agglomeration from a national structural perspective can be stabilized by considering different adjustment processes, such as urban structure index computations, model adjustment, and the inclusion of augmenting structural variables.

5. URBAN AGGLOMERATION AND INCOME INEQUALITY: IS THE KUZNET HYPOTHESIS VALID FOR SSA?

This chapter provides evidence regarding the ongoing debate about the relationship between urban agglomeration and income inequality. This follows the World Bank and United Nations statistical evidence that places Sub-Saharan Africa among the leading urbanizing regions facing sizeable urban agglomeration inequality challenges. Therefore, in this chapter, the ultimate research question is whether there is a significant relationship between urban agglomeration and income inequality and whether the relationship is non-linear, following an inverted U-shaped Kuznets Hypothesis.

5.1 Introduction

Urbanization is a valuable outcome of economic development. As nations develop, the urban share of the population increases due to population drift from underdeveloped rural to developed urban areas full of economic opportunities such as employment and better income (Kuznets, 1955; Castells-Quintana, 2018; Moreno, 2017). The metropolitan region is a critical potential factor reflecting human prosperity, development, and sustained economic growth as they contribute to consumption, innovation, and investment in developed and developing economies (Moreno, 2017). As such, the population in urban regions has been rising tremendously due to the increasing influx of people in the urban areas in search of better income, better employment, quality education, numerous opportunities for trade and commerce, excellent communication and transportation services (Ahrend & Schumann, 2017; Ikwuyatum, 2016; Moreno, 2017).

One of the contributing factors to bourgeoning urbanization and subsequent urban agglomeration (unregulated continuous concentration of people in urban regions) all over the world is the uncontainable widening variation of wealth and economic resources across different rural and urban areas (Hardoon et al., 2016; Liddle, 2017; Tripathi & Kaur, 2017). World Bank provides extraordinary statistical evidence regarding African people staying in urban regions in line with this conjecture. For instance, the World Bank reports that by 2030, over 50% of the population in Africa will be living in metropolitan areas (World Bank, 2015; World Bank, 2019). More specifically, in Sub-Saharan Africa, the urban agglomeration has risen gradually over the past decades, from 13.09 million in 2000 to 14.35 million people in

2010 and to over 17.97 million people in 2020 and with a positive propensity to increase even more (UNDESA, 2018; World Bank, 2022).

The sudden and unregulated upsurge in urban agglomeration presents conflicting outcomes in developed and developing economies. On the one hand, it leads to positive economic outcomes such as increased regional economic performance resulting from an increased labor supply pool, specialization, and proximity to urban industries (Ahrend & Schumann, 2017). On the other hand, it leads to deleterious outcomes such as increased income inequality, urban poverty, and an increased share of the urban population living in slums and dilapidated urban settlements with inadequate access to public infrastructural services and employment opportunities, hence impacting negatively on the overall human well-being and urban livability (Liddle & Messinis, 2015; UN-Habitat, 2017b).

Sub-Saharan Africa is among the world-leading regions that are witnessing a neck-breaking urbanization pace and subsequent urban agglomeration coupled with grim government policy measures to cater for public services such as water, electricity, safe sanitation, and better housing within the major metropolitan regions (Liddle, 2013; World Bank, 2020). This is attributed to the relative economic significance of this region's urban areas. Most of the nations in this region have relatively lower incomes with varying gross domestic product (GDP) produced (Liddle, 2013; United Nations, 2015). Therefore, it is time to argue that no economy can realize sustainable economic growth without spontaneous urbanization and urban agglomeration, and this argument has been empirically tested. For instance, Castells-Quintana and Royuela (2015) observed that economic growth strongly correlates with urbanization and income inequality. More subtly, most of the developing countries in Sub-Saharan Africa are facing difficulty in addressing the socio-economic challenges brought about by urban agglomeration and continuous urbanization in terms of providing adequate housing, healthcare, schooling, and employment opportunities (Manteaw, 2020; Tuholske et al., 2020; UN-DESA, 2018).

Parallel to Sub-Saharan Africa's rapid urbanization and bursting urban agglomeration is widening income inequality (Manteaw, 2020). Although fair post-reform economic development has been given the nod for addressing rural and urban poverty facing millions of people to some extent, it has widened income inequality due to the constant ineffective policy switches and ravaging disparity in the distribution systems and preferences (Bloch et al., 2015). For instance, the income inequality measured by the Gini Index for Sub-Saharan Africa averaged between 0.68 and 0.70 in the recent two decades, 2000-2020, depicting a widening income inequality (Standard World Income Inequality Database, 2022).

Given the co-occurrence of the variables, whether rising income inequality is non-linearly related to urban agglomeration is the question informing the current study. Classical development theory popularised by Kuznets (1955) considers urban agglomeration crucial in rearranging the developing economies dichotomized by a rural subsistence and industrializing urban sector. The rising rural-urban population drift is a significant dimension of the economic structural processes (Kuznets, 1955). As more people move from the perceived lower-income rural agricultural to the higher-income urban industrial sector, income inequality increases in the first stages of urbanization and declines in later stages beyond the turning point (Kuznets, 1955). Most Sub-Saharan African economies are believed to have not yet passed the turning point—income inequality is still rising with urban agglomeration and is nowhere closer to declining (Kanbur & Zhuang, 2013). This evaluation is vital for the SSA region given the fact that the income inequality in the area is primarily attributed to wider rural-urban and urban-urban income gaps; hence, urbanization cannot potentially reduce the impact of the disparity due to lack of adequate fiscal capitation and government technical ability during first stages but can be decreased after passing certain turning point (Bloch et al., 2015).

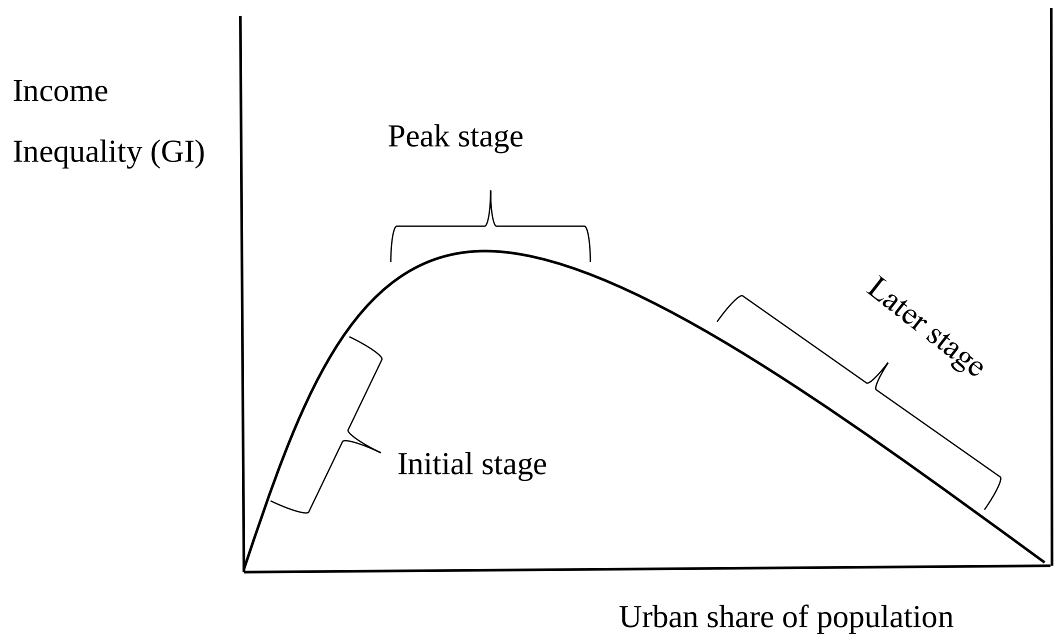
Against this backdrop, the innovation of this dissertation chapter is to contribute new knowledge to the existing literature regarding the Sub-Saharan African context in different ways. First, the study addresses whether there is a non-linear relationship between income inequality and urban agglomeration, following an inverted U-shaped Kuznets hypothesis. Secondly, the study utilizes different estimation methods such as Pooled OLS, Fixed Effects (FE), Random Effects (RE), Difference, and System GMM in estimating non-linear relationships using the sample of the latest data from 2000 to 2020 drawn from 22 Sub-Saharan African countries. The dissertation's uniqueness is that it focuses primarily on determining the validity of the inverted U-shaped Kuznets hypothesis in the case of SSA, which is currently under-researched from this perspective. Also, distinctly, the study seeks to fill the gap left by studies focusing on the SSA context (Adams & Klobodu, 2019; Nkalu et al., 2020), whereby rather than determining how urban agglomeration influences income inequality, we go a step further to determine the turning point of urban agglomeration, from which the income inequality curve starts to decline using the current panel data.

The remaining part of this thesis chapter is structured as follows: Section 5.2 presents background literature that departs from the theoretical evaluation of the inverted U-shaped Kuznets hypothesis and empirical evidence of either linear or non-linear relationship between urban agglomeration and income inequality from recent studies. Section 5.3 entails data, data sources, and the estimation strategy. Section 5.4 presents the statistical results and discussions. Section 5.5 summarizes the study findings.

5.2 Contextual Background Literature

As mentioned in chapter three, this chapter evaluates the Inverted U-shaped Kuznets curve fronted by Kuznets (1955). We explore income inequality from the regional context by considering urban agglomeration driven by the urbanization rate. As indicated in Figure 13, income inequality is plotted on the y-axis. The urban share of the population is displayed on the x-axis to show the non-linear or quadratic relationship between income inequality and urban agglomeration (urban share of the population) (Anand & Kanbur, 1993). As urban agglomeration rises, income inequality increases in the initial stages, peaks at some level, and deepens under the prevailing growing urban population share throughout the urbanization and economic processes. Therefore, according to Kuznets (1955), urban agglomeration pursued by the rural-urban migration processes fundamentally increases income inequality during the early stages of urban agglomeration. Additionally, as urban agglomeration rises, urban economic performance and industrialization increase the per capita income gap among the urban population (Anand & Kanbur, 1993).

Figure 13:Inverted U-shaped Kuznets Curve



Source: Anand and Kanbur (1993)

Kuznets (1955) further outlines urbanization's contribution to the non-linear relationship between urban agglomeration and income inequality. This chapter considers urbanization a significant factor in speeding up urban agglomeration and subsequent general income inequality in a region (Krugman, 1991; Ha et al., 2020). The rate of urbanization propels the urban agglomeration and economic performance of the urban areas, at least during the first stages of progress, signifying that a balance exists between urban agglomeration and income distribution beyond a specific turning point (Brulhart & Sbergami, 2009). Income inequality results from urban agglomeration and regional economic performance (Harris & Todaro, 1970; Lewis, 1954).

In summary, the Kuznets model explains the variation in income distribution in the first stages of urban agglomeration and falling in later stages of urban development and population growth. With the illustration above, Kuznets depicts an inverse U-shaped (non-linear or quadratic) relationship between urban agglomeration and income inequality. Thus, the continuous inflow of people from rural to urban regions is inherently linked with increased income inequality by increasing the share of the urban population in the early stages of urbanization (Ha et al., 2019).

In agreement with the theorized non-linear conjecture, Liddle (2017) empirically observed that increasing economic growth reduces poverty and narrows the rural-urban income gap. For instance, if a more significant share of the rural population moves to urban regions with disproportionate urban economic opportunities, they may end up becoming unemployed or engage in casual jobs that cannot meet their basic needs, thereby worsening their income gap (Arouri et al., 2017; Tuholske et al., 2020; UN-Habitat, 2016). Nonetheless, if the number of rural-urban populations match the urban regions' available economic opportunities, urbanization could be linked to reduced income inequality later (Arouri et al., 2017; Khan et al., 2016; Tuholske et al., 2020).

Similarly, Wu and Rao (2017) find supportive evidence of a non-linear or inverted U-shaped relationship between urban agglomeration and income inequality in Chinese provinces. In a more recent study focusing on Sub-Saharan Africa, Mahumane and Mulder (2022) observed an inverted U-shaped relationship between urban agglomeration driven by urbanization and income inequality associated with energy expenditure in Mozambique. Still on SSA, Christiansen and Weerdt (2017), using Tanzanian data between 1991 and 2010, observed no significant relationship between urban agglomeration and income inequality. Focusing on SSA from a regional perspective, Adams and Klobudu (2019) and Sulemana et al. (2019) observed an inverted U-shaped relationship between income inequality and the urban share of the population.

Maintaining this strand of literature, it can be deduced that empirical literature is divided into two broader categories. One, a section of studies has paid attention to the relationship between urban agglomeration from an in-country analysis perspective (Castells-Quintana & Larru, 2015; Chen et al., 2017; Cottineau et al., 2019; Christiansen & Weerdt, 2017; Mahumane & Mulder, 2022; Martinez Posada & Garcia, 2017; Wu & Rao, 2017). Secondly, another limited but considerably growing literature strand is shifting the focus to cross-country or regional analysis (Castells-Quintana et al., 2015; Li et al., 2019; Naguib, 2017). However, to this extent, a handful of studies have paid attention to the relationship between urban agglomeration and income inequality following the latest strand of literature (cross-country or regional) from developing regions such as the Sub-Saharan African perspective (Adams & Klobodu, 2019; Castells-Quintana, 2018; Sulemana et al., 2019).

Whereas the reviewed studies confirm the existence of a significant relationship between urban agglomeration and income inequality, there is a need to understand the exact relationship from the SSA context and whether it follows an inverted U-shaped hypothesis. Due to these inconsistencies in the literature and the limited empirical evidence for the Sub-Saharan Africa region, our paper contributes to the literature by presenting empirical evidence on whether the relationship between urban agglomeration and income inequality is non-linear and follows an inverted U-shaped hypothesis using 22 Sub-Saharan African countries, the current dataset from 2000 to 2020 and using the panel dynamic data model estimated by Pooled OLS, FE, RE, Difference and System GMM techniques.

5.3 Data and Methodology

We used a balanced panel dataset from 22 Sub-Saharan African countries from 2000 to 2020. The data availability informed the inclusion of the countries and period of urban agglomeration data; thus, countries with data breaks were dropped from the initial list of all 48 Sub-Saharan African countries, and only 22 met this threshold. Regarding variable inclusion, we included income inequality as the dependent variable measured by the Gini Index (Gini, 1909). Specifically, the study considered the Gini Index computed from mean income differences encompassing the country's population without considering location, age, and employment status (Solt, 2016). The panel data for income inequality was sourced from the Standardized World Income Inequality Database (SWIID), a derived source from the World Income Inequality Database (WIID), due to its ability to include imputation or fill in data gaps (Jenkins, 2015). Urban agglomeration measured by the urban share of the population was included as the independent variable. Urban agglomeration was measured using the urban share (%) of the population determined by dividing the total urban population by the country's population (Frick & Pose, 2018). Also, the urban share of the population from agglomerations above the 1 million threshold was included as an additional measure of urban agglomeration for a robustness check (Asogwa et al., 2020; Frick & Pose, 2018). The summary of the study variables, measures, and data sources is shown in Table 10.

Table 10*:*Variable Description, Measurements, and Data Sources

Variable name	Measure	Data source
Income Inequality	Gini Index	SWIID
Urban Agglomeration *Measure 1*	Dividing the total urban population by the total country's population (urban population (%)).	World Bank
Urban Agglomeration *Measure 2*	Share (%) of the urban population in agglomeration of more than 1 million.	World Bank
Urbanization rate	The ratio of the urban population to the rural population	World Bank/UNDP
Industrialization	Share (%) of the population employed in urban industries	World Bank
Economic Performance	GDP Per Capita Growth (annual % change)	World Bank
Policy Preferences	Governance Effectiveness Index proxy measure	WGI/World Bank
Education Level	The Human Capital Index per person is calculated based on years of schooling and returns to education.	World Penn Tables

Source: Author's Construction (2023).

5.3.1 Descriptive Statistics and Stylized Facts

Before proceeding further, it is essential to present some stylized facts about urban agglomeration and income inequality trends in Sub-Saharan Africa from 2000 to 2020. Income inequality growth averaged 62%, and the mean share of the urban population growth of the 22 selected Sub-Saharan African countries was 37.4% over the period. Similarly, the average growth of the urban share of the population in agglomerations with more than 1 million people was 16.5% (see descriptive statistics in Table 11). More interesting is the rising urban agglomeration, where the urban share of the population rose from 31% in 2000 to 36% in 2010 and 41% in 2020 (World Bank, 2023). In the same breath, income inequality in the Sub-Saharan African region averaged about 69% between 2000 and 2007 before slightly declining to an average of 68% between 2008 and 2016. Further, the recent income inequality growth averaged 67% from 2017 onwards (SWIID, 2023; Solt, 2016).

Table 11: Descriptive Statistics

Variable Name	N	Mean	Maximum	Minimum	Std. Dev.
Income Inequality	462	0.6205	0.7615	0.5231	0.0504
Urban Share of pop	462	0.3739	0.6783	0.1461	0.1474
Share Above 1m	462	0.1647	0.6318	0.0335	0.1163
Urbanisation Rate	462	0.7036	2.1084	0.1711	0.4699
Industrialization	462	0.1061	0.2879	0.0284	0.0523
GDP Per Capita Growth	462	0.0155	0.1994	-0.3070	0.0437
Human Capital Index	462	1.7478	2.9133	1.0695	0.4242
Policy Preferences	462	-0.8289	0.6459	-1.8414	0.4397

Source: Author's Computations from Eviews 12 (2023).

Further, to establish the empirical link between urban agglomeration and income inequality, we included various control variables such as urbanization rate, regional economic performance, industrialization, education level, and governance policy preferences as identified in the literature as structural factors influencing both urban agglomeration and income inequality (Bloom et al., 2010). The datasets of these variables were obtained from World Bank Development Indicators (WDI), World Governance Index, and World Penn World Tables (Heston et al., 2012). Regional economic performance arising from high labor productivity and a large pool of skilled people migrating from rural to urban regions were included to capture the structural implication of rising urbanization rate, compounded by rural-urban migration (Lengyel & Szakálné, 2012; 2018; de Bruin & Liu, 2020). For instance, the wage income per capita decreases with income per capita at earlier stages of development before declining at later stages of the increased urban share of the population (Behrens & Robbert-Nicoud, 2014; Kuznets, 1955).

We included industrialization as a control variable measured by the number of employed people in urban industries (Altunbas & Thornton, 2019). It increases the rate of urbanization, urban agglomeration, and, subsequently, income inequality. Indeed, the continuous inflow of people from rural creates a scramble for limited employment and opportunities in the city (Ali et al., 2021; Ike et al., 2020). Similarly, we incorporated the urbanization rate as part of the control variables measured by the ratio of the urban share of the population and the country's share of the rural population, as extant literature has found rural-urban migration to be the key driver of the pace of urban agglomeration growth, and income inequality in that the rural-urban income gap measured by the difference of agricultural rural sector employment and industrial urban sector employment income has a most considerable marginal impact on the income inequality (Khan et al., 2020). Ideally, as people move from rural to urban regions, the wage income gap between the rural and urban populations creates a wider income inequality (Guo et al., 2019).

The dissertation also included education level computed as human capital index per person from schooling years and returns to education as part of the structural measures preceding rapid urbanization and urban agglomeration, where people flock into cities searching for education and careers (UN-Habitat, 2017). The continuous concentration of skilled youths from all walks of life with different innovative ideas creates a labor force pool around urban industries. Income increases at the first phase of education before falling later as returns to education fall, as indicated by the high unemployment rate among youths in Sub-Saharan Africa (Castells-Quintana, 2017; Tripathi, 2021). Lastly, the study considered policy preferences by the governments in containing the socioeconomic challenges posed by rapid urbanization in terms of its effectiveness in implementing and monitoring public provisioning service policies such as urban infrastructural development (Fossaceca, 2019; Thacker et al., 2019; S Satterthwaite et al., 2015). Indeed, SSA, like the most urbanizing region, is grappling with increasing slum and unplanned settlements where over 50% of the population live under the acute proliferation of inadequate access to sanitation, water, and energy services (Castells-Quintana, 2017; Shi, 2019).

5.3.2 Empirical Strategy

This dissertation followed a panel dynamic data model of income inequality and urban agglomeration in a quadratic form derived as follows:

Beginning with the panel dynamic data model in a reduced linear format, we have:

$$G_{it} = \alpha_0 + \alpha_1 G_{it-1} + \beta_1 UA_{it} + \gamma UrbF_{it} + \eta_i + \mu_t + \epsilon_{it}\ ;\ i = 1, \dots, N, t = 1, \dots, T \quad (5.1)$$

By changing equation (1) above into a non-linear panel dynamic model, we expressed income inequality as equivalent to urban agglomeration and its squared term together with the rest of the control variables as follows:

$$G_{it} = \alpha_0 + \alpha_1 G_{it-1} + \beta_1 UA_{it} + \beta_2 UA_{it}{}^2 + \gamma UrbF_{it} + \eta_i + \mu_t + \epsilon_{it} \quad (5.2)$$

Whereby G_{it} is the income inequality (Gini Index), G_{it-1} is the lagged income inequality, UA and UA^2 is the matrix of the independent variable (urban agglomeration and its squared term) measured by the urban share of the population (ratio of total urban population to country's population) and urban share of the population from agglomerations more than 1 million people, $UrbF_{it}$ represents the vector of the unobserved urbanization factor covariates of income inequality taken care of by the control variables (urbanization, industrialization, regional economic performance, education level, and government policy preferences) discussed above. The intercept is defined by $\alpha_{0,}$ and β_1 is the slope parameter for urban agglomeration, γ is the coefficient's vector for the control variables, η_i are the fixed effects of the region i, μ_t represents the random effects at a particular time t, and the random error term is ϵ_{it} (Bond, 2002; Hsiao, 2002: Dang et al., 2015). The subscript index i refers to country 1,.., 22, and t refers to time years 2000 to 2020.

The dynamic panel data models (5.1) and (5.2) above were estimated using different estimation methods: Pooled OLS, FE, RE, Difference GMM, and Systems GMM because the use of pooled OLS, for instance, by default, assumes that at least a portion of the regression estimators is similar across the entire panel (pooling assumption) (Alvarez & Arellano, 2022). For this reason, Arellano and Bond (1991) and Arellano and Bover (1995) proposed a generalized method of moment estimators as being capable of producing unbiased estimates when the panel data has sufficiently large cross-sections (N) and short time series components (T), as is the case in this study where *N= 22* and *T= 21*. Mainly, GMM techniques present the ability to use the difference operator Δ (Difference GMM), a system of equations consisting of lag levels and lagged first differences as instrumental variables (System GMM), ideal for taking care of probable fixed effects and Nickel bias (Roodman, 2009). The System GMM technique assumes additional first difference instruments are uncorrelated with the fixed effects, dramatically enhancing estimation efficiency (Roodman, 2009; Hansen, 1982).

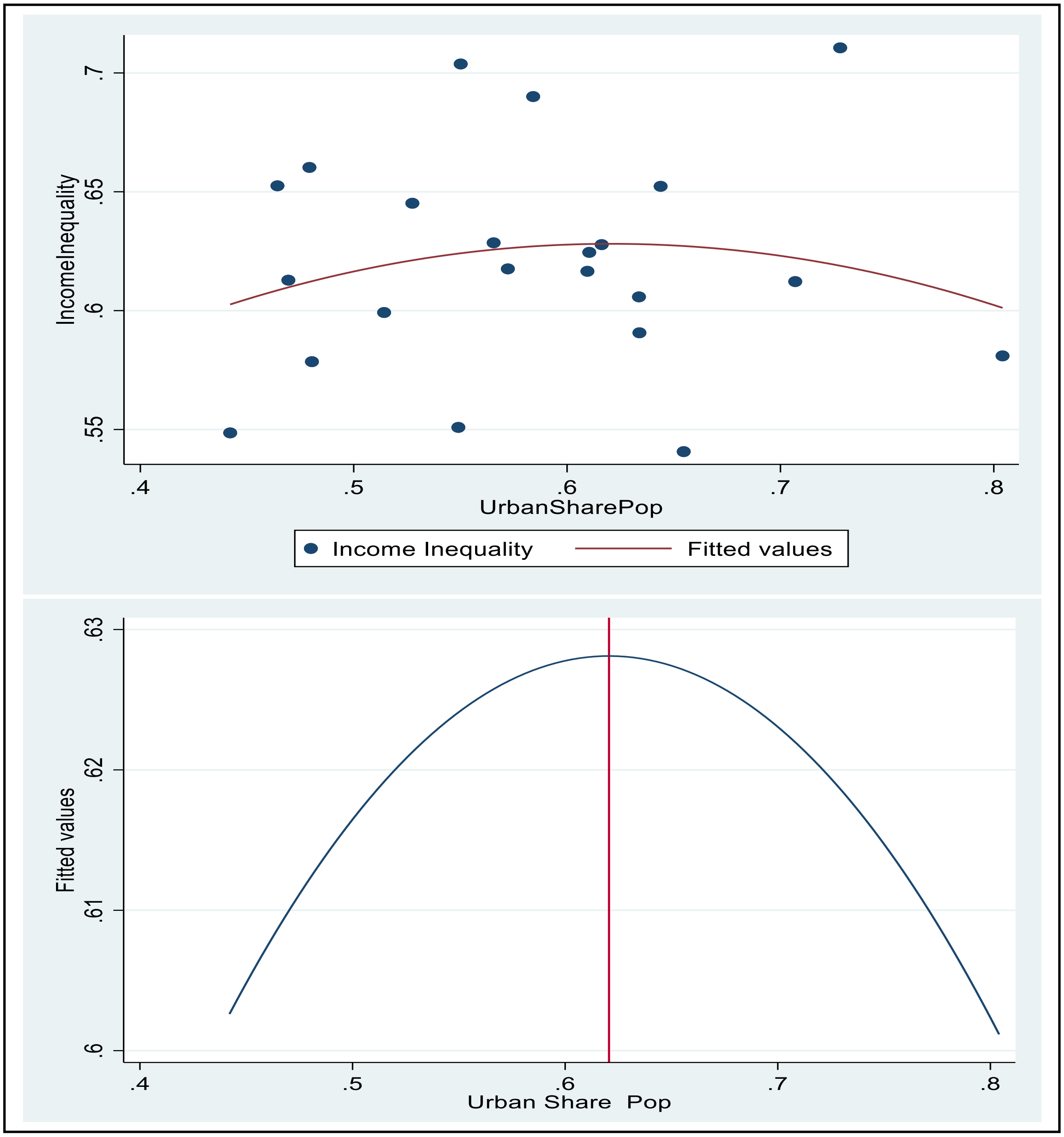
Summarily, all the variables whose measurements were in percentages: urbanization rate (ratio of urban population to rural population), the urban share of the population, the share of urban population from agglomeration above 1 million (measures of urban agglomeration), the share of the population employed in urban industries (industrialization measure), and GDP Per Capita growth (a measure of regional economic performance) were converted into index or ratio form to maintain uniformity with other variables measured in ratios; income inequality (Gini Index), human capital index and policy preference (governance effectiveness index) and ensure uniform distribution about zero (skewness).

To begin with, we departed our estimation process by assessing the order of integration of the study variables to determine whether they were stationary. We employed several panel unit root tests such as Levin et al. (200), otherwise known as (LLC), and Im et al. (2003), otherwise known as (the IPS) test, to check for the stationarity traits. LLC and IPS perform very well in cases of panels with a small T. Our rationale for using panel unit root tests (IPS and LLC) instead of first-generation unit root tests (ADF and PP) was to increase the robustness of the test through the available information provided by the cross-sections under consideration. Moreover, we employed augmented cross-sectional IPS (CIPS) by Pesaran (2007) to account for the possibility of cross-sectional dependence in our panel data. Any dataset found not stationary was differentiated to the first or second difference to make it stationary.

5.3.3 Empirical Estimation Findings

Figure 14 presents the relationship between urban agglomeration and income inequality following an Inverted U-shaped Kuznets Curve. In the first panel, the scatter plot shows an increasing relationship in the initial stages of urban agglomeration, peaking at some point and falling at later stages. The second panel shows the two-way plot with a turning point indicated by the vertical red line. Using Stata software, the turning point is determined to be 0.6206, which is calculated using regression coefficients as shown below.

*Figure 14:*Quadratic and Turning Point of Urban Agglomeration and Income Inequality



Source: Author’s Computations from Stata Software (2023).

Note: The turning point shown by the vertical red line and the value of the urban share of the population at the turning point are generated using Stata software using command codes attached in Appendix III.

Turning point calculation follows a regression expressing average income inequality as a function of the average urban share of the population and its squared value for the selected countries over the period stated below:

$$Income\ inequality = \beta_0 + \beta_1 * Urban \text{ share pop} + \beta_2 * Urban \text{ share pop}^2 \quad (5.3)$$

By differentiating equation 2 above with respect to the urban share of the population and equating the outcome to zero, we get;

$$\beta_1 + \beta_2 * 2 * Urban \text{ share pop} = 0 \quad (5.4)$$

Making the urban share of the population the subject of the formula in equation 3, we get the turning point value of the urban share of the population when the curve starts tilting given as;

$$\text{Urban share pop at turning point} = \frac{-\beta_1}{2\,\beta_2} = -0.5\,\frac{\beta_1}{\beta_2} = -0.5\left(\frac{0.99356}{-0.80046}\right) = 0.62 \quad (5.5)$$

Thus, the turning point of the inverted U-shaped Kuznets curve occurs when the urban share of the population is at a 62.06% growth mark.

The cross-sectional dependence (CD) and panel unit root findings using second-generation unit root tests are presented in Table 12 in level form, first difference, and second difference. Beginning with cross-sectional dependence (CD), the findings point out that the null hypothesis of no presence of cross-sectional dependence failed to be rejected for income inequality and government policy preference, implying the absence of cross-sectional dependence. However, the null hypothesis of no presence of cross-section dependence is rejected for an urban share of the population, urban share above 1 million, Urbanisation rate, Industrialization, GDP Per Capita Growth, and Human capital index, implying the presence of cross-sectional dependence. Further, the null hypothesis of the presence of unit root is rejected for income inequality and policy preference in level form using LLC and IPS, implying integration to order 0 (I (0). Additionally, LLC and IPS statistic values are significant at 5% for industrialization, GDP Per Capita Growth, and Human capital index at the first difference, implying rejection of the null hypothesis of the presence of unit root and the conclusion made that the variables are integrated to order 1 (I (1).

Moreover, LLC and IPS statistical values are significant at 5%, signifying rejection of the null hypothesis and conclusion that the urban share of the population, above 1 million, and urbanization rate are integrated to order 2 (I (2). Lastly, we checked whether the variables were stationary regardless of cross-sectional dependence (CD) presence. CIPS confirmed significance for all variables, implying that all variables are stationary in cross-sectional dependence. Therefore, given that the variables are stationary in different forms, that's a level form (I (0), the first difference (I (1), and the second difference (I (2), it is thus essential to consider testing for the existing relationship between variables using Pooled OLS, FE, RE, Difference and System GMM models.

Table 12: Panel Stationarity or Unit Root Test

Variable	LLC	IPS	CIPS	CD	Status
Income Inequality	-4.364**	-3.568**	-3.326**	-1.811	I(0)
Urban Share of Population	-28.114**	-14.235	-2.883**	-2.161**	I(2)
Urban Share Above 1M	-3.064**	-7.383**	-2.095**	31.067**	I(2)
Urbanisation rate	-42.305**	-18.222**	-2.392**	55.452**	I(2)
Industrialization	-3.478**	-3.366**	-2.293**	6.362**	I(1)
GDP Per Capita Growth	-8.314**	-12.751**	-3.043**	13.762**	I(1)
Human Capital Index	-4.273**	3.063	-2.635**	67.947**	I(1)
Policy Preference	-2.487**	-2.158**	-2.815**	-1.438	I(0)

Note: ** indicates significant probabilities of the unit root and cross-sectional dependence (CD) tests at a 5% confidence interval. Urban Share Above 1M is the share of urban from agglomeration with more than 1 million people.

Source: Author's Computation from Eviews 12 (2023).

After confirming the variables' panel unit root and cross-sectional dependence (CD), we empirically modeled the non-linear relationship between urban agglomeration and income inequality. Before discussing the findings obtained, it is essential to mention that Pooled OLS, FE, and RE are used as benchmark techniques. The conclusion and observation are made from the Difference and System GMM regression results. Four principles inform this decision. One, using N=22 is considerably greater than T=21, although this T may produce unreliable estimates if the conclusion is based entirely on Pooled OLS, FE, and RE

(Dorn & Schinke, 2018). Secondly, the measure of income inequality (Gini Index) is persistent over time. It has a weak correlation with its first lag (-0.3023), lower than the threshold of establishing a good relationship between a variable and itself (Asongu & Aca-Anyi, 2019). Thirdly, GMM methods help preserve cross-economy variations, given the presence of cross-sectional dependence and potential endogeneity among regressors in our panel data. Also, GMM methods mitigate all time-invariant and unobserved heterogeneity country-specific effects and account for simultaneity in the independent variable (Bond & Windmeier, 2002; Tchmyou et al., 2019).

Further, in choosing between the Difference and System GMM, we use the estimated findings of Pooled OLS, FE, RE, and Difference GMM and compare the corresponding values of α_0 in the dynamic panel model in equations 1 and 2. In this case, Pooled OLS and FE are regarded, correspondingly, as upper-bound and lower-bound estimates of α_0. Since a *priori* expectation is that α_0 is correlated positively with the error term (ϵ_{it}), the Pooled OLS value will be biased upwards while the FE value will be biased downwards; thus, the estimated GMM value for the valid parameter should fall within this range (Bond, 2002; Roodman, 2009). Additionally, the Hausman test is carried out to determine whether relying on FE or RE estimate of α_0. RE is relied upon since the null hypothesis that FE is more appropriate is rejected (see Table 13).

Table 13 presents the Pooled OLS, FE, RE, Difference, and System GMM regression results. The Pooled OLS, FE, and RE estimates of income inequality as determined by urban agglomeration and selected control variables are shown in columns 1, 2, and 3. Columns 4 and 5 report findings of complete dynamic panel model estimates following the Difference and System GMM techniques, with all control variables included. However, as indicated, the estimate ($\alpha_0 = 0.011$) for System GMM falls within the threshold required between Pooled OLS estimate (α_0 =-0.001) and RE estimate ($\alpha_0 = 0.009$). Therefore, we follow the System GMM findings, which show a significant negative relationship between the urban share of the population (urban agglomeration measure) and income inequality at a 1% confidence interval (see column 5). Further, the System GMM findings show that control variables (urbanization rate, industrialization, and governance policy preference) are significant and positively related to income inequality at 1%, except for the human capital index and D_GDP Per capita Growth (see column 5). The results further show Hansen's J-statistics for System

GMM are insignificant, depicting no evidence of model misspecification. In addition, the AR (1) and AR (2) serial correlation statistic values were statistically insignificant, pointing out the absence of serial correlation in the error terms (Arellano & Bond, 1991). The Wald and F-statistic values are significant at 5%, indicating the overall significance of the parameter estimates of the models under consideration.

Table 13: Pooled OLS, FE, RE, Difference, and System GMM Model Linearity Results

Variable	Pooled OLS (1)	FE (2)	RE (3)	GMM-Diff (4)	GMM-Sys (5)
Const.	-0.001	0.066***	0.009	0.0002	0.011
	(0.007)	(0.023)	(0.009)	(0.001)	(0.008)
Income Inequality	0.998***	0.903***	0.981***	0.792***	0.971***
(-1)	(0.014)	(0.035)	(0.018)	(0.019)	(0.014)
DD_Urban Share	-1.731	-2.077	-1.727	-2.917*	-2.968***
	(1.695)	(2.037)	(1.624)	(1.516)	(1.133)
DD_Urban Share	-0.003	-0.0005	1.131E-5	-0.031	-0.004
>1M	(0.023)	(0.023)	(0.023)	(0.059)	(0.051)
DD_Urbanisataion	0.771	0.595	0.680*	0.614	0.834**
rate	(0.494)	(0.372)	(0.409)	(0.509)	(0.386)
D_GDP Per capita	-0.015	-0.017	-0.021	-0.001	-0.004
Growth	(0.041)	(0.036)	(0.040)	(0.006)	(0.005)
D_Industrializatio	0.235***	0.263***	0.252***	0.303***	0.272***
n	(0.076)	(0.086)	(0.0772)	(0.0373)	(0.043)
Governance Policy	0.001	0.003	0.002	0.004**	0.002**
Preference	(0.001)	(0.004)	(0.001)	(0.002)	(0.001)
Human Capital	0.003***	-0.001	0.003	0.013***	0.004
Index	(0.002)	(0.008)	(0.002)	(0.005)	(0.001)
Year FE	YES	YES	YES	YES	YES
Time Dummies	YES	YES	YES	YES	YES
F-statistic	19.689**	85.237**	2.765**		
Hausman test			32.32***		
Wald Chi^2				1980.0**	14370.3**
Hansen's J-stat				433.84	688.522
AR(1)				-2.306	-2.450
AR(2)				-2.692	-3.743
N	418	418	418	396	396

Note: All columns included the lagged income inequality as part of the exogenous. Also, all estimations were done with the inclusion of asymptotic standard errors and time dummies.

The standard errors are in parentheses. For Difference and System GMM estimations, model adjustment from the 1-st step to the 2-step was considered, out of which the model with reliable estimates was reported. D and DD denote the first and second differenced variables. **p<0.05, ***p<0.01, *p<0.1. Source: Estimations from Eviews 12 and Gretl (2023).

We estimate the dynamic panel model in equation 2 below to test for the non-linearity (confirmation of the Inverted U-shaped Kuznets Hypothesis).

$$G_{it} = \alpha_0 + \alpha_1 G_{it-1} + \beta_1 UA_{it} + \beta_2 {UA_{it}}^2 + \gamma UrbF_{it} + \eta_i + \mu_t + \epsilon_{it} \tag{5.2}$$

We effected this by including the urban share of the population and its squared term. Also, we included the urbanization rate and GDP Per capita growth together with their squared terms and the rest of the control variables in their unit form. Urbanization and GDP Per capita growth were included in the non-linearity analysis because, as pointed out, income inequality tends to rise in early states of urbanization when economic performance is still developing and fall in later stages of urbanization when economic systems work better (Wu & Rao, 2016; Zhou & Qin, 2012). Table 14 reveals that including the quadratic term of the urban agglomeration, urbanization rate, and GDP Per capita growth in all the models presents different results from what was observed in Table 13. First, the results show a significant positive relationship between the urban share of the population and income inequality at a 1% significance level (see column 5). Secondly, imposing a quadratic term on urban agglomeration (urban share of population), the results reveal a significant positive relationship between the squared value of the urban share of the population and the income inequality at a 1% significance level, implying a non-linear relationship between urban agglomeration and income inequality in Sub-Saharan Africa (see column 5).

Further, the results also show a significant negative relationship between the urbanization rate and income inequality. Similarly, imposing a quadratic term on the urbanization rate measure, the relationship remains significantly negative at a 1% significant interval, implying that urbanization exhibits a non-linear relationship with income inequality (see column 5). The GMM-System results indicate a significant positive relationship between industrialization and income inequality. The Wald Test is significant in all the dynamic models, signifying the reliability of the findings in making deductions. Furthermore, Hansen's J-statistics are insignificant, depicting the correct specification of the Difference and System GMM models. In addition, the AR (1) and AR (2) serial correlation statistic values were statistically insignificant, pointing out the absence of serial correlation in the error terms (Arellano & Bond, 1991).

Table 14: Non-Linear Estimates of Pooled OLS, FE, RE, Difference and System-GMM

Variable	Pooled OLS (1)	FE (2)	RE (3)	GMM-Diff (4)	GMM-Sys (5)
Const.	-0.001	0.078***	0.006	0.001	0.002
	(0.008)	(0.028)	(0.008)	(0.004)	(0.001)
Income	0.998***	0.894***	0.985***	0.812***	0.795***
Inequality (-1)	(0.015)	(0.040)	(0.018)	(0.018)	(0.060)
DD_Urban	-1.771	-1.824***	-1.192	0.913***	0.860***
Share	(2.047)	(3.050)	(2.075)	(2.273)	(1.352)
DD_Urban	-2.708	0.636***	-2.045	1.084***	0.705***
Share. Sq	(2.704)	(2.264)	(2.315)	(1.883)	(2.065)
DD_Urban	-0.029	-0.094*	-0.680	-0.154	0.006
Share >1M	(0.063)	(0.053)	(0.060)	(0.156)	(0.022)
DD_Urbanisatai	0.778	-0.532***	0.321	-0.80***	-0.569**
on rate	(0.926)	(1.727)	(0.944)	(1.603)	(1.916)
DD_Urbanisatai	1.514	-0.726***	-0.863	-1.34***	-0.302***
on rate.Sq	(2.223)	(0.766)	(0.934)	(0.756)	(0.832)
D_GDP Per	-0.007	-0.006	-0.007	-0.003	-0.006
capita Growth	(0.007)	(0.005)	(0.006)	(0.005)	(0.005)
D_GDP Per	-0.010	-0.022	-0.016	0.024	-0.020
capita growt. Sq	(0.043)	(0.037)	(0.043)	(0.037)	(0.036)
D_Industrializati	0.239***	0.270***	0.249***	0.260***	0.230**
on	(0.078)	(0.083)	(0.078)	(0.055)	(0.083)
Governance	0.001	0.002	0.002	0.005**	0.001
Policy preference	(0.001)	(0.004)	(0.001)	(0.002)	(0.005)
Human Capital	0.003	-0.003	0.003	0.009***	0.002
Index	(0.002)	(0.007)	(0.002)	(0.002)	(0.012)
Time/Year FE	YES	YES	YES	YES	YES
F-statistic	17.154**	4.882**	2.765**		
Hausman test			1.987**		
Wald Chi^2				1980.0**	14370.3**
Hansen's J-stat				435.1	171.210
AR(1)				-2.759	-3.567
AR(2)				-2.436	-4.122

5.4 Discussion of Findings

The reviewed literature provided significant evidence regarding the non-linear relationship between urban agglomeration and income inequality. Although some studies confirmed a linear relationship, and others established a non-linear relationship between urban agglomeration and income inequality, our case focusing on SSA shows a significant non-linear relationship. Mainly, the conflict in the literature can be attributed to the difference in a particular region's urban agglomeration level. In this study, we focused on determining whether there is a significant relationship between urban agglomeration and income inequality and whether the relationship is non-linear in Sub-Sahara Africa. The observed findings align with the theoretical fact in the inverted U-shaped Kuznets hypothesis, where income inequality increases with urban agglomeration at the first stage, peaking in the middle and falling at later stages of urban agglomeration. The study modeled the non-linear relationship between urban agglomeration and income inequality using balanced panel data spanning from 2000 to 2020 for 22 Sub-Saharan African countries using a dynamic panel data model estimated using Pooled OLS, FE, RE, Difference-GMM and System-GMM estimation methods. However, all deductions were made based on System-GMM results.

The results showed a significant positive relationship between urban agglomeration and income inequality. Further, imposing a quadratic term on the urban share of the population sustained similar findings. Collaboratively, these findings align with the theoretical assertions of Kuznets (1955) that increasing agglomeration at the first stages occurs due to increased rural-urban migration, resulting in high-income differences as people take time to settle and find livelihoods due to unmatching skills and education transitions in their early years in the urban regions (World Bank, 2019). Two, at the peak of urbanization, few people may be forced to migrate to greener cities, thereby leaving a sizeable number of economic opportunities, causing income inequality to fall gradually as more people can access better incomes, government services, and returns to education (Demont, 2013). Summarily, the System-GMM results reveal a significant non-linear relationship between urban agglomeration and income inequality in SSA, aligning with the inverted U-shaped Kuznets Hypothesis and the prior empirical studies, which confirmed a non-linear relationship (Wu & Rao, 2016).

6. URBAN INFRASTRUCTURE AND REGIONAL HUMAN WELL-BEING: DOES QUALITY OF SERVICE ACCESSIBILITY MATTER?

This chapter provides evidence regarding the nexus between urban infrastructure and regional well-being in SSA using the recent two decades' data on the urban share of the population accessing basic water, sanitation, and energy services. Specifically, in this chapter, we interrogate whether the quality of accessing these critical urban services matters in enhancing regional human well-being as depicted by the Theory of Good City Form.

6.1 Introduction

Cities and urbanizing regions are currently home to more than half of the world's gross population. By 2050, more than two-thirds of the world population is projected to be urban, with many living in informal and unplanned settlements and growing cities in rapidly urbanizing and developing regions such as Sub-Saharan Africa (SSA) (UNDESA, 2018). This has been particularly notable in the most recent three decades, with the urban population share doubling (Duranton, 2015; Farrell, 2017; World Bank, 2022). Additionally, the driving forces of the enormous urban population growth in many African cities present deleterious socioeconomic outcomes. For instance, rapid urbanization in SSA is featured by enormous slums, informal settlements, insufficient infrastructure, and rising climate change effects resulting in social inequalities in access to critical urban infrastructural services among urban residents (de Bruin et al., 2021; van Vliet et al., 2020).

Moreover, although rapid urbanization occurs in all SSA economies, the trend differs significantly across countries (Acheampong et al., 2021; Nguea et al., 2022). For example, Nigeria, the most populous SSA nation, has encountered a tremendous rise in urbanization from 17% to more than 50% between 1960 and 2020, with forecasts indicating it will be over 68% by 2050. South Africa has a reasonably greater urbanization level than other SSA states but is accompanied by a high inequality level, specifically in urban informal settlements. Ghana and Kenya have also encountered noteworthy urbanization, pigeonholed by challenges such as inadequate urban infrastructural service provision, high unemployment rate, widening income inequality, and urban poverty (Maket et al., 2023). Ethiopia and

Uganda have relatively low urbanization levels, with 21% and 25% urban populations in 2020 (Acheampong et al., 2021; Nguea et al., 2022; Sakketa, 2023).

Given rapid urbanization, how the quality of urban infrastructural service provisioning in terms of the urban population share accessing water, energy, and sanitation services influences human well-being in the SSA region has received considerable political, stakeholder, and research focus in recent times (Kuddus et al., 2020; Nagendra et al., 2018; Shi, 2019). Mainly, access to urban infrastructural services such as water, sanitation, education, energy, and healthcare, collectively contribute to the overreaching concept of evolving human well-being, environmental sustainability, and economic performance (O'Neill, 2018; Quito et al., 2023; Ramaswami, 2020). Therefore, human well-being remains a far-reaching construct engrained in Sen's notion of human aptitudes measured in various ways, including the human development index (HDI) (Stanton, 2007). Also, in the most recent, surveys that measure human well-being subjectively have emerged, defined simply in terms of positive self-reporting (evaluative) and feeling fulfilled by what urban life offers (eudemonic) (Centre for Disease Control and Prevention, 2018; Ramaswami, 2020; Helliwell et al., 2020). With over 50% of the world population living in urban regions presently, understanding how the quality of accessing urban infrastructural services shapes human well-being in cities and specific countries or areas is essential in propagating the sustainability ambitions as depicted in the United Nations Sustainable Development Goal 11 (SDG#11) and the New Urban Agenda (UNDESA, 2015).

Urbanization-driven socioeconomic disparities manifest in most SSA cities in several ways, most profoundly unequal access to urban infrastructural services, resulting in undesirable human well-being (UNDESA, 2015; Clark et al., 2022; Maket et al., 2023). Rapidly urbanizing SSA continues to face overwhelming pressure of containing urban inequalities despite numerous efforts to align with (SDG#11) and the New Urban Agenda (Tuholske et al., 2020). Partly, this is due to un-procedural governance mechanisms and unattractive urban infrastructure investments (Shi, 2019). Secondly, this is due to the increasing urban agglomeration, which is much faster than urban infrastructural development and economic opportunities (Goodfellow, 2020; Lawhon et al., 2018). Lastly, the most significant part of the looming problems of accessing urban infrastructure services is due to limited urban infrastructural investment and policy governance capacity (Lawhon et al., 2018). For instance, the region must spend between $130 to $170 billion on basic urban infrastructural service needs (World Economic Forum, 2018). Yet still, the area is facing a financing shortfall of between $68 to $108 billion. Ideally, two-thirds of the spending on the urban infrastructure required by 2050 is yet to be realized (World Economic Forum, 2018). Thus, access to critical urban infrastructural services such as water, energy, and sanitation has continued exacerbating the social inequality in cities, resulting in undesirable levels of human well-being as most households shift to unclean energies and unsafe drinking water (Tuholske et al., 2020; Shackleton et al., 2022; Wang et al., 2020).

Despite the realities of urbanization-driven social inequality and projected urban agglomeration figures fueled by anti-urban bias, SSA has been depicted in academia and policy as a rural region (Parnell, 2014). This is notable in development cooperation, not only for SSA but also globally, which has been dedicated to rustic openly and is hardly cherished by city stakeholders and state governments (Satterthwaite et al., 2010). Researchers and scientists in the SSA region emphasize the urgent attention to SSA's incredibly stirring urbanization rate, its associated social outcomes, and the extent of social transformation (Maket et al., 2022; Pieterse & Parnell, 2014). However, unpacking the connectedness between the quality of accessing urban infrastructural services and human well-being from a regional perspective has been challenged by measuring human well-being, given the complexities across social-ecological-infrastructural urban system attributes of cities (SEIUS) (Ramaswami, 2020). While there have been notable scientific strides in quantifying the connection between the quality of accessing urban infrastructural services and human well-being worldwide, most studies have shifted focus from a quantitative measure of human well-being to subjective well-being (SWB) measures (Ramaswami, 2020). Also, although several studies link the quality of accessing urban infrastructural services such as water, sanitation, and energy services to SWB, few studies have explored how a range of urban infrastructural services shape human well-being from an objective and regional perspective measures of human well-being.

Against this backdrop, this dissertation chapter contributes to the literature in threefold ways. First, the study interrogates how the quality of access to urban infrastructural services influences human well-being in the SSA region. Most previous studies have considered urbanization's effect on human development without paying attention to objective components of human well-being (Njoh, 2003; Vasher, 2011; Nguea, 2023). Secondly, the paper evaluates how governance in terms of service provisioning, planning, management, and investment effectiveness interactively influences the urban infrastructural service accessibility quality and human well-being using balanced panel data from 2000 to 2020 from 22 SSA countries. Several previous studies have consistently mentioned in passing the challenges of urbanization in SSA without analyzing the missing governance link toward ensuring sustainable urbanization and better human well-being (Maket, 2021).

Additionally, this study evaluates the interactive relation between governance and the quality of urban infrastructural service accessibility to point out how local, national, and regional governments and stakeholders plan, implement, and finance urban infrastructural services in line with the sustainable development goal of making cities livable and resilient for better human well-being (Bekun, 2022; Satterthwaite, 2016). Thirdly, we evaluate the SSA regional human well-being from the objective panel perspective as informed by evolving objective measures such as HDI, which capture an urban region's overall quality of living conditions and economic resilience more robustly compared to subjective well-being measures that are context-specific and time-bound (UNDP, 2018; Das et al., 2022; Mavoa et al.,2019). In this conjecture, this dissertation sought to fill the gap where most papers focusing on urban infrastructural service accessibility in the SSA region are case studies; hence, there is no sufficient panel analysis base. As informed by the recent United Nations Development Programme 2021 Report, SSA's HDI averages at 0.547, far below the global threshold of 0.732, with 10 out of 54 countries featuring among the bottom countries (UNDP, 2021). Objectively, this study applies different estimation techniques such as Pooled OLS, Driscoll-Kraay, and Two-Step Instrumental Variable-Generalized Method of Moments (2SIV-GMM) techniques, which are robust in case of autocorrelation, cross-section dependence, regional endogeneity, and heteroscedasticity (Amponsah et al., 2023).

The remaining part of this dissertation chapter is structured as follows: Section 6.2 presents literature that sets off from the theoretical evaluation and provides empirical evidence from recent studies. The 6.3 section describes variables of interest, data type, data sources, estimation strategy, and estimation techniques. Data analysis and discussions of findings are presented in section 6.4. Section 6.5 summarizes key chapter findings.

6.2 Contextual Background Literature

Conceptually, this paper is built from three theoretical perspectives: modernization, dependency, and urban bias theories. Modernizationists view urbanization as a natural process through which traditional society passes to become industrialized or modern nations (Bradshaw & Noonan, 1997). This theory contends that urbanization has positive social effects and must be encouraged (Dumont & Mottin, 1983). On the other hand, urban bias theorists do not agree with these assertions; instead, they contend that urbanization is a government policy product that systematically redirects most precious resources to urban regions, causing rural-urban disparities (Lipton, 1977). This leads to massive rural-urban migration, creating large agglomerations with long-term social outcomes (Stren, 1975). lastly, dependency theorists are concerned with urbanization's effect on available social resources, such as land for rural-based populations (Njoh, 2003). They posit that urbanization causes disparities between rural and urban dwellers, a scramble for limited urban infrastructural services, and urban labor market distortions due to large, uncontainable agglomerations in developing regions such as Sub-Saharan Africa (Njoh, 2003).

In line with dependency theory, urban infrastructure refers to the systems that provide energy, water, sanitation, waste management, communication, public green spaces, and affordable housing services (Bradshaw & Noonan, 1997; Njoh, 2003). These are vital in supporting human well-being and economic prosperity in city regions (Ramaswami et al., 2012). Consequently, the quality of accessing these urban infrastructural services refers to the ease and extent with which a particular share of the urban population can obtain these services, as determined by proximity and the efficiency of getting them, and quantity provided by the local government and private suppliers (Rode et al., 2019). In this connection, governance has recently received much attention as it is the process by which central, local, municipal, or regional governments and stakeholders collectively determine the provision and access to social services. Governance refers to systems and processes influencing urban populations' access to infrastructural services (Dewita et al., 2019).

Human well-being is made up of three words: “human,” “well,” and “being,” and it can be interpreted as “human being well in a particular region” or a situation whereby things are generally fine among a specific region’s population. Various dictionaries have defined it as a state resulting from comfort, health, happiness, and prosperity (Cambridge University

Press, 2016; Merriam-Webster, 2016; Oxford University Press, 2016). All these factors point out some form of positivity in human life. Researchers across different scientific subjects have been trying to define better and enhance understanding of human well-being. Nevertheless, there is an imminent agreement in the literature that due to its nature, human well-being can be better described than defined (Dodge et al., 2012). Conventionally, the concept of human well-being stemmed from metaphysics, where traditional ancestors regularly contemplated life and its purpose (Merriam-Webster, 2016). The concepts of Eudaimonism and Hedonism were among the primary trials to understand human well-being. Hedonism relates to the experience of a positive emotional state and satisfaction of needs and preferences, whereas Eudaimonism corresponds to the meaning and development of an individual's potential and capabilities (Disabato et al., 2016; Kraut, 2018).

Human well-being is linked to two distinct categories: subjective (individual) and collective (society's population) in a particular region. Subjective human well-being refers to an individual's well-being (Diener & Ryan, 2009). On the other hand, collective human well-being is derived from the socio-cultural and economic relationships shared by people in one space (Lee & Kim, 2015). Earlier attempts to understand human well-being concentrated majorly on subjective notions such as individual happiness and satisfaction with one's life; however, the collective idea of human well-being is currently gaining research traction (Uchida & Oishi, 2016). Several researchers began to compute quantitative means of subjective well-being as indicator measures of collective human well-being, leading to the development of objective measures such as the Human Development Index (HDI) and average gross domestic product (Diener et al., 1995; Oguz et al., 2013; Stanton, 2007; Uchida & Oishi, 2016). A new research strand has argued that collective well-being measures substantially impact overall and regional human well-being more than subjective well-being measures (Trebeck, 2012; Oxfarm, 2013).

According to Shekhar (2017), human well-being can be understood from different dimensions, summarized as the well-being wheel in human settlements. Among the dimensions of the wheel of human well-being is access, which stands for equality of chances for a population to gain access to essential, supportive, and conducive physical and social infrastructural services, social interrelationships, as well as space and capital resources required in utilizing them (O'Neill et al., 2018; Sen, 1999). Simply put, the access dimension refers to the extent to which the urban population can obtain infrastructural services such as water, sanitation, health, energy, recreational places, educational places, employment, and sources of information (Cave & Wagner, 2018). Access incorporates a broader array of governance practices that can be directly impacted by spatial infrastructural planning provisions such as sanitation, water, energy, education, green space, recreation, health, and transportation. Research has documented that improving general access to these critical infrastructural services enhances the human well-being of a population in a particular region (White, 2009). Moreover, improving the quality of accessing infrastructural services can significantly impact different attributes of human well-being in a specific area (IOM, 2006; Graham & Nikolova, 2012; Bisung & Elliot, 2017; Islam & Winkel, 2017).

In the wake of rapid urbanization, the theoretical linkage between urbanization and human development can be explored by linking it with economic performance, which affects the population's income distribution, purchasing ability, and general living standards (Nguea, 2023). in line with this surmise, research indicates that urbanization is significantly linked to better economic outcomes such as better incomes, living standards, and employment (Baldwin & Martin, 2004; Fujita & Thisse, 2002). Consequently, urbanization's effect on economic performance is mediated by urban agglomeration, which brings out technological spillovers, economic efficiency, human capital accumulation, innovation, and labor specialization (Duranton &Puga, 2004; Maiti, 2017). Thus, as economies grow, urbanization effects become beneficial as people can access services such as water, better income jobs, and industrial agglomeration creates a compact economic advantage for the urban populace in terms of better living (Wang et al., 2019; Maket et al., 2023).

Better access to urban infrastructural services such as energy, sanitation, and water significantly affects the population's household conditions and living standards (Beard et al., 2016; Lewin et al., 2018). In this connection, necessary infrastructural service provision through government spending and governance practices ensure these critical infrastructural services are accessible to the entire population at different economic levels (Nair & Mishra, 2023). Existing theories such as Wagner's Law and Ratchet Effect substantiate the need for state spending in an economy (Nair & Mishra, 2023). Fiscal transfers from the central governments through devolution and program-based budgeting help the state to close the social inequality gaps in urban infrastructural service accessibility and income levels and undo development backwardness (Gupta & Sarma, 2022). For instance, regional urban electrification is expected to enhance human well-being by reducing the use of kerosene lamps, hence decreasing the burden of respiratory disease (Dendup, 2022).

Therefore, the dissertation chapter follows and maintains the objective measure of regional human well-being, a new and limited but primarily growing strand of literature (Enqvist & Ziervogel, 2019). Following this literature strand, several studies have been carried out in the Sub-Saharan Africa region, from city to city, country to country, and the region as a whole. For instance, Adams and Vásquez (2019) indicated that households in Accra, Ghana, were more sensitive to water quality as part of their general well-being. Similarly, Nzengya (2018) observed that delegated management enhances the availability and accessibility of water services and the general well-being of the city population in Kisumu City, Kenya. Along the same line, Wamuchiru and Moulaert (2018) concluded that community-led provision of water increases water accessibility and the human well-being of informal settlements where there is neglect from the state and private sector ordinary market suppliers in Nairobi City, Kenya. Velzeboer et al. (2018) found that the powers and practices of the local water management bodies determine the quality of water access, especially in low-income areas and among unemployed households in Lilongwe City, Malawi. Focusing on 15 Sub-Saharan African cities, Beard and Mitlin (2021) found that most urban households receive piped water intermittently, affecting water quality negatively due to privatization and infringing the well-being of low-income families.

Focusing on urban energy infrastructural service accessibility, Salite et al. (2021) evaluated electricity accessibility in Mozambique's four major cities: Maputo, Matola, Nampula, and Beira. The study observed that the cost of accessing electricity service is always politicized and is not cost-reflective due to the governance challenges, leading to unreliable, low-quality energy use and low general human well-being among urban dwellers. Similarly, Tesfamichael et al. (2021) studied urban energy accessibility among households in Ethiopia. The study observed that power outages cause food spoilage, paralyze essential services such as water, cause economic losses, and disrupt household social activities such as night-time studies. Also, studies carried out in Tanzania, Kenya, and Senegal found that lack of sufficient access to energy creates low human well-being driven by night-time criminal activities and uncertainty of electricity restoration (Gregory & Sovacool, 2019).

A section of the studies has also focused on the implication of urban sanitation infrastructure service accessibility on regional human well-being. For instance, Strande and Brdjanovic (2014) observed that many people in Sub-Saharan African cities who use onsite sanitation infrastructure services have no access to better fecal sludge management, hence low human well-being. A recent study indicated that 25-40% of Africa's urban water and sanitation points must be fixed. Furthermore, the study noted that the general accessibility quality of sanitation infrastructure was deficient and worth no human use (Burr et al., 2015; Tincani et al., 2015). In another recent study by Marques Arsénio et al. (2018), about 92% of urban households in Sub-Saharan African cities use non-sewer sanitation methods. Using 15 Sub-Saharan African cities, Beard et al. (2022) established that 62 percent of urban waste was not safely managed by urban municipalities, where most households engaged in unsafe sanitation practices, creating public health threats. Similarly, Berendes et al. (2020) focused on sanitation and waste management infrastructural service accessibility in Accra, Ghana. The study observed that multisectoral governance and management interventions help reduce contamination, thereby enhancing human well-being.

In sum, while the reviewed studies confirm the existence of the link between the quality of accessing urban infrastructural services and regional human well-being, a significant number of them have followed subjective or qualitative approaches (Parsons et al., 2019; Carter, 2019; Truelove, 2019; Das et al., 2022; Pradhan et al., 2018; Ramaswami et al., 2016). Also, most studies have focused on the country-level or city-level unit of analysis (Tesfamichael et al., 2021; Salite et al., 2021; Wamuchiru, 2018). Very few studies have focused on more than one urban infrastructural service, mainly focusing on a regional-level unit of analysis (Beard et al., 2022; Arsénio et al., 2018; Beard et al., 2022; Beard & Mitlin, 2022; Salite et al., 2021). Whereas all the studies have mentioned passing the accessibility quality challenges orchestrated by overlapping functions of urban governance, few have investigated the different influences of urban governance on the link between urban infrastructure accessibility and regional human well-being.

6.3 Data and Methodology

The study utilized balanced panel data for 22 Sub-Saharan African countries from 2000 to 2020 to study the link between urban infrastructure and regional human well-being due to the limited availability of data on urban infrastructure before 2000. The dependent variable is regional human well-being, for which data for its measure (HDI) from UNDP is utilized. The primary explanatory variable is the urban infrastructure, from which quality of accessibility is measured using three key indicators: the share of the urban population accessing improved water, the share of the urban population accessing improved sanitation, and the share of the urban population accessing electricity sourced from World Bank Development Indicators (World Bank, 2022). For the control variables ($Z_{1,i}$ in equation 6.2), we start by considering the urban agglomeration as a share of the urban population, urbanization rate as a fraction of the urban population over the total population, urban employment as a share of people employed in urban industries, and urban governance as the government effectiveness index (Adams & Klobodu, 2019; Brülhart & Sbergami, 2009; Henderson, 2003; ltunbas & Thornton, 2019). The data for urban agglomeration, urban employment, and urbanization is obtained from the World Bank and Penn World Tables (Heston et al., 2012; World Bank, 2022). We introduce the Panel Fixed Effects-Instrumental Variable (Panel FE-IV) estimation technique for robustness checks. Table 13 lists all variables' names, brief definitions, and data sources.

*Table 15:*Contextual Variable Description and Measurement

Variable name	Measure	Data source
Human well-being	Human Development Index (HDI)	UNDP
Urban Infrastructural Service	Share of the urban population accessing water, sanitation, and electricity	World Bank/UNDP
Urban Agglomeration	Urban share of the population	World Bank/UNDP
Urban Governance	Government Effectiveness Index	Worldwide Governance Indicators/World Bank
Urbanization rate	The ratio of the urban population to the total population	World Bank/UNDP
Employment	Share of the population employed in urban industries	World Bank

Source: Author's Construction (2023).

6.4 Theoretical Model

The empirical analysis of this dissertation chapter focuses on the link between the quality of accessing urban infrastructural service and human well-being, following the foundations of Adams and Klobodu (2019), Brülhart and Sbergami (2009), Castells-Quintana (2017), and Frick and Rodríguez-Pose (2018). This study relies on the neoclassical theoretical framework, which considers country-specific attributes such as the human development index (HDI) as the overall measure of human well-being. HDI captures a country's GDP per capita, population's health, and economic well-being to enable heterogeneity in primary conditions that impact human well-being, illustrated as follows:

$$y_{it} = \alpha_0 + \alpha_1 y_{it-1} + \beta_1 \mathrm{X}_{it} + \pi \mathrm{Z}_{it} + \varepsilon_{it} \quad ; i, \dots, 22; \; t \dots, 21 \tag{6.1}$$

where y_{it} represents the HDI (a measure of human well-being) level of country i, and time t, y_{it-1} is the lagged level of HDI, X_{it} illustrates the explanatory variables, Z_{it} is a vector of country-specific explaining the cross-country human well-being differences, and the well-behaved error term is represented by ε_{it}. The intercept is defined by $\alpha_{0,}$ α_1 is the coefficient estimate for lagged HDI, β_1 is the slope parameter for the quality of accessing urban infrastructural services, π is the coefficient's vector for the control variables, and the random error term is ϵ_{it} (Bond, 2002; Dang et al., 2015; Hsiao, 2002). The subscript indexes i refer to country 1,…,22, and t refer to time from 2000 to 2020.

Introducing the country-specific factor affecting human well-being at the urban level as represented by X_{it}, this dissertation considers the quality of accessing urban infrastructure (share of the urban population accessing improved water, improved sanitation, and energy) as the urban processes that collaboratively influence the well-being of the urban populace (Castells-Quintana, 2017; Henderson, 2005). Specifically, the quality of urban infrastructural services refers to the urban environment that results from various capacities of urban agglomeration economies (Castells-Quintana, 2017; Henderson, 2005). The provision of public infrastructural services mainly affects resources devoted to the urban share of the population and the overall country's human well-being status (Henderson, 2005). In line with this argument, Bertinelli and Black (2004) stylized an urban economics model that suggests empirically testable prediction that the quality of accessing urban infrastructure influences human well-being. Thus, taking this prediction into perspective, equation 1 extends to the following generalized empirical dynamic panel data model:

$$HDI_{it} = \alpha_0 + \alpha_1 HDI_{it-1} + \beta \text{Urb\_Infr}_{it} + \pi \text{Z}_{it} + \varepsilon_{it} \tag{6.2}$$

Where Urb_Infr is the urban infrastructure capturing the specificities of the urban processes in a country.

The dynamic panel data model (equation 6.2) is estimated using different panel regression techniques such as Pooled OLS, Driscoll-Kraay, and instrumental variable (IV) estimation based on the fixed effect (FE) two-step generalized method of moments (GMM) technique (2SIV-GMM). The explanation of results and deductions are based on the fixed effect (FE) Two-Step Generalized Method of Moments (GMM) technique (2SIV-GMM) approach because, by default, the Pooled OLS panel technique assumes that at least a portion of the regression estimators is similar across the panel (Baltagi, 2005; Arellano & Bond, 1991). In this case, Pooled OLS was utilized as a benchmark technique for establishing an overview of cross-country analysis of human well-being (Baltagi, 2005). Specifically, the Driscoll-Kraay estimation technique was used to unravel the preliminary link between the quality of accessing urban infrastructural services and human well-being in SSA (Hoechle, 2007). Nevertheless, this method suffers if omitted variables correlate with human well-being and urban infrastructural service quality measures, resulting in endogeneity issues (Amponsah et al., 2023; Fotio & Nguea, 2022).

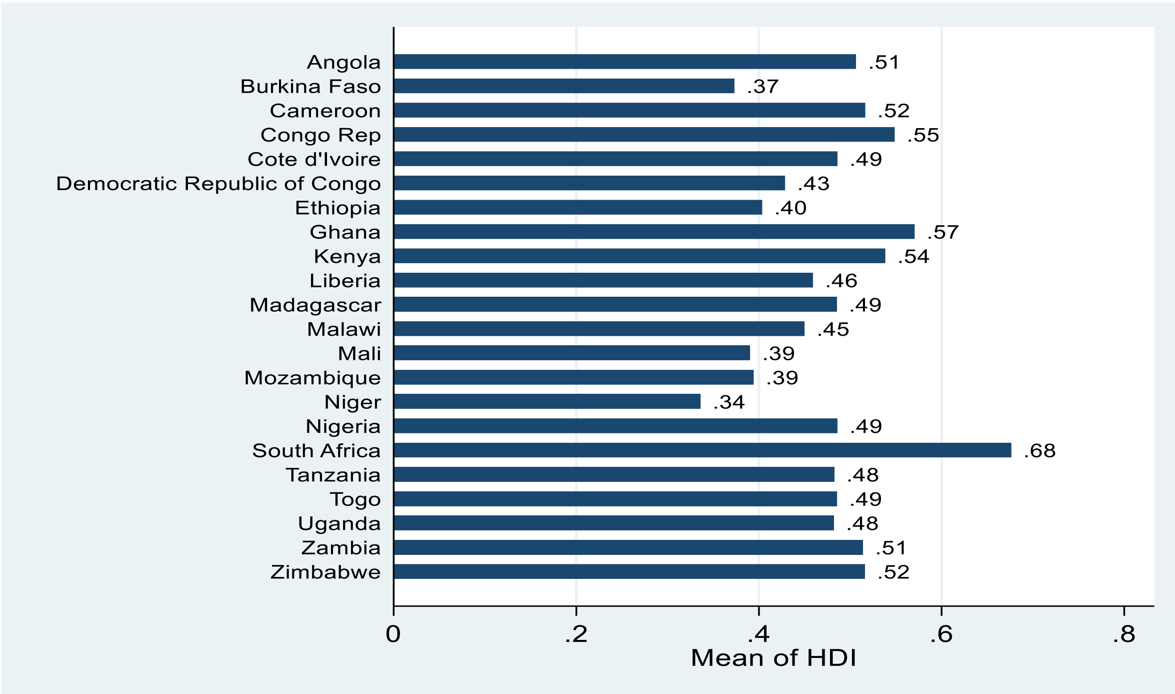
Given that we have $N>T$ ($N = 22$ and $T = 21$) and social welfare variables that are hard to measure, it signifies that biased estimates can be obtained. However, applying panel data models such as (FE) two-step generalized method of moments (GMM) technique (2SIV-GMM) helps to control state and time-invariant variables and tackle endogeneity issues (Banerjee & Duflo, 2003; Fotio & Nguea, 2022). In addition, applying Driscoll-Kraay standard errors in IV-GMM setup, probable heteroscedasticity, and cross-sectional dependence problems, which automatically exist in variables measured in panel form (Fotio & Nguea, 2022; Nguea, 2023). Additionally, since the IV-GMM utilize instrumental variables as part of the regressors, they enhance the performance of dynamic panel models with small N and T as it is in this study (Berg et al., 2018; Hansen, 1982; Norkute et al., 2021). Using Driscoll-Kraay standard errors helps robustly account for cross-sectional dependence (Driscoll & Kraay, 1998; Hoechle, 2007). It accounts for spatial and other forms of cross-sectional correlation results in a significant complication of empirical studies. Failure to care for spatial dependence results in spurious standard error estimates (Maket et al., 2023). Furthermore, the Driscoll-Kraay estimator allows for autocorrelation, heteroscedasticity, and temporal and spatial dependence (Hoechle, 2007). Although the applied panel models account for cross-sectional dependence, autocorrelation, heteroscedasticity, and endogeneity, they cannot partition the effects at different levels (Nguea, 2023). To account for this, this dissertation chapter carried out robustness checks by disaggregating the impact of the quality of accessing urban infrastructural services on human well-being by separating the selected countries into high-HDI (HDI >0.5) and low-HDI (HDI <0.5) countries and estimate using 2SIV-GMM (Berg et al., 2018).

6.5 Descriptive Statistics and Stylized Facts

As mentioned above, data for the Human Development Index (HDI) are obtained from the official website of UNDP. In contrast, data for urban infrastructural service accessibility quality indicators (water, sanitation, and electricity), urbanization rate, and industrial employment are obtained from the World Development Indicators database of the World Bank (2022; Heston et al., 2012) and data for governance are obtained from the Worldwide Governance Indicators database (2022). This dissertation chapter considered 22 Sub-Saharan African countries for the period spanning from 2000 to 2020 due to data unavailability for the quality of accessing urban infrastructural services before 2000. Before carrying out any econometric analysis, a primary look at the quality of urban infrastructural service accessibility and regional human well-being patterns in recent decades enables us to outline some basic yet interesting stylized facts. First among these is that human well-being in several developing regions is characterized by a more extensive section of the urban population living under acute inadequate accessibility of urban infrastructural services (water, sanitation, and electricity), depicted by a lower HDI of less than 0.5. As indicated by the UNDP estimates in Appendix Figure 1V, whereas the HDI for Sub-Saharan Africa has been rising over the recent decades, the value has trailed behind other regions, with an average value of less than 0.50 between 2000 and 2021 (UNDP, 2021).

In addition, Figure 15 depicts the average HDI for the selected countries from 2000 to 2020. Figure 15 shows that South Africa had the leading average HDI value of 0.68, followed by Ghana with an average value of 0.57, Congo Republic with 0.55, and Kenya with 0.54. Other countries with an average HDI value above 0.5 included Angola, Cameroon, Zambia, and Zimbabwe. On the other hand, Burkina Faso, Cote d'Ivoire, DRC, Ethiopia, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Tanzania, Togo, and Uganda.

Figure 15: The Average HDI for the Selected SSA Countries for 2000-2020



Source: Own Construction (2023)

Table 16 presents the descriptive statistics, where the average means of the HDI for the selected 22 Sub-Saharan African countries from 2000 to 2020. The average HDI value over the period is 0.4785, less than the average world value above 0.65 (UNDP & Our World in Data, 2022). The second fundamental fact concerns urban infrastructural service accessibility. An average of 37.31% of the urban population had access to essential sanitation services, 82.33% to basic water services, and 62.80% to electricity services. Regarding urban governance, an average government effectiveness index of -0.8289 indicates the weak effectiveness of the Sub-Saharan African governments in initiating, monitoring, and providing urban infrastructural service policies. The average urban agglomeration is 16.49%, preceding an average galloping urbanization rate of 37.39%.

Table 16:Descriptive Statistics

Variables	N	Mean	Maximum	Minimum	St. Dev.
Human Development Index (HDI)	462	0.4785	0.7360	0.2620	0.0857
Sanitation (SAN)	462	0.3731	0.7713	0.0957	0.1547
Water (WAT)	462	0.8233	0.9900	0.5953	0.0842
Electricity (ELEC)	462	0.6280	0.9660	0.0343	0.2190
Employment (EMPI)	462	1.0927	3.3930	0.2830	0.5835
Urban Agglomeration (URAG)	462	0.1649	0.6318	0.0335	0.1166
Governance(G)	462	-0.829	0.6459	-1.8414	0.4397
Urbanisation Rate (UR)	462	0.3739	0.67829	0.1461	0.1474

Source: Own Construction (2023)

Table 17 presents the correlation test results. As indicated, there is a significant positive correlation between the Human Development Index (HDI) and the selected variables. Specifically, a strong positive correlation exists between the Human Development Index (HDI) and the urbanization rate. In addition, there is an average positive correlation between the Human Development Index (HDI) and electricity accessibility, urban agglomeration, and water accessibility. In contrast, there is a weak positive correlation between the Human Development Index (HDI) and sanitation access and governance. Although the significant correlation between explained and explanatory variables indicates ideal regression results, it is essential to check for a multicollinearity problem as its presence results in overestimating coefficient estimate standard errors. This dissertation relied on the variance inflation factor (VIF) test to detect the presence of multicollinearity. Studenmund (2011) posited that the rule of thumb for the VIF test is that VIF values greater than 5 and tolerance values less than 0.1 (Miles, 2014) indicate the presence of a multicollinearity problem, and the converse is true. The results shown in Appendix V show that the VIF and tolerance values for all selected variables are less than 5 and more significant than 0.1, respectively. These collaboratively signify that including the explanatory variables together doesn’t result in strong multicollinearity in the subsequent regression models.

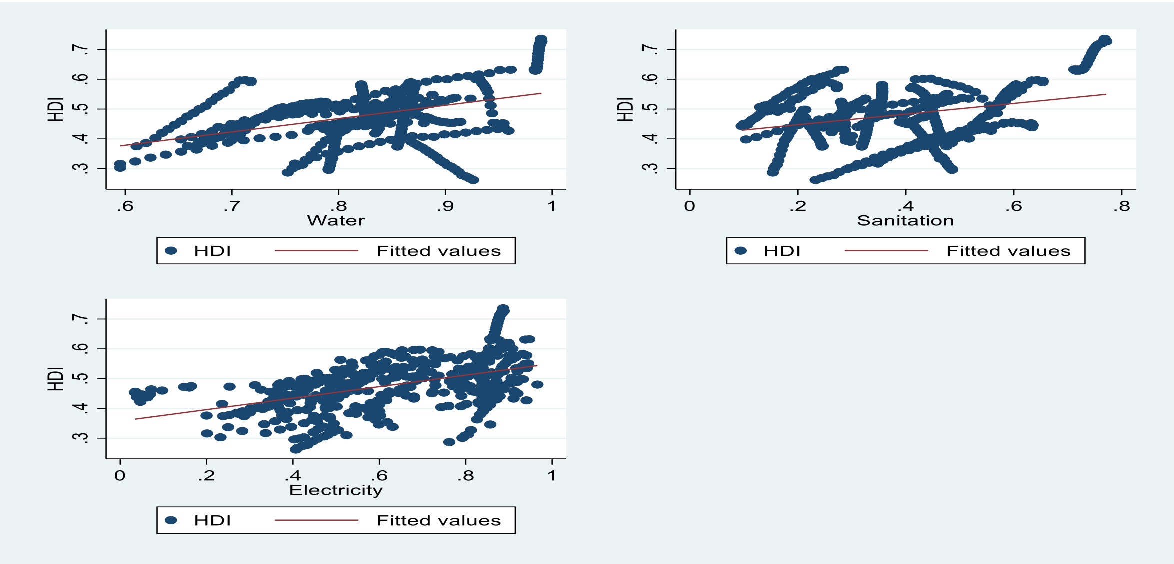
Table 17:Correlation Test Results

Variable	1	2	3	4	5	6	7	8
HDI	1.000							
Water Access	0.439*	1.000						
Sanitation Access	0.322*	0.39*	1.000					
Electricity Access	0.4938	0.48*	080*	1.000				
Agglomeration	0.4768	0.18*	0.11*	0.023	1.000			
Governance	0.323*	0.27*	0.25*	0.29*	-0.21*	1.000		
Employment	0.453*	0.41*	0.23*	0.29*	0.64*	0.24*	1.000	
Urbanisation Rate	0.630*	0.17*	0.36*	0.29*	0.83*	-0.07	0.57*	1.000

Note: ***p<0.1;* Source: Own Construction (2023)

Figure 16 presents correlation plots between HDI and Urban Infrastructural Service Accessibility Quality measures. Specifically, Figure 16 depicts an increasing relationship between HDI and Urban Infrastructural Service Accessibility Quality measures. This implies that SSA countries with increasing quality of accessing urban infrastructural services experience higher HDI, as elaborated by Appendix Figure VI. Moreover, Appendix Figure VII shows an increasing relationship between higher quality of governance and higher HDI, and urban agglomeration is associated with lower HDI.

Figure 16:Correlation Plots for HDI and Urban Infrastructural Service Accessibility Quality



Source: Own Construction (2023)

6.6 Empirical Strategy

The starting point of estimation of this dissertation's chapter is checking the presence of cross-sectional dependence (CD) between the cross-sectional units of analysis (countries). Due to urbanization resulting from rural-urban migration, attributed mainly to political instability and forced displacement in most SSA countries, the effect can spill over to the neighboring countries. Additionally, most African countries are highly connected, resulting in dependence problems, mainly if applied to panel data modeling. As indicated in Table 18, most variables are cross-sectionally dependent, thus rejecting the null hypothesis of panel homogeneity. However, governance and urbanization rates are cross-sectionally independent; the null hypothesis of panel heterogeneity is accepted at a 5% significance level.

Table 18:Cross-sectional Dependence Tests

Variable	CD-Test	*P-value*	Abs(Corr)
Human Development Index (HDI)	66.29	0.000**	0.952
Water Access	26.28	0.000**	0.995
Sanitation Access	17.58	0.000**	0.969
Electricity Access	43.93	0.000**	0.682
Urban Agglomeration	31.06	0.000**	0.824
Governance	-1.44	0.150	0.374
Employment	-1.13	0.257	0.588
Urbanisation Rate	55.10	0.000**	0.960

Note: In the null hypothesis of cross-sectional independence. ***p<0.1, ***p<0.05, *p<0.01.*

In line with the evidence of cross-sectional dependence among most of the selected variables, the next step is checking the stationarity or order of integration by carrying out second-generation unit root tests, which are ideal in addressing the presence of cross-sectional dependence in the estimated models. The dissertation combined several panel unit root tests such as Levin et al. (200), known as (LLC), Im et al. (2003), and known as the IPS test. These stationarity tests perform well in short panels with a small T. The validation for using panel unit root tests (IPS and LLC) instead of first-generation unit root tests (ADF and PP) is the robustness of the test, especially for short panels as it is in this study. Also, we employed augmented cross-sectional IPS (CIPS) by Pesaran (2007) to account for the possibility of cross-sectional dependence in our panel data. The stationarity test findings of variables follow the underlying null hypothesis of the presence of unit root. Based on the results in Table 19, the null hypothesis is rejected under all tests for the human development index (HDI) at the first difference, *I*(1). However, the null hypothesis of the presence of unit root is rejected for all other variables (water accessibility, electricity accessibility, sanitation accessibility, urban agglomeration, governance, urban employment, and urbanization rate) at level form, that's, *I*(0), implying the absence of non-stationarity traits.

Table 19:Panel Stationarity Unit Root Test

Variable	LLC	IPS	CIPS	Status
Human Development Index (HDI)	-2.4905**	-1.7132**	66.2944**	I(1)
Water Access	1.1981	-2.6212**	26.2842**	I(0)
Sanitation Access	1.0723	-22.9533**	17.5843**	I(0)
Electricity Access	-4.0305**	-2.2772**	43.9284**	I(0)
Urban Agglomeration	-4.4858**	-2.6979**	31.0635**	I(0)
Governance	-2.4293**	-1.7909**	-1.4381**	I(0)
Employment	-0.2362**	2.1998	-1.1330**	I(0)
Urbanisation Rate	-1.7918**	3.3154	55.1005**	I(0)

Note: ***p<0.1, ***p<0.05, *p<0.01.*

6.6.1 Dynamic Panel Model Estimation

The main aim of this dissertation is to determine the link between the quality of accessing urban infrastructural services and human well-being in 22 SSA countries from 2000 to 2020. The genesis point discusses the results per the estimation of the statistic panel data model form of equation (6.2) using Pooled OLS as a benchmark model and Driscoll-Kraay's estimator as the preliminary technique. Table 20 presents the results of Pooled OLS and Driscoll-Kraay's findings for the static model form of equation (6.2), where all the two models include HDI as the dependent variable, with an observation size of 462. The Pooled OLS estimates with all variables linked to regional human well-being are shown in column 1. Column 2 reports the findings following the Driscoll-Kraay technique, including all control variables, country, and time-fixed effects.

The Driscoll-Kraay findings show a significant positive relationship between urban water infrastructural service accessibility and regional human well-being at a 10%

confidence interval (see column 2). However, the findings indicated an insignificant negative effect of sanitation and a significant negative relationship between urban electricity infrastructural service accessibility and human well-being. This can be explained by the fact that most Sub-Saharan African cities lack important sanitation and electricity development capacity, negatively affecting the people's welfare in the urban regions. Further, the Discroll-Kraay Fixed Effect findings show that governance significantly positively affects regional human well-being at 1%. This implies that as governance effectiveness in policy implementation and monitoring of urban infrastructural development programs improves, the welfare of the people improves as well.

On the other hand, urban employment and urbanization have insignificantly positive and negative effects on human well-being (see column 2). On the other hand, increased urban agglomeration could enhance human well-being. Rapid rural-urban migration increases agglomeration economies through sharing, matching, and interaction, promoting better incomes and access to industrial employment. Nevertheless, Discroll-Kraay Fixed Effect estimates may be biased due to the endogeneity issue orchestrated by the presence of cross-sectional dependence uncovered earlier in this paper (Baum et al., 2003; Baum et al., 2010). Therefore, we extended the analysis and presented results in the subsequent sections.

Table 20:Urban Infrastructure and HDI: POLS and Driscoll-Kraay Fixed Effect Results

Dependent Variable: HDI	Pooled OLS	Driscoll-Kraay FE
	(1)	(2)
Const.	0.560***	0.644**
	(0.046)	(0.140)
Water Access	0.216***	0.216*
	(0.043)	(0.110)
Sanitation Access	-0.041**	-0.041
	(0.019)	(0.052)
Electricity Access	-0.048***	-0.048**
	(0.013)	(0.020)
Urban Agglomeration	0.318**	0.318**
	(0.073)	(0.152)
Governance	0.034***	0.034***
	(0.006)	(0.011)
Urban Employment	0.008*	0.008
	(0.004)	(0.006)
Urbanisation Rate	-0.457***	-0.457
	(0.103)	(0.295)
Country/Year FE	YES	YES
Adjusted/Within Adjusted R^2	0.973	0.964
Observations	462	462
Number of Countries	22	22
F-stat, *p*-value	0.000	0.000

Note: All variables are measured at the beginning of the period. The time spans from 2000 to 2020. Standard errors are enclosed in parentheses. The Driscoll-Kraay nonparametric covariance matrix estimator produces the standard errors in the Fixed Effect model. Dummies for country and time effects are included to control fixed effects.

*$p<0.1$; **$p<0.05$; ***$p<0.01$

As a corrective robust measure of the endogeneity bias, the dynamic panel model specified in equation (6.2) was re-estimated using the Two-step Instrumental Variable-Generalized Method of Moments (2SIV-GMM) estimation technique (with the Discroll-Kraay standard errors). The 2SIV-GMM utilizes the orthogonality condition to produce efficient coefficient estimates in the presence of autocorrelation, cross-sectional dependence, variable omission, measurement error, endogeneity, and heteroskedasticity of unknown form (Boateng et al., 2021). Conceptually, we anticipate the correlation between explained, explanatory, and instruments to exist (Ahmed et al., 2021; Wooldridge, 2012). This paper assumed that the quality measures of accessing urban infrastructural services (main regressors) are endogenous except for the year. Thus, we utilized a maximum of three-year lags of the main regressors as instruments and included urban agglomeration and second differenced governance as external instruments of the estimation. Mainly, governance captures the effectiveness of government policies influencing urbanization and urban agglomeration-related welfare. Using lag structure enables the instruments and endogenous explanatory variables to be strongly associated (Scholl & Klasen, 2018). Additionally, by following Amponsah et al. (2023) and Sovey and Green (2011), we tested the statistical validity of the selected instruments' validity to minimize the probable bias, especially in heteroscedasticity. We considered standard errors and Kernel (Bartlett) band-with to account for the potential in the model estimations (Amponsah et al., 2023; Sovey & Green, 2011). Moreover, we performed instruments' validity, under-identification, over-identification, and weak identification tests using the Hansen J test, Kleibergen-Paap rk LM tests, and Cragg-Donald Wald F-statistics.

Table 21 provides the 2SIV-GMM regression estimated results. Looking at the model reliability tests, the findings show a significant Kleibergen-Paap rk LM (p<0.05) and an insignificant Hansen *J*-statistic value of 3.651 (p=0.4553>0.05). Empirically, a significant Kleibergen-Paap rk LM test (Kleibergen &Paap, 2006) resulted in the rejection of the null hypothesis of under-identification and weak instruments, signifying the appropriateness of the instruments. Additionally, an insignificant Hansen *J*-statistic value indicated that we do not reject the null hypothesis (instruments are valid) and deduce that the selected instruments are valid. This further implies that the instruments excluded are independently distributed in the error process (Ahamed et al., 2021). it is also important to mention that 2SIV-GMM corrects for the endogeneity problem by including regressors as both exogenous and endogenous variables in the model estimation (Douch et al., 2022).

The findings in Table 21 show the coefficient of sanitation and electricity urban infrastructural service accessibility to significantly and positively affect human well-being. This signifies that holding all other factors constant, as the quality of access to sanitation and electricity infrastructure improves in the sampled countries, the human well-being of the people is enhanced by increasing the HDI. These findings align with the previous studies, which observed that increased accessibility of sanitation services such as sludge management, emptying of solid waste, and electrification services improves the welfare of the people by reducing environmental pollution, diarrheal disease, infant mortality rate and enhances security certainty of the people (Antunes & Martins, 2020; Gaffan et al., 2023; Enyew et al., 2021; Nano, 2021; Shobande, 2020). Additionally, improving the quality of access to urban sanitation improves human well-being by reducing air pollution and enhancing human productivity, economic well-being, and social dignity (Satterthwaite et al., 2019). On the other hand, the findings indicate the coefficient estimate of water service accessibility quality significantly negatively affects human well-being. This can be described by the fact that most cities in Sub-Saharan Africa lack essential drinking and domestic water, thereby detriment to human well-being (Ahmed, 2021; Guma et al., 2019). Collaboratively, this aligns with the observations made by (Kjellstrom et al., 2007) that there exist significant health inequalities in cities, such as differences in life expectancy due to inadequate water services for drinking.

Regarding the effect of governance in terms of the effectiveness of incepting, implementing, and monitoring social welfare policies, the findings indicate governance has a significant negative impact on human well-being. This implies that holding all other factors constant, an increase in governance ineffectiveness deters human well-being by reducing HDI. This holds water for the case at hand in many ways. First, as indicated by the negative governance effectiveness index, the majority of the Sub-Saharan African countries exhibit detrimental urban governance policies, including inadequate enforcement of contracts and failure to guarantee property rights that promote inclusive economic growth, which affects human well-being negatively (Lahouji, 2017; Fagbemi et al., 2021). Secondly, research studies such as Fisayo et al. (2021) have indicated the governance challenges associated with human well-being in the SSA region. Studies have shown that Africa's governance and institutional environment for social welfare have been weak and unchanged in recent decades (Al Mamun et al., 2017; Fayissa & Nsiah, 2013). However, as observed in Table 21, it is unexpected for a higher governance level to result in reduced human well-being; we extended the analysis by including governance and its interaction term in the dynamic panel model and estimated it robustly in Table 22, where the findings pointed out that higher government effectiveness enhances human well-being.

Regarding the control variables in Table 21, the urbanization rate is significantly and negatively linked with human well-being. Indeed, the SSA region is characterized by rapid urbanization, which presents governance pressure of managing large agglomerations and providing vital social amenities such as water, sanitation, and electricity services, which are crucial to the well-being of the urban population (Castells-Quintana & Wenban-Smith, 2020; de Bruin et al., 2021; van Vliet et al., 2020). On the other hand, urban industrial employment is insignificantly linked to human well-being. This can be attributed to the SSA region being an agricultural-based economy that produces primary goods. Hence, urban industrial employment has an insignificant influence on human well-being (Griffin, 1989). Also, excessive state interference and poorly designed industrial investment policies contribute to shrinking SSA's urban industrial performance (Griffin, 1989; Guivis et al., 2023).

Table 21:2SIV-GMM Regression Findings

Dependent Variable: HDI	2SIV-GMM
Const.	0.0291***
	(0.0037)
HDI(-1)	0.9903***
	(0.0046)
Water Access	-0.0243***
	(0.0053)
Sanitation Access	0.0062**
	(0.0025)
Electricity Access	0.0041**
	(0.0017)
Urban Agglomeration	-0.0051
	(0.0040)
Governance	-0.0054**
	(0.0024)
Urban Employment	0.0010
	(0.0007)
Urbanisation Rate	-0.6394***
	(0.1742)
Country/Year FE	YES
Observations	396
Number of Countries	22
F-stat, *P*-value	0.000
Kleibergen-Paap rk LM *P*-value	0.000
Hansen's J-stat	3.651

Note: Standard errors are enclosed in parentheses. The Driscoll-Kraay nonparametric covariance matrix estimator is used to produce the standard errors. Dummies for year and country effects are included to control fixed effects.

**p<0.1; **p<0.05; ***p<0.01*

6.6.2 Robustness Checks

This section presents detailed robustness checks regarding the connection between the quality of accessing urban infrastructural services and human well-being. Given the varied human well-being indicated by different HDIs, the probable effect of the quality of accessing urban infrastructural services on human well-being varies in different model specifications. This paper pays a deeper robustness focus to the Sub-Saharan African context for two main reasons. One resides in the identified positive differential impact of the quality of accessing urban infrastructural services and urban governance on human well-being, as shown in Table 8. The second reason is the methodological deficiencies of Pooled OLS and the different HDI values of the selected countries. As mentioned, the 2SIV-GMM estimation technique addresses endogeneity problems and enhances estimation efficiency. Nevertheless, 2SIV-GMM estimation relies on adjustments to internal and external instruments, such as lagging and variable transformations (Bazzi & Clemens, 2013). Therefore, ideal external instruments for regional human well-being from the quality of urban infrastructural service accessibility are complex to find.

Still, literature has pointed out urban agglomeration and urban governance as reliable external instruments for regional human well-being in Sub-Saharan Africa (Adams& Klobodu, 2019; Castells-Quintana, 2017). Higher levels of urban agglomeration are anticipated to negatively impact urban infrastructural service accessibility. Also, the weak effectiveness of governance in initiating and implementing urban population policies jeopardizes the overall living standard of the urban population (Abass et al., 2018; Adams& Klobodu, 2019; Castells-Quintana, 2017). In this effect, we used urban agglomeration and urban governance along with their squared values as the exogenous and instrumental variables along with the interactive term of these instrumental variables, with the electricity access as a proxy for quality urban infrastructure accessibility having been identified as significantly positive in pooled OLS, Driscoll-Kraay and 2SIV-GGMM models in Tables 20 and 21. Using these instrumental variables as part of exogenous variables and electricity accessibility allows us to control for simultaneity bias and feedback effect (Adams& Klobodu, 2019; Castells-Quintana & Royuela, 2015; Castells-Quintana, 2017; Wooldridge, 2010). The strategy here entails regressing electricity access (a proxy for quality of accessing urban infrastructural services), an urban agglomeration, and urban governance, their squared terms along with the interactive terms on regional human well-being using 2SIV-GGMM technique (see models in Appendix VIII).

Appendix IX presents the first-stage OLS and Driscoll-Kraay FE estimations for equations (3), (4) and (5). Urban agglomeration and urban governance, along with their squares, appear statistically significant in explaining the variation in the human well-being of the urban population in Sub-Saharan Africa, as depicted in literature. We further utilize Driscoll-Kraay FE and 2SIV-GGMM techniques to estimate the model presented in equation

(5). In this case, urban agglomeration and governance are used as basic instruments, and their interactive terms with urban infrastructural services (proxied by electricity access) are used as additional regressors. Before evaluating the results presented in Table 22, we check the validity of electricity access (a proxy for urban infrastructure) and urban agglomeration and governance as instruments for human well-being following the first-stage OLS approach. For these variables to be valid instruments, they should explain the variation of human well-being and influence the quality of urban infrastructural services and urban agglomeration via human well-being (exclusion procedure). The F-statistic test is carried out to further evaluate the exogeneity and relevance of urban agglomeration and governance, along with their squares (see Appendix IX). As seen in Appendix IX, the selected variables significantly affect the variation of human well-being and impact the urban infrastructure and urban agglomeration (see columns 2 and 3).

Table 22 presents the robustness checks by 2SIV-GGMM estimates of the HDI model for SSA. In alignment with the findings observed in Table 8, 2SIV-GGMM results show a significant positive effect on human well-being of the quality of access to sanitation and electricity urban infrastructural services (see Column 2). Still, the significant negative impact of water urban infrastructural service is sustained. However, it turns out to be significantly positive if the country's HDI level disaggregates the estimation (see column 2 of Appendix X). Additionally, suppose a composite measure of the quality of accessing urban infrastructural services (mean summated share of the population accessing improved sanitation, modern energy, and clean drinking water) is considered; it becomes significantly positive (see column 5 in Appendix VIII). In that case, it has a significantly positive effect on human well-being. This implies that enhanced quality of accessing urban infrastructural services such as water, sanitation, and electricity improves the well-being of a country's population through reduced health-related risks, increased productivity, and reduced environmental pollution (Field & Kremer, 2006; Nguea, 2023; Riva et al., 2018).

Regarding the role of governance on human well-being, the 2SIV-GGMM findings indicate a significant positive effect of governance and a negative interactive effect with the urban infrastructure (proxied by electricity) (see column 2 of Table 22). Further, the findings confirm a significant positive effect of urban agglomeration and a negative interactive impact with electricity accessibility (a proxy for urban infrastructural service accessibility) on human well-being, aligning with the results in Table 21. This signifies that the increased urbanization rate pushes more people to concentrate (urban agglomeration) in urban regions, thereby increasing energy needs for education and production and affecting the urban population's welfare (Byaro & Mmbagga, 2023). However, the findings show a significant positive interactive effect between urban agglomeration and electricity accessibility on electricity infrastructural services (see column 3 of Table 22), meaning as urban agglomeration as an outcome of continuous urbanization increases, the government, through local authorities, enhances the quality of accessing urban infrastructural services, thereby improving the welfare of the urban people (Nguea, 2023). Increased urban productivity and governance enable more households to have sufficient disposable income to purchase home appliances such as electric cookers, TV sets, electric radios, kettles, and iron boxes, which depend on electricity use, all meant to make life enjoyable (Byaro & Mmbagga, 2023; Faisal et al., 2018; Tewathia, 2014).

Regarding the influence of governance on urban infrastructural service accessibility quality, results depict a significant positive effect (see column 3 of Table 22). This signifies that enacting sound urban development and demographic-transition policies, such as decentralization of urban industries and agricultural mechanization, reduces urban concentration and encourage a particular share of population to back to the rural, hence enhancing equitable access to urban infrastructural services such as electricity (Agergaard et al., 2019; Berdegue et al., 2015; Daw et al., 2016; Karg et al., 2019; Mumssen et al., 2018). This reduces competition and pressure exerted on urban infrastructural services, enhancing the remaining urban population's quality, usability, livability, and general human well-being (Baker, 2019; Beard et al., 2016; Dessie, 2013; Hoare et al., 2019). On the other hand, the interactive term between governance and access to urban infrastructure is negative (see columns 2 and 3 of Table 22), signifying that persistence in weak governance effectiveness results in the deterioration of the quality of accessing urban infrastructural services, hence reduced human well-being (Amoako & Adom-Asamoah, 2019; Asibey et at., 2019; Asamoah, 2010). A case of SSA region is that of continuous concentration of people in the city regions, driven by massive rural-urban migration and natural births, which has been touted to be growing much faster than the urban infrastructural development and governance capacity (Brown et al., 2014; Maurya et al., 2020; Schoch & Lakner, 2020). The aftermath of the SSA region's increasing urban glomeration is insufficient government provision of critical urban infrastructural services such as water, sanitation, and energy services, and exacerbated environmental deterioration (Behera & Sethi, 2022; Lee et al., 2022).

Table 22:2SIV-GMM Robustness Checks: Urban Infrastructure and Human Well-being

Dependent Variable	Drisc-Kraay FE (1) HDI	2SIV-GMM (2) HDI	2SIV-GMM (3) Electricity	2SIV-GMM (4) Governanc	2SIV-GMM (5) Agglomerati
Const.	0.0524**	0.0234***	0.4716***	-0.8938***	0.1959***
	(0.0053)	(0.0045)	(0.0383)	(0.1108)	(0.0245)
HDI(-1)	0.9809***	0.9842***	0.3657**	-0.0678	-0.6836
	(0.0157)	(0.0054)	(0.0728)	(0.0913)	(0.6221)
Water Access	-0.0367**	-0.0119**		-0.0181	0.0277
	(0.0175)	(0.0048)		(0.1088)	(0.0353)
Sanitation	0.0083	0.0069*		0.1141**	-0.0845***
Access	(0.0057)	(0.0026)		(0.0399)	(0.0145)
Electricity	-0.0090**	0.0017*		1.2552**	-0.2823***
Access	(0.0030)	(0.0041)		(0.0538)	(0.0224)
Urban	-0.0217	0.0189**	-0.6190***	-0.5734***	
agglomeration	(0.0332)	(0.0097)	(0.2621)	(0.1075)	
Governance	0.0100**	0.0067**	0.4287**		
	(0.0046)	(0.0019)	(0.0601)		
Elect*Governan	-0.0153**	-0.0073**	-0.6359***	1.2662***	
ce	(0.0060)	(0.0025)	(0.0680)	(0.0196)	
Elect*Urban	-0.0198	-0.0280*	1.2179***		1.5536***
Agglomeration	(0.0348)	(0.01363)	(0.3749)		(0.0303)
Country/T/CFE	YES	YES	YES	YES	YES
Observations	440	441	441	441	441
N. of countries	22	22	22	22	22
Centered/Within R^2	0.9871	0.9961	0.8851	0.9131	0.9260
F-test *p*-value	0.000	0.000	0.000	0.000	0.0000
Kleibergen-Paap rk LM		57.365**	48.882**	48.215**	29.43**
Hansen's J-stat		4.025	0.808	0.7146	0.5504

Note: Controls comprise urbanization, industrial employment, urban agglomeration, and urban governance. The Driscoll-Kraay nonparametric covariance matrix estimator is used to produce the standard errors. Dummies for year and country effects are included to control fixed effects. **p<0.1; **p<0.05; ***p<0.01*

6.7 Summary of the Findings

In sum, the statistical evidence provided by development organizations such as the World Bank and UNDP regarding developing regions such as SSA provides the dire situation of the quality of accessing urban infrastructural services such as water, energy, and sanitation. Partly, this is attributed to the constrained economic opportunities for the rural population orchestrated by the dwindling agricultural sector and forced migration to cities. Also, the limited accessibility to urban infrastructural services is attributable to the bursting urban population and government mishaps. Indeed, due to the worst quality of accessing essential social amenities, resulting from government ineffectiveness in initiating and adopting development policies geared toward achieving better accessibility of social services.

The findings from this study, in many ways, confirm these assertions. First, the results depict SSA's general human well-being standard trailing behind other regions. This observation is confirmed by previous studies such as Castells-Quintana (2017), who observed that the quality of urban infrastructural services in SSA is significantly lower than in counterpart rapidly urbanized regions such as East Asia. The disparity in the quality of accessing urban infrastructural services also differs across SSA countries and cities and between genders (Osei et al., 2015; UNICEF, 2016). This can be justified by the fact that informal settlement in the SSA region houses over 50% of the urban population, living in dilapidated housing conditions without adequate access to improved water, sanitation facilities, and connection to the electricity grid (Acuto et al., 2018; Bloch et al., 2015; Lilford et al., 2016; Lopez & Moloney, 2020). The estimated results showed a significant positive link between the quality of accessing urban infrastructural services and human well-being in SSA, implying that better quality of accessing critical services enhances the general human well-being of the urban population. These results confirm the observations made by previous studies that adequate access to essential urban infrastructural services results in significant improvement in human well-being by significantly reducing several social problems in SSA, ranging from diarrheal diseases and respiratory disease to reduced household healthcare expenditure, energy poverty, and social inequalities (Armah, 2014; Nguea, 2023; Pullan et al., 2014; Kitole et al., 2023; Simiyu et al., 2021).

Second, the study indicated an increasing urban agglomeration that does not match the available urban infrastructural services. Particularly, the results suggest that countries like

Democratic Republic of Congo and South Africa with sizeable urban agglomeration experience declining human well-being compared to countries like Burkina Faso and Niger with smaller urban agglomerations. This is because large agglomerations in SSA encounter severe pressure to accommodate ever-increasing population as the majority of the cities in the region are characterized by limited employment opportunities, inadequate housing facilities, water, sanitation, healthcare facilities, waste management systems, and rising effects of climatic changes and environmental degradation, increase in non-communicable and water-borne diseases (Garba & Bellingham, 2021; Gitau, 2019; Twumasi et al., 2021). Garba and Bellingham, 2021 confirm these findings, and Gulamussen et al. (2019) identified rapid urbanization and urban population growth as the major factors of urban water scarcity and stress in most SSA urban regions.

In terms of the government's role, the findings show that SSA governments have been ineffective in incepting, implementing, and monitoring social development policies in recent decades. Specifically, a few countries like Zambia, South Africa, Madagascar, Kenya, and Niger, with perceived fair governance as indicated by positive governance index effectiveness, experience slightly better human well-being as compared with countries like Nigeria, with higher levels of corruption. The results imply that enhanced governance results in an improvement in human well-being. For instance, coordinated waste and sludge management leads to declined diarrheal diseases and mortality rates in urban informal settlements and promotes sustainability and waste management culture (Ndam et al., 2023). These findings are confirmed by Branchet et al. (2019), who established that reclaimed urban water resources and moves by local authorities to protect urban water resources and safe disposal of wastes enhance the health of the urban population and environmental quality in SSA. In addition, Ndam et al. (2023) and Ipara et al. (2023) observed that coordinated urban household waste management is a gateway to cities' new well-being, reflecting long-term collective infrastructural development actions defined by local authority in SSA. In general, an increase in urban agglomeration in SSA increases urban infrastructural needs, negatively impacting human well-being, resulting from insufficient accessibility and compromised quality of services. Therefore, it calls for collective infrastructural development and refocused urban governance in initiating and implementing urban policies targeting different social clusters of people confronted by different livability needs.

Although the study covered several aspects of the quality of accessing urban infrastructural services and how it influences human well-being, it suffers from some limitations. First, the dissertation excluded urban green infrastructure's influence due to the unavailability of panel data. Therefore, further studies can include the impact of urban green infrastructure in assessing how it impacts the well-being of the people. Secondly, the paper used the urban share of the population to measure the quality of accessing urban infrastructural services. However, future studies can interrogate the quality of accessing urban infrastructural services using daily water intake, daily volume of emptied waste, and daily hours of power outage. Thirdly, future studies can focus on quantitative case studies to provide new insight from a specific contextual perspective. These will help in enlarging the urban economics literature and provide a basis for further quantitative research on urban demographic transitions, which can be of great value to understanding better the link between urban infrastructure and human well-being, a relevant issue for developing regions presently. Lastly, the selected quality of accessing urban infrastructural services and HDI are not the only indicators of urban infrastructural services and human well-being from a population dynamic perspective. Future studies can focus on more in-depth indicators such as quality of life, urban livability index, inequality, and happiness index that can be computed using micro or survey-based data, widely recognized in the literature as robust measures of human well-being.

7. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

This chapter summarizes the key findings, conclusion, and policy professes based on various observed findings. In particular, the leading question of this thesis work was to interrogate whether urban agglomeration is a growth-enhancing or inhibitor, how it influences income inequality, and how it influences the distributive power of urban governance in terms of urban infrastructural service provision of water, energy, and sanitation, critical urban systems for general human well-being in Sub-Saharan Africa. The study has addressed these questions in different profound ways following a deductive approach, compounded by various hypotheses. Therefore, in this chapter, the summary of key findings in line with the set hypotheses is explained briefly, out of which overall conclusive remarks are made. Based on the conclusion, this chapter professes various specific policy measures that can be adopted to address critical urban agglomeration issues in line with the observed findings. Lastly, the chapter provides a road map for future studies covering the urban agglomeration and urbanization aspects and outlining the study's limitations. The chapter is organized as follows:

7.1 Overall Summary

In the recent two decades, there has been a dramatic rural-urban population drift, particularly in developing regions such as Sub-Saharan Africa and Asia. Profoundly, bursting population growth entangled with the galloping urbanization pace has compounded the increase in some cities' sizes, attenuating population in other regions, and the birth of new urban areas (Frick & Rodríguez-Pose, 2018). As per UNDESA (2018) projections, more than two-thirds of the world's population will be urban, with many living in informal and unplanned settlements and growing cities in Sub-Saharan Africa by 2050. This has attracted rigorous research attention interrogating the connectedness between urban agglomeration and economic performance dynamics such as the reduction of poverty, income inequality, and general human well-being of the urban populace (Castells-Quintana & Royuela, 2015; Moreno, 2017; Sekkat, 2017). A growing number of academic and policy evidence hold the dominant view that urban agglomeration engenders agglomeration economies and economic productivity gains via pooled labor supply, knowledge spill-overs, and forward and backward ties (Fujita & Thisse, 2003; Chong et al., 2016). However, this perceived positive urban agglomeration-economic performance nexus strand of literature is supposedly built on thin ice, particularly in developing regions such as Sub-Saharan Africa and Eastern Asia, where urban infrastructural development is wanting (Castells-Quintana, 2017).

Three noticeable facts point to this direction: One, there is little information regarding how urban agglomeration has evolved in different regions globally because most studies on this subject interrogate drivers of urban agglomeration and economic performance within a country (Camagni et al., 2015). A handful of studies evaluate urban agglomeration patterns from a cross-sectional, cross-country, or regional dimension (Castells-Quintana et al., 2015; Li & Liu, 2018). Two, urban primacy levels (concentration of urban population) in the largest city or share of urban population living in a city with a specific population size threshold (primarily urban population of about 750,000 or 1 million) have been commonly used as measures, but highly regarded as poor indicators of urban agglomeration (Anthony, 2014; Brülhart & Sbergami 2009; Castells-Quintana, 2017; Henderson, 2003; Sekkat, 2017). Third, there is a mysterious black box regarding ensuring sustainable urbanization in developing regions, where over 50% of the urban population live under acute proliferation, lacking adequate access to urban infrastructural services such as water, sanitation, and energy due to limited government investment capacity and ineffective urban governance policy measures (Lawhon et al., 2018; Shi, 2019; Thacker et al., 2019).

Based on the theoretical literature such as NEG and Urban Economics, an urban agglomeration is beneficial, at least in the first stages of urbanization and development. Still, as continuous rural-urban migration persists, the urban economic capacity dwindles, as indicated by dire human well-being, ravaging household poverty, and inadequate accessibility of essential infrastructural services. However, several empirical studies have discounted these two chief theoretical frameworks by providing a daunting disconnection between urban agglomeration and economic performance dynamics in developing economies and supportive evidence in developed economies. It is thus legitimate to argue from a non-universal point of view in literature—the relationship between urban agglomeration and economic performance is specific to regions with distinct factors augmenting urban agglomeration (Frick & Rodríguez-Pose, 2018). In this connection, we contributed to this debate by interrogating the economic performance dynamics of urban agglomeration, focusing on determining the relationship between urban agglomeration and economic performance, urban agglomeration and income inequality, and the relationship between urban infrastructure and human well-being.

In summary, the chapter provides the existing problem surrounding increasing urbanization in SSA and East Asia as opposed to developed regions such as Europe. We do this by setting the tone of the study and specifying the study objectives and hypotheses anchoring the study. In the second chapter, the study provides a general overview and statistical trends and compares the urban agglomeration dynamics of SSA and East Asian economies. In the third chapter, we offer detailed theoretical literature, conceptualization, and empirical evidence with no particular direction to uncover all hanging research gaps. We also set the methodological framework, practical strategy, and estimation techniques used in the subsequent chapters. Chapters four, five, and six cover a detailed analysis of the hypotheses set. The chapters provide in-depth theoretical, empirical, and methodological analysis with particular directions, from which conclusive deductions are made and policy recommendations are professed.

In chapter four, we purge whether urban agglomeration is growth-enhancing or an inhibitor from the developing world perspective. A 5-year interval panel data from 2000 to 2020 is used for 22 SSA, 22 Asian, and 22 European economies. The descriptive and stylized facts from the data show a declining urban agglomeration in the last two decades for all economies regardless of their income levels, disabusing the long-held notion of an increasing urban agglomeration in developing economies. However, the urban agglomeration in developing, especially SSA, ranks higher, almost double that of Asia and Europe. Regarding the relationship between urban agglomeration and economic performance, we observe distinct findings depending on the income level and urban specificities—the quality of urban infrastructure. Specifically, although we observe beneficial effects of urban agglomeration in developed economies, urban agglomeration appears deleterious in developing economies of Asia and SSA, where there is inadequate urban capacity to meet the social needs of out-of-hand urbanization. However, the interactive positive effect of urban agglomeration with urban infrastructure indicates the need for better accessibility to urban infrastructural services as they are growth-enhancing. Therefore, the study contributes to the literature and policy advocacy by depicting the augmenting effect of urban infrastructure on the relationship between urban agglomeration and economic performance in developing economies.

Chapter five interrogates the validity of an inverted U-shaped Kuznets Hypothesis in the case of SSA by investigating the relationship between urban agglomeration and income inequality. A balanced panel data of 22 SSA economies from 2000 to 2020 was estimated using System GMM, Difference GMM, Pooled OLS, RE, and FE techniques. The choice of the multi-model approach was informed by varied empirical outcomes when using strictly one model. However, based on the weakness of Pooled OLS, RE, and FE models, the discussions, conclusions, and policy recommendations are based on the System GMM model due to its corrective power, especially when using short panels. Regarding the validity of the inverted U-shaped Kuznets Hypothesis, we applied the urban agglomeration measure (urban share of population) in its second-order polynomial to capture a non-linear relationship. The findings indicated an inverted U-shaped Kuznets Hypothesis holds for SSA, with income inequality rising gradually with urban agglomeration until a threshold of 62% urban share of the population, after which it declines. Therefore, SSA economies will continue encountering increased income inequality until they pass the turning point of 62%.

Further, the findings indicate a significant positive relationship between urban agglomeration and income inequality. In addition, imposing a quadratic term on a measure of urban agglomeration sustains the relationship, depicting a significant non-linear relationship. We also controlled for the urbanization rate, which showed a significant negative relationship with income inequality, implying a non-linear relationship between the two variables. However, GDP per capita growth and its quadratic term produce an insignificant influence on income inequality. Lastly, industrialization and governance effectiveness in implementing urban infrastructural development and returns to education affect income inequality significantly.

Chapter Six investigates the relationship between urban infrastructure and regional human well-being using balanced panel data from 22 SSA countries from 2000 to 2020. In particular, our interest was to ascertain whether the accessibility of urban infrastructure matters in enhancing the human well-being of the urban population. The descriptive findings point out that the general human well-being, as measured by the human development index (HDI), has been trailing behind other regions with an overall average value of less than 0.5. Notably, the findings indicated a significant negative link between urban infrastructural service accessibility quality and human well-being for SSA. Similarly, the findings highlighted the considerable role of urban agglomeration and urban governance when evaluating the association between urban infrastructure and human well-being. Mainly, the findings confirm the disastrous effects of increasing urban agglomeration on human well-being in SSA, a region with limited urban infrastructural investment capacity, as depicted by high government ineffectiveness in implementing and monitoring public policies.

7.2 Conclusion

This thesis interrogates the connectedness between urban agglomeration and economic performance by first describing the evolution of urban agglomeration in recent decades using a more nuanced computed measure. Secondly, it determines the extent to which the urban agglomeration has influenced economic performance income inequality, and how it has affected the urban infrastructure and general human well-being in SSA. Based on the findings, the thesis details a conclusion based on each case question and hypothesis.

On the relationship between urban agglomeration and economic performance, we concluded that a significant heterogeneous observation regarding the relationship between urban agglomeration and economic performance implies a lack of consensus in the literature. Perhaps this can be implicitly attributed to specific contextual driving factors of economic performance beyond urban agglomeration. Nonetheless, in our particular case, developing SSA and Asia, we conclude that continuous rapid urbanization and subsequent urban agglomeration remain significant growth inhibitors. However, this can be corrected by putting the necessary urban infrastructure and governance effectiveness in policy implementation.

On the non-linear relationship between urban agglomeration and income inequality, we concluded that income inequality increases with urban agglomeration through increased rural-urban migration, which shifts the skilled labor factors of production to formal urban regions, leaving out informal and rural sectors with limited economic productivity (Liddle, 2017). Also, the disproportionate productivity and grim state policy preferences focused on engaging hopeful rural-urban migrants in economic production contributed to a massive scramble for limited resources in the urban region in their early years in cities (Liddle, 2013). Turning to the second part of the inverted U-shaped Kuznets curve, it can be argued that income inequality starts to decline when the majority of the urban population is accessing better public provisions and returns to education, resulting from the distributive power of government through increased urban investment and development (Kanbur & Zhuang, 2013). Also, scaled industrialization through public-private partnerships and increased government investment capacity on social amenities such as water, sanitation, and energy access result in a gradual decline in income inequality at later stages of urbanization (Castells-Quintana, 2017). However, the policy puzzling question is what must be done to ensure the inflection or turning point of the inverted U-shaped Kuznets curve comes sooner.

On the relationship between urban infrastructure and human well-being, we concluded that the quality of accessing urban infrastructural services such as water, energy, and sanitation plays a pivotal role in enhancing the human well-being of the urban population and the entire economy, as confirmed by literature and results. However, great heterogeneities across nations, cities, and regions are orchestrated by urbanization processes and quality of governance. In this regard, we argue that the low quality of access to urban infrastructural services due to high agglomeration is attributable to poor governance effectiveness. This situation is dire in developing regions such as SSA, where urbanization is stirring and urban infrastructure development is limited. Also, access to water, electricity, and sanitation is deficient and is hampering positive structural change and the ultimate benefits from the active population flooding urban regions.

As per the obtained results, the adverse impacts of the quality of accessing urban infrastructure are linked to the increasing urban agglomeration and poor quality of governance. In tandem with these arguments, the Malthusian trap might be the ideal reality, as the pace of urbanization supersedes the government's provision of urban infrastructural services vital for human well-being in SSA. Previous studies have suggested that when urban agglomeration is due to forced displacement rather than regular rural-urban migration, the government’s effectiveness in investments in urban infrastructural service provisioning becomes highly fundamental. The quality of accessing urban infrastructural services, mainly, is not desirable in terms of the quality of life of the urban population but also the general human well-being at the regional level.

7.3 Policy Implications

Based on the obtained findings and conclusion, several interesting policy implications can be drawn from various analyses in this thesis. To begin with, and about analyzing urban agglomeration and economic performance, the findings depicted the deleterious effects of uncontained urban agglomeration on economic performance. We also provided the corrective solution by justifying the significant augmenting interactive effect of urban agglomeration with urban infrastructure on economic performance. Thus, the study demonstrates the significant role to be played by governments in terms of policy implementation, paving an avenue for a policy focus on increasing infrastructural development as this will not only contribute to the positive influence of urban agglomeration but also provide a sustainable development framework of containing the currently stirring urbanization with great uncertainty of turning point.

About the non-linear relationship between urban agglomeration and income inequality, we suggest that the Sub-Saharan African economies should tap into the rising active population moving into cities by implementing urban policies that favor employment creation, better accessibility to social amenities supported by scientific and technological innovations, and a favorable business working environment. This can be achieved through collaborative inward-looking industrialization frameworks such as public-private partnerships. Through this employment, business and scientific innovation opportunities can be increased, as Nkalu et al. (2020) alluded to.

Lastly, about the relationship between urban infrastructure and regional human well-being, the study findings point to the fact that the government's investment and policy effectiveness that raises the quality of accessing urban infrastructural services such as water, energy, and sanitation, can influence the higher levels of human well-being significantly, especially in SSA—subsequently, certifying that better quality of accessing urban infrastructural services in these large agglomerations will help in stripping the entire region from *Malthusian trap*. Additionally, there is a need for Sub-Saharan African leadership and development stakeholders to review fiscal policy allocation to social development, such as quality education and accessibility to better healthcare. These policy measures will ensure the distributional effect of the productive urban and rural populace. Lastly, government agencies charged with the responsibility of urban development should dissuade their focus on decentralizing services and development projects, as this will be the avenue of opening up the peri-urban and connecting rural regions in the Sub-Saharan African region through industrialization and ago-processing. To achieve this objective, the development agencies in the agricultural sector should enact policy incentives to make agriculture attractive to educated and uneducated people, thereby reducing massive rural-urban migration pushed by the perceived better urban jobs and economic prosperity (Nkalu et al., 2020).

7.4 Suggestion for Further Studies

Although this study has attempted to uncover the growth effects of current urban agglomeration on economic performance, our study leaves out several thematic areas that future studies can investigate. For instance, the study restricted itself to the recent two decades due to the unavailability of urban infrastructural long-time series data before 2000. Therefore, future studies can incorporate long-time series of urban infrastructure data as more data is being explored. Also, the current study did not consider the urban population density due to a lack of available data, leaving the probable implication of urban concentration structure on economic performance. Future studies can incorporate population density as an alternative measure of urban agglomeration as this will not only point out the effect but also the structural effect as an impediment to growth.

In addition, the current study computed HHI50 and HHI100 using population data from all cities holding a capacity of 50,000 and 100,000, ruling out the implication of concentration in the towns with 10,000 and above. Therefore, future studies can investigate the implication of urban concentrating by considering the non-FUA population in computing the urban agglomeration HHI measure. Although the study pointed out the significant role played by urban governance as a control variable, future studies can investigate the direct linearity between urban governance and urban agglomeration, as this will help uncover the contribution or prevention of persistent urbanization and subsequent urban agglomeration.

Lastly, we observed no universal relationship between urban agglomeration and economic performance; the relationship depends on country-specific factors. Therefore, future studies can focus on country-based microdata analysis to provide a more robust policy framework regarding the potential economic benefits of urban agglomeration rather than far-reaching policy suggestions. Lastly, further studies on urban demographic transitions using longitudinal data can be of great value to better understand the link between urban agglomeration and regional economic performance, a relevant present issue for developing regions presently.

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Appendices

Appendix I: VIF Test Results

Variable	GDP per capita growth	
	VIF	1/VIF
Initial GDP per capita growth	2.86	0.350
NoHHI50	1.41	0.710
NoHHI100	2.80	0.357
Infrastructure	2.64	0.379
Urbanization	2.26	0.442
Schooling	1.04	0.965
Governance	3.07	0.326
Fertility Rate	1.40	0.714
Consumption	1.37	0.732
Investment	1.38	0.725

Source: Author's Construction (2023)

Appendix II: First Stage Least Squares Estimation for Developing Economies

Model	OLS	TSLS	TSLS	TSLS
	GDP per capita	HHI50	HHI100	Urban Infrastructure
	(1)	(2)	(3)	(4)
Consumption	-0.884**			
	(0.313)			
Investment	0.968			
	(0.565)			
Constant	0.127***	0.097***	0.092**	0.538**
	(0.059)	(0.010)	(0.010)	(0.034)
GDP per capita		-0.028*	0.025**	-0.325**
		(0.026)	(0.033)	(0.102)
Country/ Year effects	YES	YES	YES	YES
Observations	198	164	164	164
First-stage F-stat *p*-value.	0.000	0.000	0.000	0.0012

Source: Author's Construction (2023); $**p<0.05$, $***p<0.01$, $*p<0.10$

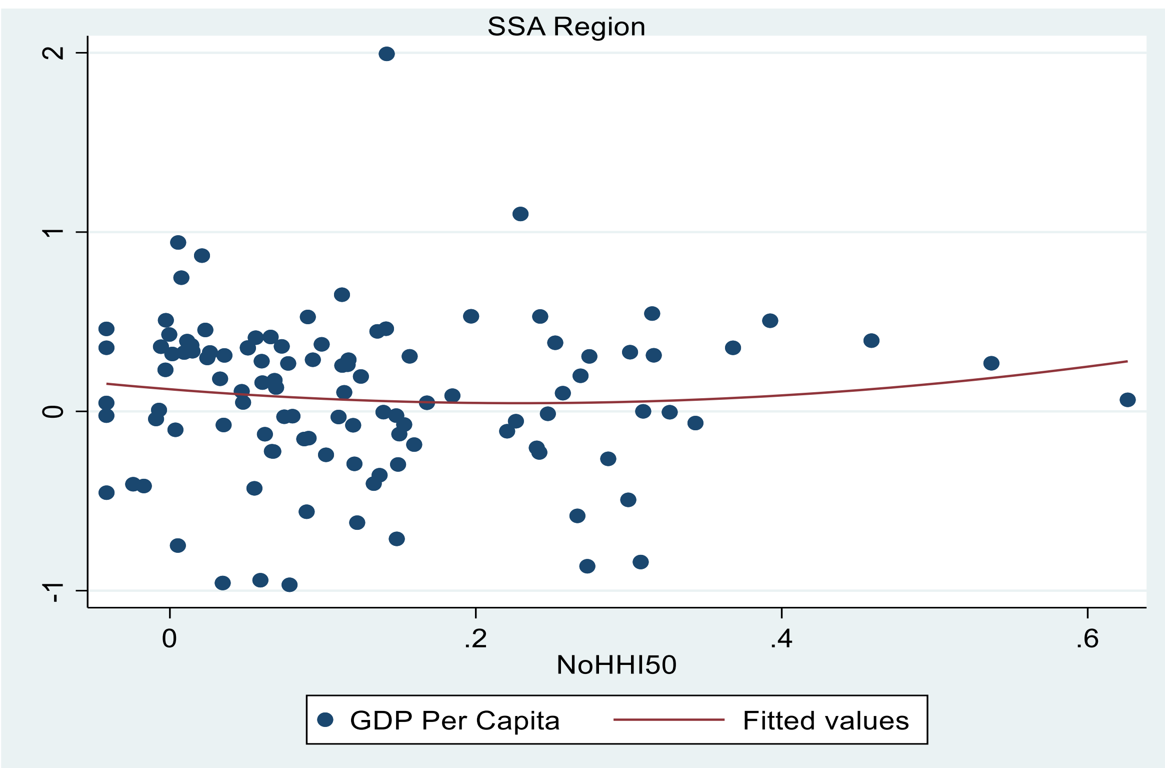
Appendix III: Turning Point Regressions and Plots

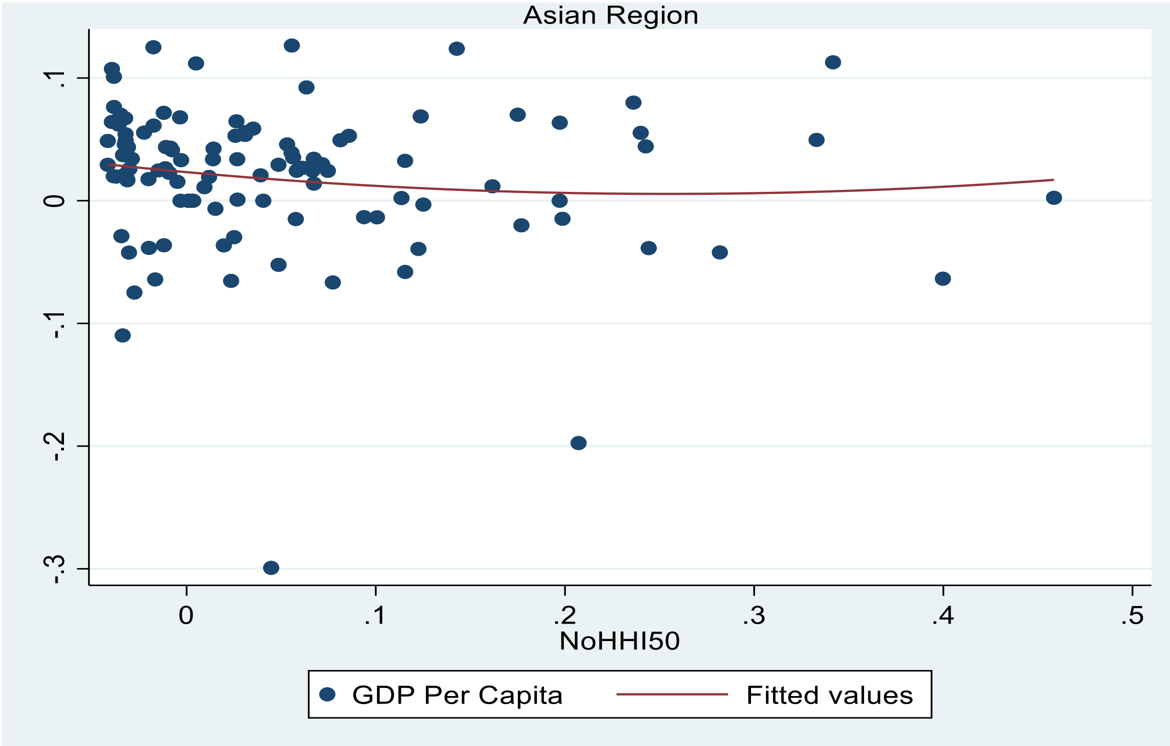
```
twoway qfit IncomeInequality UrbanSharePop
gen UrbanSharePopSQ = UrbanSharePop^2
reg IncomeInequality UrbanSharePop UrbanSharePopSQ
di -_b[UrbanSharePop]/(2 * _b[ UrbanSharePopSQ ])
local tp = -_b[UrbanSharePop]/(2 * _b[ UrbanSharePopSQ ])
twoway qfit IncomeInequality UrbanSharePop , xli(`tp')
```

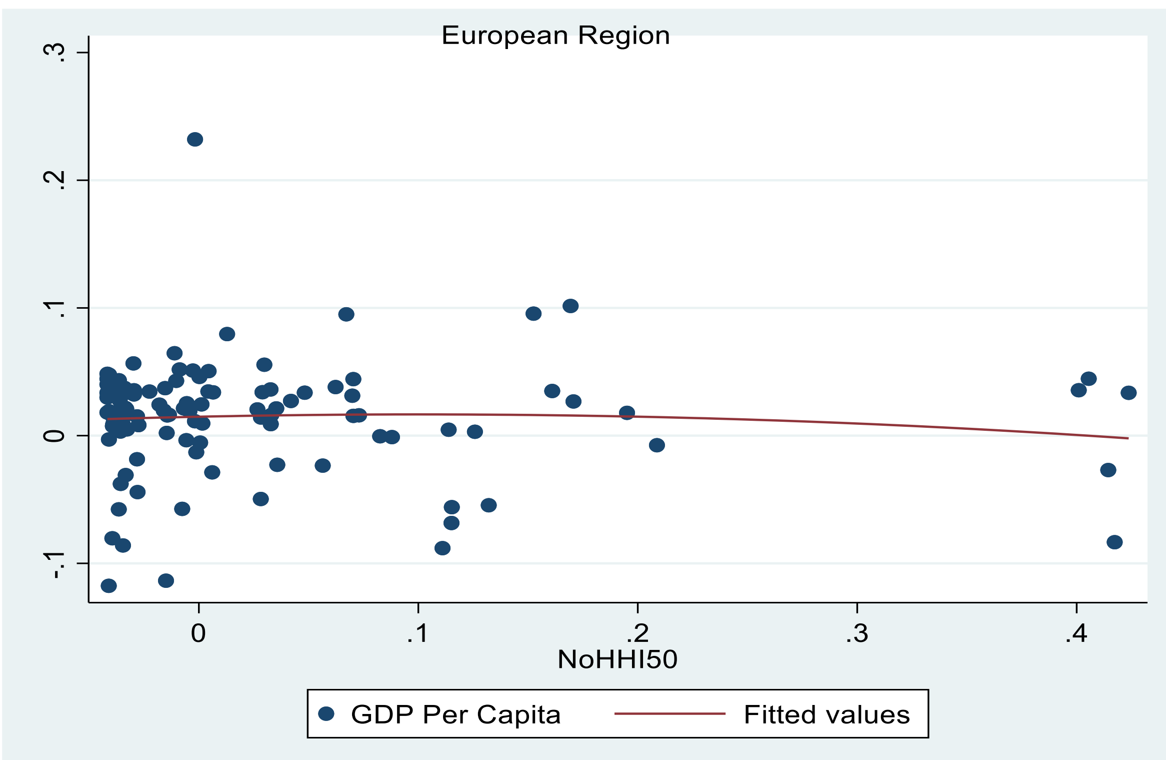
Variable	Coefficients
Constant (β_0)	3198
	(0.3632)
Urban Share of Population (β_1)	0.99356**
	(1.2145)
Urban Share of Population.SQ (β_2)	-0.80046**
	(0.9997)

Source: Author's Computations from Stata 17 (2023).

Appendix IV: Correlation between Economic Performance & Agglomeration by Region

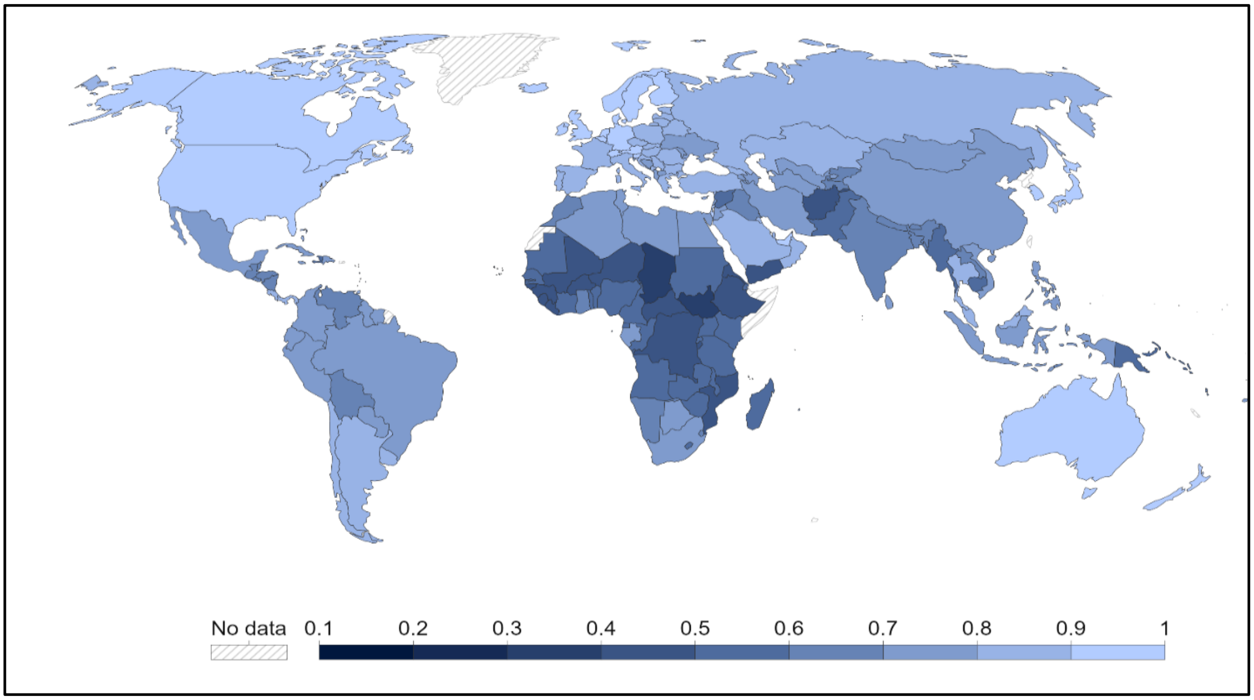






Source: Author’s Construction (2023)

Appendix V: Human Development Index in SSA



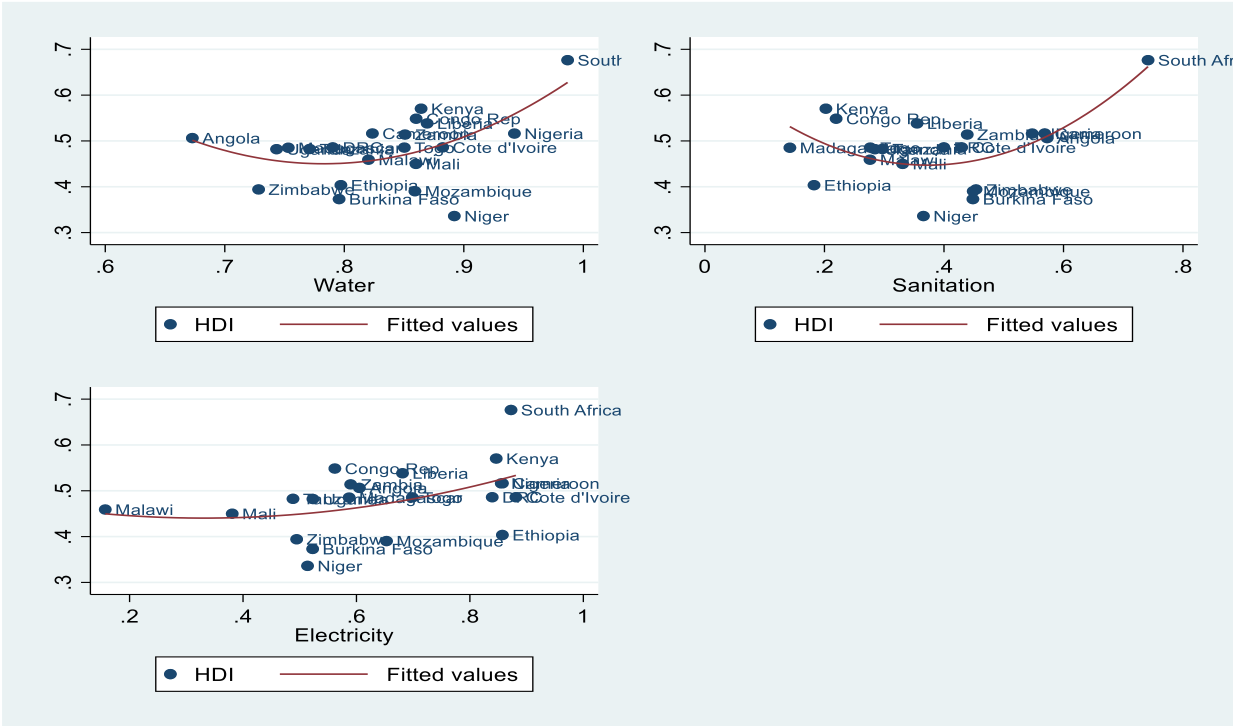
Source: Author's Construction (2023)

Appendix V1: VIF Test Results

Variable	Human Development Index (HDI)	
	VIF	1/VIF
Water Access	1.60	0.6239
Sanitation Access	1.44	0.6929
Electricity Access	1.46	0.6827
Urban Agglomeration	1.06	0.9405
Governance	1.30	0.7715
Employment	1.89	0.5299
Urbanisation Rate	1.92	0.5203
Mean VIF	1.53	

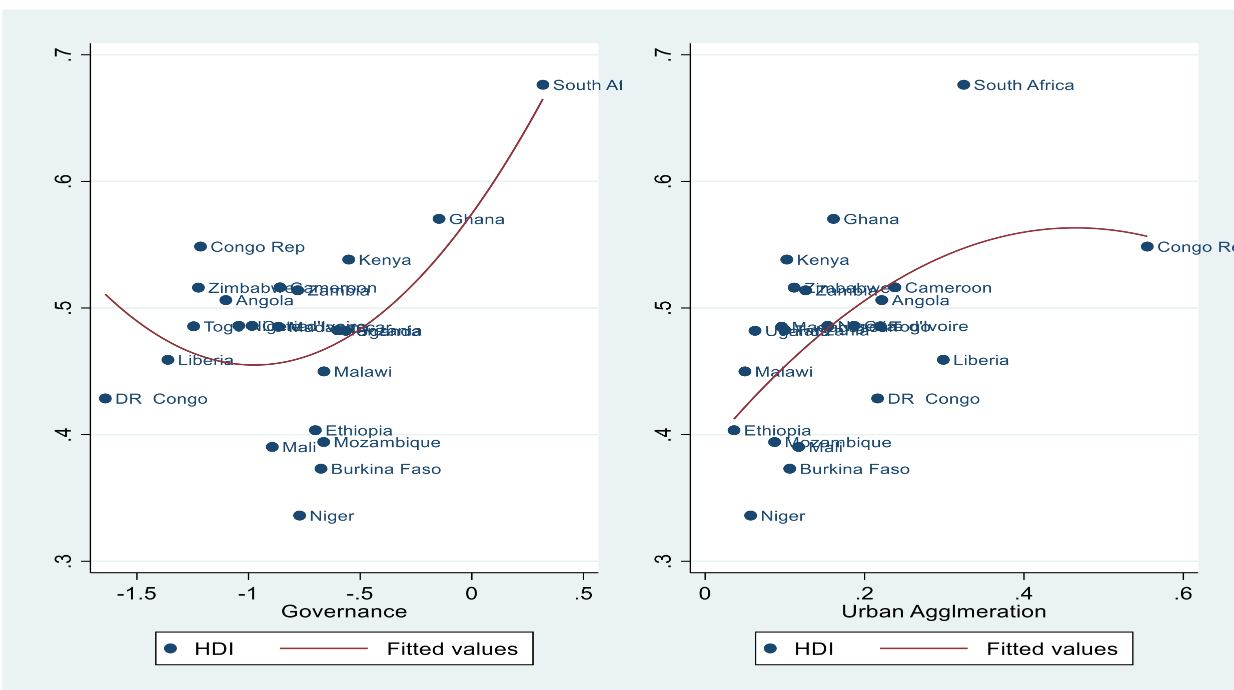
Source: Author's Construction (2023)

Appendix VII: Correlation between HDI and Urban Infrastructural Services Quality



Source: Author's Construction (2023)

Appendix VIII: Correlation between HDI and Governance and Urban Agglomeration



Source: Author's Construction (2023)

Appendix IX**:** Robustness Checks Equations

$$\text{Electricity Access}_{\text{it}} = \rho_1(\Delta y_{it-1,t}) + \alpha_i + b_t + \mu_{it} \quad (6.3)$$

$$\text{Urban Agglomeration}_{\text{it}} = \rho_2(\Delta y_{it-1,t}) + \alpha_i + b_t + \mu_{it} \quad (6.4)$$

$$HDI_{it} = \alpha_0 + \alpha_1 HDI_{it-1} + \beta_1 \text{Urb\_Infr}_{it} + \beta_2 \text{G}ov * \text{E}lect + \beta_3 \text{UrA}g * \text{E}lec + \pi \text{Z}_{it} + \varepsilon_{it} \quad (6.5)$$

Appendix X: First Stage OLS and Driscoll-Kraay FEs

Dependent Variable: HDI	Pooled OLS HDI (1)	Driscoll-Kraay FE HDI (2)	Driscoll-Kraay FE Elect (3)	Driscoll-Kraay FE Agglom (4)	Driscoll-Kraay FE G-servic (5)
Urban Agglomeration	0.933***	2.859***	1.4737**		
	(0.0785)	(0.2052)	(0.5528)		
Urban Governance	0.0896**	-0.0309**	0.0399		
	(0.0069)	(0.0135)	(0.0362)		
Urban Agglomeration. SQ	-0.969***	-2.5244*	-1.9726***		
	(0.1368)	(0.2216)	(0.4232)		
Urban Governance. SQ	0.039***	-0.032***	0.0532**		
	(0.0152)	(0.0065)	(0.0233)		
HDI(-1)			1.4459***	0.2052***	0.8673***
			(0.0760)	(0.0107)	(0.0377)
Const.	0.442***	0.140***	-0.2304***	0.0667***	0.1931**
	(0.0094)	(0.0321)	(0.0423)	(0.0051)	(0.0171)
Country/ Year FE	YES	YES	YES	YES	YES
N. of countries	22	22	22	22	22
Adjusted/Within R^2	0.4698	0.3794	0.4796	0.2625	0.4815
F-stat *P-value*	0.000	0.000	0.000	0.000	0.000

Note: Standard errors are enclosed in parentheses. The Driscoll-Kraay nonparametric covariance matrix estimator is used to produce the standard errors. Dummies for year and country effects are included to control fixed effects. **p<0.1; **p<0.05; ***p<0.01*

Appendix XI: IV-GMM Regression by HDI Country Difference

Dependent Variable: HDI	IV- SysGMM	IV- SysGMM
	HDI≤0.5	HDI>0.5
Const.	0.0339***	0.0130
	(0.0052)	(0.0083)
HDI(-1)	0.9897***	0.9107**
	(0.0073)	(0.0164)
Water Access	-0.0275***	0.0443**
	(0.0048)	(0.0131)
Sanitation Access	0.0068	0.0090**
	(0.0044)	(0.0034)
Electricity Access	0.0018	-0.0042
	(0.0021)	(0.0033)
Urban Agglomeration	-0.0076	-0.0055
	(0.0178)	(0.0084)
Governance	-0.0010	0.0018
	(0.0022)	(0.0018)
Urban Employment	-0.0002	-0.0027
	(0.0009)	(0.0027)
Urbanization Rate	-0.0115	0.0242**
	(0.0097)	(0.0070)
Country/ Year FE	YES	YES
Observations	224	172
Centered R^2	0.9911	0.9920
F-stat, *P*-value	0.000	0.000
Kleibergen-Paap rk LM	34.340**	31.409**
Hansen's J-stat	0.1828	0.2608

Note: Standard errors are enclosed in parentheses. The Driscoll-Kraay nonparametric covariance matrix estimator is used to produce the standard errors. Dummies for year and country effects are included to control fixed effects. **p<0.1; **p<0.05; ***p<0.01*

Appendix XII: List of SSA, Asian, and European Selected Countries

ID	SSA	Asia	Europe
1	Angola	Bahrain	Austria
2	Burkina Faso	Bangladesh	Belgium
3	Cameroon	Cambodia	Cyprus
4	Cote d'Ivoire	China	Czechia
5	Ethiopia	India	Denmark
6	Ghana	Iran	Estonia
7	Kenya	Japan	Finland
8	Liberia	Jordan	France
9	Malawi	Lebanon	Germany
10	Mali	Malaysia	Greece
11	Mozambique	Mongolia	Iceland
12	Zimbabwe	Myanmar	Ireland
13	Nigeria	North Korea	Italy
14	DR. Congo	Pakistan	Lithuania
15	South Africa	Papua-New Guinea	Netherlands
16	Tanzania	Philippines	Norway
17	Uganda	Qatar	Poland
18	Zambia	Singapore	Slovenia
19	Togo	Indonesia	Spain
20	Madagascar	Thailand	Sweden
21	Congo Rep	Vietnam	Switzerland
22	Niger	Yemen	United Kingdom

Source: Author’s Construction (2023)

Appendix XIII: List of Economies by Income (GDP per capita) Level

ID	Developing	ID	Developing	ID	Developed
1	Angola	26	China	1	Austria
2	Burkina Faso	27	India	2	Belgium
3	Cameroon	28	Iran	3	Cyprus
4	Cote d'Ivoire	29	Jordan	4	Czechia
5	Ethiopia	30	Lebanon	5	Denmark
6	Ghana	31	Malaysia	6	Estonia
7	Kenya	32	Mongolia	7	Finland
8	Liberia	33	Myanmar	8	France
9	Malawi	34	North Korea	9	Germany
10	Mali	35	Pakistan	10	Greece
11	Mozambique	36	Papua-New Guinea	11	Iceland
12	Zimbabwe	37	Philippines	12	Ireland
13	Nigeria	38	Indonesia	13	Italy
14	DR. Congo	39	Thailand	14	Lithuania
15	South Africa	40	Yemen	15	Netherlands
16	Tanzania	41	Vietnam	16	Norway
17	Uganda			17	Poland
18	Zambia			18	Slovenia
19	Togo			19	Spain
20	Madagascar			20	Sweden
21	Congo Rep			21	Switzerland
22	Niger			22	United Kingdom
23	Bahrain			23	Japan
24	Bangladesh			24	Qatar
25	Cambodia			25	Singapore

Source: Author’s Construction (2023)