DOCTORAL DISSERTATION

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Fiscal Decentralisation and Regional Development in Kenya: A Spatiotemporal Econometric Analysis of Poverty, Health, Finance, and Economic Spillovers under Devolution

Doctoral Dissertation

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DISSERTATION ABSTRACT

This dissertation examines the spatially interconnected effects of fiscal decentralisation on regional development in Kenya within its post-2010 devolution framework. Anchored in regional development theory, it integrates insights from New Economic Geography, Fiscal Federalism, and Convergence theory, combined with a systematic literature review and three empirical studies. The review synthesises post-2010 evidence using CIMO, PRISMA, and network analysis, identifying fragmented findings across six themes: growth, intergovernmental relations, environment, spatial dependence, poverty, and aid effectiveness. Empirical analyses employ exploratory spatial data analysis and spatiotemporal econometric models (SLX, SDM, SARAR, SAR) to capture spillovers, feedback effects, and convergence dynamics across Kenya's 47 counties. Results indicate that revenue-based instruments (own-source revenue, equitable share, conditional grants) have a stronger influence than expenditures in reducing poverty, with equitable share transfers being particularly effective across demographic groups. Economic performance improves through own-source revenue and operational expenditure, although negative inter-county spillovers reveal inefficiencies and competitive backwash effects. Evidence of absolute and conditional β-convergence shows that poorer counties tend to grow faster, primarily driven by operational expenditure. Health outcomes exhibit significant spatial clustering: Central Highlands and Nairobi benefit from positive spillovers, while morbidity and mortality hotspots remain in peripheral regions. Conditional grants emerge as the most effective fiscal instrument for improving health, while sectoral composition and population density cause differentiated spatial health effects. The dissertation makes four major contributions: it reconceptualises fiscal decentralisation within regional development theory; offers a context-specific analysis of Kenya's devolution with broader lessons for developing countries; links decentralisation to poverty, growth, convergence, and health; and advances methodological frontiers through spatially explicit econometric models. Overall, it demonstrates how fiscal decentralisation functions both as a fiscal instrument and as a structural driver of spatial outcomes. It provides policy insights on optimising resource allocation, strengthening intergovernmental transfers, and fostering inclusive, balanced development under devolution.

DEDICATION

I dedicate this work to the men and women who steadfastly advocate for community self-determination in driving regional development and to the policymakers who have relentlessly championed and empowered these regions to realise their potential. I also dedicate this work to the people of Hungary, whose intellectual legacy provided me with the analytical tools necessary to comprehend and dissect complex regional economic phenomena.

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Glossary (Definition of Key Terms)

Capital Expenditure (Capex): Capital expenditure (Capex), or development expenditure in public finance management, refers to government spending on acquiring, creating, or improving fixed assets such as infrastructure, buildings, equipment, and land. These assets generate benefits over multiple fiscal years, thereby increasing public capital stock and enhancing the long-term capacity for service delivery and economic development.

Confirmatory Spatial Data Analysis (CSDA): involves using formal statistical and econometric modelling techniques to test hypotheses and establish causal or structural relationships in spatially referenced data. It moves beyond descriptive exploration (like ESDA) to specifying, estimating, and validating spatial econometric models (such as spatial lag, error, SARAR, or Durbin models) that explicitly account for spatial dependence and heterogeneity, enabling statistically valid inferences.

Convergence: Convergence describes how disparities in economic performance or welfare indicators across regions decrease over time. This means lagging regions grow faster than more developed ones, moving toward similar long-term income, productivity, or living standards. This can be measured using concepts such as β-convergence (the inverse relationship between initial levels and subsequent growth rates) and σ-convergence (the reduction in variation of regional outcomes across space and time).

Divergence: Divergence describes the process where disparities in economic performance, welfare, or living standards across regions expand over time. More developed areas tend to grow more quickly than lagging ones, thereby increasing spatial inequality. Analytically, it is often characterised by the lack of β-convergence or increasing σ-dispersion in regional indicators such as income, productivity, or human development.

Equitable share: In the Kenyan context, the equitable share refers to the constitutionally guaranteed, unconditional transfer of nationally raised revenue from the central government to county governments, designed to ensure that subnational units receive a fair and predictable share of national resources to fund devolved functions and promote horizontal equity across regions, as stipulated under Article 202(1) and operationalised through Article 203 of the Constitution of Kenya (2010).

Exploratory Spatial Data Analysis (ESDA): is a set of statistical and visualization techniques used to describe, visualize, and identify spatial patterns, spatial heterogeneity, and spatial dependence in geo-referenced data, relying on tools such as spatial autocorrelation measures

(e.g., Moran's I, Geary's C, Local Indicators of Spatial Association) and spatial mapping, to generate hypotheses, guiding model specification, and enhancing the understanding of spatial processes before formal econometric analysis.

Fiscal Decentralisation: Fiscal decentralisation denotes the transfer of revenue-raising powers, expenditure responsibilities, and intergovernmental fiscal arrangements from central to subnational governments. It encompasses expenditure assignment, revenue autonomy, and intergovernmental transfers that collectively shape the degree of subnational fiscal autonomy, capacity, and accountability within a multi-tiered public finance system.

Gross County Product (GCP): GCP is the total monetary value of goods and services produced within a county's geographic boundaries over a specified period. It is calculated as the sum of all industries' Gross Value Added (GVA) plus taxes on products (minus subsidies). GCP acts as the county-level equivalent of Gross Domestic Product (GDP), facilitating the measurement, comparison, and monitoring of economic performance, productivity, and structural change across counties. In Kenya, GCP is compiled by the Kenya National Bureau of Statistics (KNBS) to provide an official framework for tracking county growth and regional disparities under devolution.

Gross Value Added (GVA): GVA measures a county or region's net economic contribution by capturing the value of goods and services produced within its territory minus the value of intermediate inputs. It serves as a core indicator for comparing the structure, productivity, and growth performance of regional economies in Kenya. It complements Gross County Product (GCP) in assessing spatial disparities and development outcomes under devolution.

Intergovernmental fiscal transfers: intergovernmental fiscal transfers or Grants refer to constitutionally and legally mandated allocations from the national government to county governments, beyond the equitable share, that are designed to finance devolved functions, correct vertical and horizontal fiscal imbalances, and support specific policy objectives; these include conditional grants (earmarked for designated programmes or sectors), unconditional additional allocations, and equalisation transfers intended to address disparities in service delivery and development across counties.

Local Indicators of Spatial Association (LISA): LISA are statistical measures that break down global spatial autocorrelation into contributions from individual spatial units, thereby identifying local clusters (e.g., high–high or low–low concentrations) and spatial outliers (e.g., high–low or low–high anomalies). LISA statistics provide both a value indicating the extent of

local spatial association and a significance test, allowing for the detection of spatial heterogeneity and localised dependence patterns within cross-sectional or panel data.

Moran's I test: Moran's I test is a global measure of spatial autocorrelation that assesses whether the distribution of a variable or the residuals of an estimated model across spatial units shows systematic spatial dependence. Positive values indicate clustering of similar values, negative values indicate spatial dispersion, and values near zero suggest spatial randomness. Its statistical significance is usually evaluated through permutation or asymptotic tests, making it a crucial diagnostic for detecting spatial dependence in panel data models.

Non-spatial econometrics: This pertains to the branch of econometrics that examines economic relationships using cross-sectional, time-series, or panel data, based on the assumption that observations are independent across spatial units. This approach omits explicit modelling of spatial dependence (autocorrelation) or spatial heterogeneity; it concentrates on estimating, testing, and forecasting relationships between variables without considering the impact of geographical location or spatial interactions.

Operational expenditure: Recurrent or operational expenditure refers to government spending on the ongoing costs of running public services and maintaining existing assets, including wages and salaries, consumables, utilities, operations, maintenance, and transfers, which are necessary for sustaining day-to-day service delivery but do not create new assets or extend the lifespan of existing ones.

Own source revenue (OSR): Own-source revenue (OSR) refers to the income that subnational governments are legally empowered to mobilise and retain directly from within their jurisdictions through instruments such as taxes, user fees, charges, licences, and other locally generated levies, representing the core component of their fiscal autonomy and a critical determinant of their capacity to finance devolved functions, enhance accountability, and reduce dependence on intergovernmental transfers.

Principal Component Analysis (PCA): PCA is a multivariate statistical method used to reduce the dimensionality of a dataset by transforming a set of correlated variables into a smaller set of uncorrelated variables, called principal components. These components are linear combinations of the original variables arranged to capture the maximum possible variance in the data, thereby simplifying data analysis, pattern recognition, and interpretation without significant loss of information.

Region: A region is a spatially contiguous population linked to a particular area by historical, socio-cultural, or economic reasons, or through deliberate institutional choices. Dependence on a location arises from shared ties to local culture, employment centres, natural resources, administrative boundaries, or other site-specific amenities that shape collective identity, socio-economic interactions, and development trajectories. Conceptually, regions can be categorised as functional areas, such as labour market zones or regions of economic activity, or as administrative units, like Kenya's counties, which are territorially defined governance entities under devolution.

Regional Development: Regional development refers to the spatial–temporal evolution of welfare, encompassing the complex dynamics through which the economic, social, and institutional conditions of regions, or interdependent sets of regions, transform and interact, leading over time to patterns of divergence or convergence in regional welfare trajectories.

Spatial econometrics: Spatial econometrics is a branch of econometrics that develops and applies statistical and econometric techniques to explicitly account for spatial dependence (autocorrelation) and spatial heterogeneity in cross-sectional, time-series, and panel data, enabling more accurate estimation, inference, and interpretation of economic relationships embedded in geographic space.

CHAPTER ONE:

Introduction

1.0.Introduction

1.1. Research Background

In recent decades, widening income inequality, growing poverty, and persistent regional economic disparities have become significant challenges for developed and developing countries. These inequalities not only perpetuate structural underdevelopment but also trigger social unrest and political instability, particularly in Sub-Saharan Africa and Kenya (Berg and Ostry 2017; Willis and Gona 2013). Therefore, understanding how public finance systems, especially fiscal decentralisation, affect inclusive development has become a crucial focus for both academic research and public policy reform.

Theoretical foundations in Fiscal Federalism, New Economic Geography and Convergence indicate that decentralisation can enhance allocative efficiency, better respond to local preferences, and improve governance accountability. The first-generation fiscal federalism theory states that decentralisation boosts allocative efficiency by enabling subnational governments to tailor services to local needs, fostering responsive governance and efficient public service delivery (Oates 1999; 2008). In contexts of diverse preferences and resources, decentralised systems are believed to promote productive efficiency, innovation, and economic growth through localised decision-making. Moreover, the second-generation fiscal federalism expands this perspective by recognising the importance of institutions, intergovernmental bargaining, and political incentives, emphasising that the success of decentralisation depends on the quality of governance, fiscal capacity, and institutional frameworks (Oates 2008; 2005; Weingast 2009; Qian and Weingast 1997). Additionally, the New Economic Geography theory suggests that spatial disparities result from agglomeration effects, economies of scale, and the mobility of capital and labour, which tend to concentrate economic activities in core regions, often at the expense of peripheral or lagging regions (Krugman 1998; 1991). Fiscal decentralisation interacts with these processes by enabling or limiting regions' leverage of their comparative and competitive advantages. Depending on institutional design and interregional spillover mechanisms, it can exacerbate regional divergence or promote convergence.

Advocates of fiscal decentralisation claim that devolved fiscal powers enable subnational governments to meet local needs better, reduce regional disparities, and encourage sustainable development. However, empirical evidence remains highly debated and varies depending on context, with studies showing mixed or even contradictory results, ranging from improvements in service delivery and poverty reduction to increasing inequalities and regional divergence. At the heart of this debate lies a significant gap: while extensive research has explored fiscal decentralisation in developed economies with well-established institutions, empirical insights from developing countries, particularly in Sub-Saharan Africa, remain scarce. Furthermore, most studies focus on national-level outcomes, overlooking subnational spatial heterogeneity, regional spillovers, and institutional dynamics that play a crucial role in the success of decentralisation reforms.

Kenya provides a compelling empirical setting to examine these issues. Since the 2010 Constitution and the implementation of devolution in 2013, the country has embraced one of Africa's most ambitious frameworks for fiscal decentralisation. The devolved system aims to address historical marginalisation, promote regional equity, and improve service delivery across its 47 counties. However, after more than a decade, the outcomes of this reform remain uncertain. Ongoing development gaps between regions, spatial clustering of poverty and health disparities, and uneven fiscal capacity among counties underscore spatial interdependencies and asymmetries that traditional econometric models fail to capture. These contradictions highlight the need for a more nuanced understanding of the interaction between fiscal, economic and spatial structures and their effects on citizen welfare and regional convergence.

1.2. Motivation of the study

This study is driven by three key considerations: the ongoing theoretical ambiguity and policy significance. First, despite decades of debate, the effectiveness of fiscal decentralisation in reducing poverty, inequality, and regional disparities remains inconclusive. This ambiguity hampers evidence-based policymaking, especially in countries like Kenya, which are navigating complex decentralisation transitions. Second, there are empirical gaps in the developing country context: most studies focus on developed economies, overlooking unique political, fiscal, and institutional dynamics in developing nations. Kenya's recent devolution provides a timely and policy-relevant case to examine these dynamics within an African setting. Third, there is a need for spatially informed empirical approaches. Regional development outcomes are inherently spatial, influenced by geographic spillovers, clustering, and spatially

dependent fiscal capacities. However, conventional econometric models often overlook such dependencies, resulting in biased or incomplete conclusions. Spatiotemporal econometric techniques employed in the empirical framework provide a robust framework to address these limitations by explicitly modelling inter-county spillovers, convergence clubs, and location-specific effects. Table 1.1 depicts the research questions addressed in this dissertation.

TABLE 1.1 RESEARCH QUESTIONS AND PLACEMENT IN THE DISSERTATION

Chapter and study type	Research question
Chapter 2: Theoretical and Systematic Literature Review	RQ1: How does fiscal decentralisation influence regional development, and what theoretical and empirical gaps remain post-2010?
Chapter 4: Poverty (Empirical study 1)	RQ2: How do different dimensions of fiscal decentralisation affect poverty reduction across Kenyan counties, including spatial spillovers and age-specific effects
Chapter 5: Economic Growth and Convergence (Empirical Study 2)	RQ3: How does fiscal decentralisation affect county-level economic performance and spatial spillovers?
	RQ4: Does fiscal decentralisation promote absolute or conditional convergence among Kenyan counties?
Chapter 6: Health outcomes (Empirical study 3)	RQ5: How does fiscal decentralisation shape spatial disparities in health outcomes, and which fiscal instruments are most effective in improving key indicators?

Accordingly, this dissertation leverages a spatiotemporal econometric framework to analyse the impacts of fiscal decentralisation on the following decentralisation pathways in Kenya's devolutionary context.

i) poverty and inequality

Fiscal federalism postulates that decentralisation should facilitate more targeted poverty reduction by adapting redistributive programmes to local needs. The subsidiarity principle indicates that local governments are better positioned to understand and address poverty and inequality within their areas (Faguet 2004; 2014; Oates 1999). However, without robust intergovernmental transfers and equalisation mechanisms, fiscal imbalances and limited institutional capacity in poorer regions may restrict the redistributive capacity of decentralisation, potentially intensifying horizontal inequalities (Hernandez-Trillo 2016). Empirical evidence remains inconclusive, reflecting the complex interaction between local autonomy, fiscal effort, and administrative capacity.

Hypothesis:

H2a: Own-source revenue (OSR), equitable share, and conditional grants have heterogeneous effects on poverty reduction across counties

H2b: These effects exhibit spatial spillovers and inter-county feedback mechanisms.

ii) regional economic growth and convergence,

Fiscal decentralisation is considered to promote regional growth by improving public sector efficiency, fostering competition between jurisdictions, and allowing regions to prioritise local development efforts (Qian and Weingast 1997). However, based on growth theories and New Economic Geography (NEG), sustained convergence relies on addressing initial conditions, externalities, and geographic disparities (Krugman 1998; Barro 1990; Barro and Sala-i-Martin 1992). In this context, fiscal decentralisation may encourage β-convergence (where poorer regions grow faster) if supported by compensatory transfers and coordinated national frameworks. Without such mechanisms, it may increase σ-divergence by enabling already wealthier regions to accelerate growth through agglomeration effects, thus leaving lagging regions further behind.

Hypothesis

H3a: Fiscal decentralisation positively influences county-level economic performance, with significant spatial spillover effects across neighbouring counties.

H3b: Kenyan counties exhibit absolute β-convergence under devolution.

H3c: Conditional convergence provides a better fit than absolute convergence when controlling for structural and fiscal heterogeneity.

iii) health outcomes

The devolution of the health sector reflects the core principle of "finance follows function" (Bahl and Martinez-Vazquez 2013; Bahl 1999), assuming that local authorities are best suited to deliver responsive health services. Fiscal federalism theory supports the idea that local governments can better align service provision with citizen needs, potentially enhancing health outcomes. However, the literature shows mixed results, as many decentralised contexts struggle with fragmented health financing, uneven capacity, and spatial disparities in service delivery, as finance does not always follow function (Cavalieri and Ferrante 2020; Rodriguez-Pose and Vidal-Bover 2022). Furthermore, few studies incorporate spatial econometric analysis to

account for spatial spillovers and diffusion effects, which limits the understanding of how decentralised health systems influence interregional equity and well-being.

Hypothesis

H4a: Fiscal decentralisation reduces disparities in health outcomes (mortality, morbidity, composite health), conditional on county capacity and sectoral structure.

H4b: Equitable share and conditional grants are more effective than OSR in improving population-level health indicators.

H4c: Health outcomes are subject to spatial externalities, mediated by population density and sectoral composition.

This dissertation aims to align regional development theories with real-world observations. Each study explores interconnected pathways through which fiscal decentralisation impacts subnational development, considering spatial interdependencies, regional heterogeneity, and institutional asymmetries. While decentralisation is often regarded as a remedy for development challenges, its effects vary significantly depending on context, institutional quality, spatial patterns, and interactions among policy areas. Few studies have employed spatiotemporal econometric methods to examine these dynamics at the subnational level, particularly within African settings. Addressing these thematic and methodological gaps contributes to the expanding body of research on decentralisation and regional development in Sub-Saharan Africa. It also provides policy-relevant insights for strengthening intergovernmental fiscal systems, fostering inclusive growth, and enhancing spatial equity within Kenya's devolution framework.

1.3 Dissertation Framework

This dissertation, titled "Fiscal Decentralisation and Regional Development in Kenya: A Spatiotemporal Econometric Analysis of Poverty, Health, Finance, and Economic Spillovers under Devolution," comprises a theoretical and systematic literature review and three empirical studies. The literature review identifies existing research gaps. The subsequent three studies are empirical studies utilising spatial econometrics to highlight the significance of accounting for spatial effects, such as spatial dependence in analysing regional public finance. These empirical studies aim to provide scholarly insights into the impact of spatial spillovers and fiscal

decentralisation on various aspects of regional economic growth and welfare. The rest of the dissertation proceeds explicitly as follows:

Chapter two (Literature Review) undertakes a theoretical and systematic literature review (SLR). The SLR leverages a bibliometric analysis to synthesise the extant research on the impacts of fiscal decentralisation on regional economic growth and development in developing countries. The review is grounded in fiscal federalism principles and employs the Context, Interventions, Mechanisms, and Outcome (CIMO) logic to structure the analysis. Additionally, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) framework was utilised to ensure methodological rigour. At the same time, Keyword Co-Occurrence Network Analysis was applied to identify emerging themes and research trends within the literature. The review is organised around six critical thematic areas: (1) the impact of fiscal decentralisation on economic growth, regional disparities, and convergence; (2) intergovernmental fiscal relations and local governance structures; (3) the interplay between fiscal decentralisation and service delivery including health and environmental sustainability; (4) spatial dependence and its implications for fiscal policies; (5) the role of fiscal decentralisation in poverty reduction and addressing inequalities; and (6) the effectiveness of fiscal decentralisation in the context of foreign aid and official development assistance. The literature contributes to the field of fiscal federalism by providing a comprehensive synthesis of the theoretical and empirical literature and proposing targeted research agendas. It informs policymakers and researchers about the efficacy of fiscal decentralisation policies. It highlights the need for more nuanced and context-specific analyses to optimise resource allocation strategies, enhance public finance management, and achieve broader development objectives such as poverty alleviation, reduced inequality, and sustainable economic growth in developing countries.

Chapter three outlines the methodology, data, and economic models. We use a multi-stage empirical strategy combining spatial and econometric techniques to assess the developmental effects of fiscal decentralisation in Kenya. First, Exploratory Spatial Data Analysis (ESDA) identifies global and local patterns of spatial dependence through visual tools (choropleth maps and LISA maps), Moran's I, Local Indicators of Spatial Association (LISA), and related diagnostics, confirming the presence and nature of spatial clustering in fiscal and developmental indicators. Second, Confirmatory Spatial Data Analysis (CSDA) employs spatial econometric panel models (Spatial Lag (SAR), Spatial Error (SEM), Spatial Durbin (SDM), and SARAR specifications) estimated via Maximum Likelihood (ML) methods, to accurately measure

spatial spillovers, feedback effects, and inter-county dependencies in poverty, growth, and health outcomes. The Monte Carlo simulations also estimate spatial spillovers and feedback impacts (R=1000). Finally, convergence dynamics are tested through traditional panel convergence models (absolute and conditional β-convergence) and spatial panel extensions that incorporate interdependence in county-level trajectories, thereby clarifying the extent to which fiscal decentralisation encourages regional equalisation versus persistent divergence. This approach explicitly models spatial heterogeneity, fiscal structure, and institutional context, providing robust evidence for the theoretical propositions and research hypotheses.

Chapter four presents the study's results, “Role of Fiscal Decentralisation in Poverty Reduction: Spatiotemporal Evidence from Kenya’s Devolution Framework”. The study investigates the spatiotemporal dimensions of fiscal decentralisation, focusing on the nuanced impacts of revenue decentralisation and intergovernmental transfers on poverty reduction within Kenya's devolved governance framework. By leveraging advanced spatiotemporal econometric techniques, including Spatial Lag of X (SLX) models and Spatial Panel Fixed Effects Models (SPEM-FE), this research seeks to uncover the spatial spillover and feedback effects of fiscal decentralisation on poverty across different demographic groups. These models allow for a detailed exploration of how fiscal tools such as Own-Source Revenue (OSR), equitable shares, and grants influence poverty levels within individual counties and across neighbouring regions, reflecting the interconnected nature of economic outcomes. The study identifies significant spatial clustering of poverty using Exploratory Spatial Data Analysis (ESDA) and spatial dependence from the Confirmatory Spatial Data Analysis (CSDA). It examines how fiscal decentralisation can be strategically utilised to address these clusters. The findings demonstrate that revenue-based decentralisation indicators, particularly OSR and equitable shares, are more consistently associated with poverty reduction than expenditure-based indicators. Moreover, the results highlight the critical role of spatial interactions in shaping the effectiveness of fiscal policies, with substantial spillover effects observed across county borders. These insights are crucial for formulating targeted and effective poverty alleviation strategies in Kenya and offer valuable lessons for other developing countries grappling with similar challenges of fiscal decentralisation and regional inequality.

Chapter five presents and discusses the study's results, “Nexus Between Fiscal Decentralisation and Regional Economic Dynamics: A Spatio-Temporal Econometric Analysis within Kenya's Devolution Framework “. This is a detailed analysis of the economic performance of Kenyan counties from 2013 to 2023, with a specific emphasis on the impact of

fiscal decentralisation. The findings reveal significant spatial dependencies and spillover effects, underscoring the interconnected nature of regional economies in Kenya. Fiscal decentralisation, mainly through revenue-based measures like own-source revenue, positively influences economic performance, though its effect is moderated when spatial interactions are accounted for. Expenditure-based autonomy, primarily operational (recurrent) expenditure per capita, emerges as a significant driver of economic growth across all models, highlighting the importance of effective public spending.

Regarding economic convergence, the study provides strong evidence of both absolute and conditional convergence among Kenyan counties. Absolute convergence is observed, where less economically developed counties exhibit faster growth rates, suggesting a catch-up effect over time. Considering counties' structural characteristics and initial conditions, conditional convergence further supports the notion that poorer regions are closing the gap with wealthier ones, albeit at varying speeds depending on regional factors and policy interventions. These findings suggest that fiscal decentralisation has contributed to narrowing regional disparities, although the convergence process is complex and influenced by spatial interdependencies.

Chapter six presents the study's results, “Spatial Interdependence and Fiscal-Economic Dynamics in Regional Health: A Spatiotemporal Analysis of Kenya’s Devolution”. Results reveal strong spatial clustering: high health performance in central regions and urban corridors, with persistent mortality and morbidity in peripheral counties. The SAR panel models confirm significant spatial dependence across outcomes. Conditional grants have the strongest positive health impacts, followed by own-source revenue and equitable share transfers. Sectoral Gross Value Added (GVA) shows mixed effects: whereas finance improves health, manufacturing worsens it. Population density consistently worsens health through system strain. The findings highlight spatial interdependence, the vital role of fiscal instruments, and the need for place-sensitive, coordinated policies to reduce regional health disparities and foster inclusive, resilient health systems aligned with Sustainable Development Goals.

Chapter seven presents the dissertation conclusion and policy implications. It provides the study's thesis, policy implications, limitations, and suggested areas of further research.

Chapter eight presents this dissertation's theoretical, thematic, contextual, and methodological innovations as a comprehensive advance in the study of fiscal decentralisation and regional development. The study clarifies concepts by placing fiscal decentralisation within the broader framework of regional development theory and proposing an integrative model that

captures both direct and indirect impact pathways. Thematically, it consolidates diverse strands of literature by exploring poverty, inequality, economic performance, convergence, and health in an interconnected and under-researched region of sub-Saharan Africa. Contextually, the Kenyan case provides a unique perspective for analysing decentralisation in a lower-income, diverse setting that is largely absent from mainstream research. Methodologically, advanced spatiotemporal econometric models go well beyond static or aspatial approaches, establishing a new benchmark for empirical research in economic development.

1.4. Kenya's Country Profile in the Context of Devolution

Kenya is the largest economy in the East African region, contributing around 40% of the region's GDP. Nationally, it ranks as the fourth-largest economy in Sub-Saharan Africa and the ninth largest in Africa. Geographically, Kenya is strategically situated along the East African coast, bordered by Somalia to the east, Ethiopia and South Sudan to the north, Uganda to the west, and Tanzania to the south, with an important Indian Ocean coastline that supports maritime trade through the key port cities of Mombasa and Lamu. The country covers approximately 582,646 square kilometres and exhibits diverse ecological, economic, and demographic features across its regions.

According to the 2019 Kenya Population and Housing Census, the population was 47.6 million, compared to 10.9 million in 1969, showing sustained population growth. Although the inter-censal growth rate dropped 2.2% between 2009 and 2019, the demographic momentum still strains public services, infrastructure, and job creation.

Over the past twenty years, Kenya has made notable progress in political and economic reform, driven by strengthening democracy, increasing public spending, and improving governance structures. However, the country still faces ongoing development challenges, such as high poverty rates, income and spatial inequalities, youth unemployment, and a shortage of quality jobs. Despite its vibrant and youthful workforce, private sector investment remains underdeveloped, and the economy continues to be vulnerable to external shocks (like commodity price swings) and internal pressures, including climate variability and fiscal deficits. Before the COVID-19 pandemic, Kenya experienced strong economic growth supported by infrastructure-focused public investments. Nonetheless, this growth relied on rising public debt, raising concerns about fiscal sustainability and crowding out private

investment. The government has initiated a fiscal consolidation plan to restore macroeconomic stability, although revenue shortages still hinder progress towards fiscal targets.

Kenya's long-term development plan, Vision 2030, aims to transform the country into a globally competitive, middle-income economy that provides a high quality of life for all citizens. This is supported by the current administration's Bottom-Up Economic Transformation Agenda (BETA), which focuses on five key pillars: agriculture, healthcare, affordable housing, micro and small enterprises (MSEs), and the digital and creative economy. These policy directions are closely linked with the devolution framework, emphasising empowering local governments to achieve these development goals.

The enactment of the 2010 Constitution formalised a two-tier governance system consisting of the national and 47 county governments, representing a significant shift from the previously centralised governance model. Devolution in Kenya transfers political, administrative, and fiscal powers to counties, each headed by an elected governor, a county assembly, and executive committees. The county governments now play a key role in service delivery, local development, and public finance management, particularly in vital devolved sectors such as healthcare, agriculture, trade, early childhood education, water services, and local infrastructure.

The devolved system was explicitly designed to address historical regional inequalities, promote equity, enhance local accountability, and bring services closer to the people. The Constitution mandates equitably sharing at least 15% of nationally raised revenues with counties, complemented by conditional and unconditional grants, and own-source revenue (OSR) generated locally. County governments are also empowered to establish urban areas and municipalities, managed by appointed boards, to oversee urban service delivery and spatial planning within their jurisdictions.

However, despite these ambitious reforms, Kenya's devolution process faces several implementation challenges, including low OSR performance, capacity constraints, gaps in intergovernmental coordination, and concerns about fiscal accountability and elite capture. Nonetheless, devolution remains a key pillar of Kenya's governance and development framework, offering a unique opportunity to promote inclusive growth, regional equity, and responsive service delivery through localised governance and participatory planning.

Figure 1-1 is a choropleth map illustrating the significant disparities in geographical size, population density, and the locations of Kenya's counties. The regional population and land distribution are detailed in Appendix A-1.

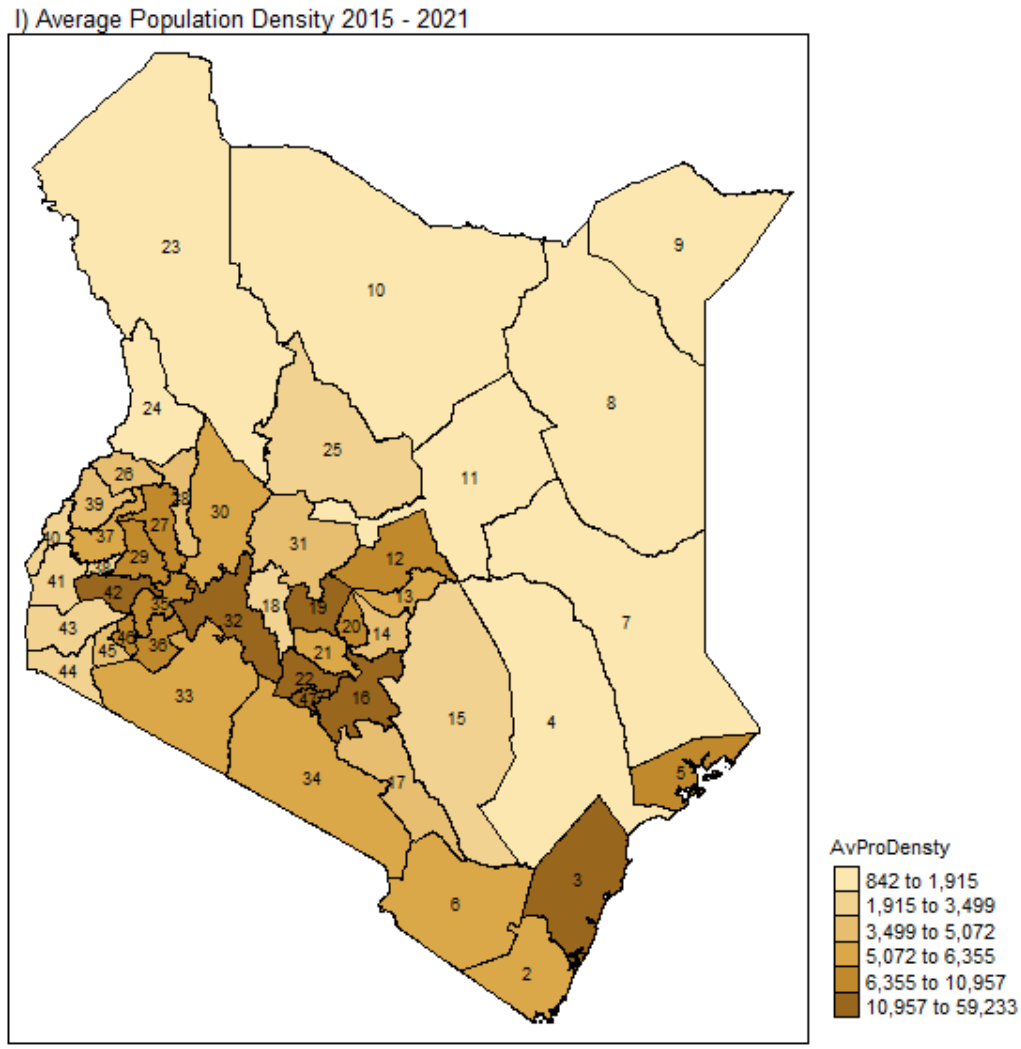


FIGURE 1.1. CHOROPLETH MAP OF THE COUNTIES OF KENYA AND THEIR POPULATION DENSITIES - 2021

Source: Authors' Visualisation

Note: 1=Mombasa, 2=Kwale, 3=Kilifi, 4=Tana River, 5= Lamu, 6=Taita Taveta, 7 = Garissa, 8=Wajir, 9 = Mandera, 10= Marsabit, 11 = Isiolo, 12 = Meru, 13 = Tharaka -Nithi, 14 = Embu, 15 = Kitui, 16 = Machakos, 17 = Makueni, 18 = Nyandarua, 19 = Nyeri, 20 = Kirinyaga, 21 = Murang'a, 22 = Kiambu, 23 = Turkana, 24 = West Pokot, 25 = Samburu, 26 = Trans Nzoia, 27 = Uasin Gishu, 28 = Elgeyo-Marakwet, 29 = Nandi, 30 = Baringo, 31 = Laikipia, 32= Nakuru, 33 = Narok, 34 = Kajiado, 35 = Kericho, 36 = Bomet, 37 = Kakamega, 38 = Vihiga, 39 = Bungoma, 40 = Busia, 41 = Siaya, 42 = Kisumu, 43 = Homa Bay, 44 = Migori, 45 = Kisii, 46 = Nyamira, 47 = Nairobi City

1.4.1 Fiscal Devolution in Kenya: Evolution, Structure, and Challenges

Kenya's fiscal decentralisation is a unique example of constitutionally enshrined devolution in Africa. The country's experience with fiscal decentralisation reflects a lengthy and complex process shaped by historical centralisation, uneven regional growth, and changing political regimes. Since gaining independence in 1963, efforts to address spatial inequalities have guided multiple decentralisation strategies, from the short-lived federal Majimbo system (1963–64), through decades of centralisation (1966–2013), to the current devolutionary framework established by the 2010 Constitution and put into effect in 2013. During the centralised period, regional development policies aimed to reduce regional disparities, including District Focus for Rural Development (DFRD), Regional Development Authorities, and the Constituency Development Fund (CDF). However, overlapping mandates, elite capture, poor coordination, and limited public engagement often hampered these initiatives. Centralised control over finances and development priorities, patronage politics, and bureaucratic inefficiencies exacerbated interregional inequalities and spatial marginalisation.

The 2010 Constitution shifted towards devolved governance, establishing a two-tier structure consisting of the national and 47 county governments. The system balances autonomy and interdependence between the national and county governments. The new devolved framework is based on subsidiarity, inclusivity, citizen participation, equitable resource sharing, and intergovernmental collaboration. Counties replaced the fragmented local authorities and were granted political, administrative, and fiscal responsibilities, including health, agriculture, local infrastructure, and trade functions. This design provides a hybrid of unitary and federal features, often called integrated federalism, where the two levels of government are separate but interdependent.

Kenya's fiscal decentralisation is governed by a robust legal and institutional framework, including the Public Finance Management (PFM) Act, the Commission on Revenue Allocation (CRA), the Controller of Budget, the Intergovernmental Budget and Economic Council (IBEC), and other forums that coordinate intergovernmental fiscal relations. To establish policy coherence, counties must constitutionally prepare County Integrated Development Plans (CIDPs) that align with national priorities. County governments are funded through four principal means. First, revenue from the equitable share - the standard national revenue is distributed vertically between the national and county governments via a political process and horizontally among county governments according to a predefined formula recommended by the Commission on Revenue Allocation. The formula's parameters, considered over four cycles,

include population index, basic share index, geographical size index, poverty index, fiscal responsibility/effort, development factor, health index, agriculture index, urban services index, and rural access index. This equitable share constitutes an unconditional transfer. Second, county governments are funded through both conditional and unconditional grants. These can originate from the national government's equitable share, proceeds of loans and grants from development partners, conditional transfers from the equalisation fund, or grants transferred following the assignment of a function. Third, county governments generate revenue from their own sources (OSR). While the national government collects income tax, value-added tax, customs duties, and excise tax, county governments are responsible for property tax, entertainment tax, and charges for county services. However, OSR performance has been underwhelming, with a 35-94% gap between potential and actual OSR due to weak tax administration (Fjeldstad 2006; Bird 2009). Fourth, borrowing is permitted provided it is guaranteed by the national government and approved by the county assembly. Nevertheless, borrowing by subnational governments has been cautiously managed due to the fiscal risks posed to the national government, such as contingent liabilities, and the increased demand for grants to financially distressed subnational governments (Saxena 2022). Consequently, the borrowing indicator was not measured due to difficulties with data availability.

Despite a decade of devolution, its effectiveness in addressing development disparities and promoting growth remains understudied. Kenya offers a unique case for evaluating how devolution and democratic governance influence economic performance. This study leverages spatial econometrics to empirically examine fiscal decentralisation's role in economic growth by analysing subnational revenue, expenditure composition, and growth trends - an area largely underexplored in Kenya’s devolutionary experience.

Despite this framework, counties continue to underperform in OSR collection, with shortfalls ranging from 35% to 94% of estimated potential. Weak local revenue administration, capacity constraints, and overreliance on intergovernmental transfers have undermined local fiscal effort, reducing incentives for revenue mobilisation. This results in fiscal dependency and limits the autonomy envisioned by devolution.

Moreover, spatial inequalities persist. Counties entered the devolution era with uneven infrastructure, institutional capacity, and human capital, reflecting the legacy of historically biased central planning. Although devolution aimed to equalise these disparities, emerging evidence suggests mixed results. While some regions, especially agriculturally rich or urbanised counties, have experienced growth, marginalised counties still face development gaps. Political

factors, such as ethnic alignment with national leadership, continue to influence the distribution of resources and development outcomes, sometimes reinforcing divergence rather than bringing about convergence.

Devolution in Kenya has also transformed the governance of social sectors, especially health. County governments now oversee primary healthcare provision, while national governments maintain policy and regulatory oversight. However, fiscal capacity and governance differences have led to varied health financing and service delivery outcomes across counties. Evidence shows that a large part of health budgets is spent on recurrent costs, especially salaries, leaving limited funds for development. Therefore, although it has enhanced local autonomy and participation, challenges remain in fully realising its potential for regional economic convergence and balanced development.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This chapter discusses the study's theoretical foundations and synthesises empirical findings from previous research. The empirical section adopts a systematic literature review approach to ensure thorough and transparent coverage of the relevant evidence.

2.2. Theoretical Literature Review

2.2.1 Regional Development Theory

This dissertation is grounded in regional development theory, which provides the overarching framework for understanding how economic activity is distributed across space, why disparities persist, and how growth trajectories evolve. The field has advanced through several phases, beginning with classical approaches such as growth poles (Perroux 1950), cumulative causation (Fujita 2007), and core-periphery models (Hubert 1968), which emphasised structural imbalances and self-reinforcing agglomeration. Neoclassical perspectives later introduced convergence mechanisms based on factor mobility and diminishing returns (Solow 1956; Barro and Sala-i-Martin 1992; Sala-i-Martin 1996). In parallel, endogenous and innovation-based theories highlighted the roles of knowledge, institutions, and territorial competitiveness (Romer 1986; Lucas 1988; Grant 1991). New Economic Geography has recently integrated microeconomic foundations into spatial concentration processes (Krugman 1991; 1998; Holmes 2000), while territorial development perspectives emphasise regional resilience and competitiveness (Lengyel 2009; 2005). Complementary frameworks such as fiscal federalism (Oates 2005) and convergence theory (Barro and Sala-I-Martin 1992; Sala-i-Martin 1996) further enrich the multi-dimensional theoretical landscape of this study.

2.2.1.1 New Economic Geography

New Economic Geography (NEG) emerged in the early 1990s with Paul Krugman's formalisation of how increasing returns, transportation costs, and factor mobility interact to shape the spatial distribution of economic activity (Krugman 1991; 1998). Drawing on Dixit–Stiglitz monopolistic competition and spatial trade theory, NEG established a micro-founded general equilibrium framework that explains the endogenous formation of economic cores and peripheries. NEG centres on the tension between centripetal forces (agglomeration economies such as market access, labour pooling, and knowledge spillovers) and centrifugal forces (dispersion drivers such as congestion, immobile resources, and rising land costs). The

interaction of these forces generates non-linear spatial outcomes: reductions in trade costs may, initially, intensify agglomeration in advantaged regions, widening disparities, while only at later stages might dispersion equilibria emerge (Krugman and Venables 1995). This circular causation underscores why small initial advantages can lock regions into divergent development trajectories.

Regarding regional inequality, NEG demonstrates that integration disproportionately benefits core regions, reinforcing spatial divergence before convergence mechanisms take effect. This is especially relevant for developing economies pursuing fiscal decentralisation. For these economies, NEG offers essential insights. First, decentralisation in contexts with weak infrastructure and uneven market access may unintentionally strengthen agglomeration in urban or economically dominant regions, thus increasing inter-regional inequality. Second, fiscal transfers and local revenue mobilisation must be carefully designed considering NEG dynamics: lacking compensatory mechanisms, spatially concentrated tax bases in core regions could lead to widening fiscal disparities across subnational units. Thirdly, NEG emphasises the importance of sequencing policy measures to reduce transport costs or improve inter-regional connectivity. Decentralisation needs to be paired with redistributive fiscal tools if convergence is to be realised. Therefore, NEG highlights the dual challenge for developing countries: harnessing the efficiency advantages of agglomeration while mitigating its decentralising effects through fair fiscal policies and targeted investments in underdeveloped regions (Rodríguez-Pose and Gill 2004; Baldwin et al. 2003).

2.2.1.2 Convergence Theory

Convergence theory offers a framework for analysing whether poorer economies or regions grow faster than richer ones, reducing income and development gaps over time. Its origins are in the Solow–Swan neoclassical growth model, which predicts that, under diminishing returns to capital, economies will converge towards a steady-state income level determined by savings, population growth, and technological progress (Solow 1956; Swan 1956). This framework holds that convergence occurs because capital accumulation produces higher marginal returns in capital-scarce regions than in regions rich in capital.

Empirically, convergence has been evaluated in the literature through two main concepts: σ-convergence, which indicates a reduction in the spread of per capita income across regions over time, and β-convergence, which examines whether initially poorer regions grow faster than richer ones (Barro and Sala-i-Martin 1992; Sala-i-Martin 1996)The literature distinguishes between absolute convergence (where all economies are assumed to converge to

a single steady state) and conditional convergence (where steady states vary due to structural factors such as human capital, institutional quality, or savings behaviour). However, the conditional convergence hypothesis has received stronger empirical support, especially in contexts characterised by heterogeneous regions and countries.

Extensions to the convergence theory emphasise spatial spillovers and institutional characteristics. Spatial econometric approaches demonstrate that regional growth is interdependent through trade, migration, and knowledge diffusion, with spatial neglect biasing estimates of convergence speed (Ertur and Koch 2007; Vincent and Osei Kwadwo 2022; Cavalieri and Ferrante 2020; Chenglin et al. 2013). Institutional quality and fiscal frameworks also influence whether convergence forces function effectively, especially in lagging regions (Rodríguez-Pose and Muštra 2022; Mendez and Bachtler 2024). In subnational settings of developing countries, convergence is often slow or incomplete due to structural dualism, weak infrastructure, and uneven fiscal capacity (Quah 1996; Young et al. 2008). Fiscal decentralisation further influences outcomes: while well-designed transfer systems can promote convergence, poorly arranged structures may reinforce divergence (Rodríguez-Pose and Muštra 2022; Rodríguez-Pose and Ezcurra 2010).

Thus, convergence theory has evolved from the neoclassical focus on diminishing returns to broader frameworks that include spatial interdependencies and institutional heterogeneity. These advancements are particularly relevant to our study of Kenya's regional growth patterns after devolution, where fiscal decentralisation interacts with structural and spatial inequalities.

2.2.1.3 Fiscal Federalism and Decentralisation Theories

Fiscal federalism offers the theoretical framework for intergovernmental fiscal relations: allocating functions and resources among government levels. The Classical theory, developed by Musgrave (1959), Tiebout (1956), and Oates (Oates 1999; 2008), assigns stabilisation and redistribution roles to the central government, whilst subnational governments focus on allocating local public goods. Tiebout's "voting with feet" model demonstrates preference matching through interjurisdictional competition, and Oates' decentralisation theorem formalises efficiency improvements when local governments tailor services to residents' preferences in the absence of spillovers.

Literature distinguishes between first-generation theories, which emphasise efficiency and welfare maximisation, and second-generation theories, which incorporate institutional

incentives, accountability, and information asymmetries (Oates 2008; 1999; 2005). Decentralisation aims to enhance efficiency and responsiveness by aligning expenditure with local needs and improving accountability through citizen oversight. However, potential pitfalls of decentralisation include fiscal disparities from different fiscal capacities and coordination failures when intergovernmental fiscal relations are weak. Without equalisation transfers or strong institutions, decentralisation may deepen inequality and threaten social cohesion. Increasing income inequality, poverty levels, and regional economic disparities are global phenomena credited with disenfranchising communities and fueling political instabilities in developing countries (Rodgers 2022; Yang 2016).

Theoretically, assigning economic outcome functions in multi-level governments faces a dilemma, with three schools of thought: redistributive, allocative, and concurrence, each advocating for a different approach, such as centralisation or decentralisation (Hernandez-Trillo 2016). Of the three, decentralisation has been a germane policy reform theorised to promote good governance, public service delivery, poverty reduction, and regional inequality (Qian and Weingast 1997; Sanogo 2019; Faguet 2014; Nath and Madhoo 2022; Weingast 2009; Oates 2008). However, in practice, the results of its effectiveness from literature have been controversial and inconclusive. Whereas some authors see fiscal decentralisation as effective (Cavusoglu and Dincer 2015; Hussain et al. 2021; Cristian F Sepulveda and Martinez-Vazquez 2011), others contend that decentralisation aggravates poverty and income inequality (Hernandez-Trillo 2016; Nguyen 2008; Gavriluta et al. 2020). The effectiveness of fiscal decentralisation is thus contingent on a multiplicity of factors, including how competencies are assigned to the levels of government. However, the knowledge of how policymakers balance devolution and centralisation and assign responsibilities to different levels of government is still not consolidated.

Countries typically prefer vertical imbalanced models over complete decentralisation. Governments optimise fiscal decisions in three scenarios: complete centralisation, full decentralisation, and a hybrid approach (Rueda Lopez et al. 2020). Under complete centralisation, welfare maximisation occurs when public expenditure productivity is uniform across regions. Complete decentralisation, or devolution, provides sub-nationals full fiscal and legislative autonomy, ideal for high productivity heterogeneity. Partial decentralisation allows central governments to address fiscal externalities while sub-nationals tailor spending to their unique needs. Asymmetric decentralisation fosters national integration in culturally diverse countries (Salinas and Solé-Ollé 2018). Varying sub-national fiscal capacities may hinder

service efficiency, necessitating central government support (Lele 2019). However, research on these policies lacks coherence without a unified emerging agenda and practice.

Fiscal decentralisation's impact on economic development depends on context rather than policy isomorphism. Research indicates it is more significant in highly developed nations, where strong institutions and redistribution capacity enhance efficiency (Lessmann and Markwardt 2016; Tanzi and Zee 1997). However, studies on regional disparity often focus on developed countries, needing more relevance to poorer nations facing institutional challenges and data scarcity (Lessmann and Markwardt 2012). Research in developing countries mainly concentrates on a few Asian economies like China, Indonesia, and Vietnam, neglecting other regions, such as Africa, due to data accessibility issues. These contextual differences highlight the need to thoroughly examine fiscal decentralisation's impact on economic development in developing countries over the past decade.

In Kenya, the 2010 Constitution created a devolved system where counties receive an equitable share of national revenue, conditional grants, and limited own-source revenues. This approach reflects traditional principles by assigning local service provision to subnational units but also highlights second-generation issues: vertical imbalances, uneven fiscal capacities, and the difficulty of maintaining coordination. Kenya's experience shows the efficiency and accountability improvements expected from fiscal federalism and the risks of increasing county disparities.

2.2.2 Integrative Framework

Synthesising New Economic Geography (NEG), Convergence Theory, and Fiscal Federalism creates a framework where fiscal decentralisation influences spatial growth patterns. NEG emphasises agglomeration forces and spatial spillovers, suggesting decentralisation may deepen core–periphery inequalities if wealthier regions utilise their stronger fiscal capacity. Convergence theory focuses on regional equalisation, indicating that transfers and subnational abilities can promote absolute or conditional welfare and income convergence. Fiscal federalism offers the normative basis for allocating revenue and expenditure responsibilities, highlighting how intergovernmental arrangements affect efficiency, equity, and accountability in service delivery. Fiscal decentralisation should be viewed as a complex process whose results depend on spatial structure, institutional capacity, and transfer mechanisms. This comprehensive framework supports the study's analytical approach. It also validates the research hypotheses: whether Kenya's devolved fiscal

arrangements encourage balanced growth, convergence, poverty alleviation, better health outcomes, or reinforce divergence.

2.2.2.1 Overview of Fiscal Decentralisation and the Poverty Nexus

Rising income inequality, persistent poverty, and expanding regional disparities are global issues that marginalise communities and increase political instability in developing countries. These factors have driven research into the role of fiscal decentralisation in tackling poverty, inequality, and broader development outcomes (Ramirez et al. 2017a; Rodgers 2022; Yang 2016). Theoretical discussions focus on three perspectives: redistribution, which prefers centralisation; efficiency, which advocates decentralisation; and concurrency, which suggests a combination of both (Hernandez-Trillo 2016). In this debate, fiscal decentralisation—alongside political and administrative structures, is promoted as a reform to enhance governance, service delivery, poverty reduction, and regional convergence (Martinez-Vazquez et al. 2017; Faguet 2014; Nath and Madhoo 2022; Qian and Weingast 1997; Oates 2008). It comprises three elements: expenditure assignment, revenue collection, and decision-making autonomy.

Empirical evidence regarding its effectiveness, however, remains contested. Some studies suggest fiscal decentralisation reduces poverty and inequality (Cavusoglu and Dincer 2015; Hussain et al. 2021; Cristian F Sepulveda and Martinez-Vazquez 2011; Siburian 2022; 2020), while others find it ineffective or even harmful (Gavriluta et al. 2020; Hernandez-Trillo 2016; Nguyen 2008). Further research shows mixed or context-dependent outcomes, with some arguing that decentralisation tools such as fiscal transfers are influential nationally but have a limited effect on spatial disparities (Ahmed and Lodhi 2009; Freinkman and Plekhanov 2010; Yeeles 2015). These inconsistencies highlight the importance of examining intergovernmental fiscal relations within specific contexts to develop effective policies for poverty reduction.

The poverty-decentralisation relationship resembles a hen-egg dilemma. Fiscal autonomy at the subnational level depends on revenue capacity, which is shaped by poverty-related factors such as institutional quality, household consumption, and unemployment (Gnangnon 2022; Hung Thanh Nguyen et al. 2020). Regional inequalities further complicate this link. For example, Ramirez (2017b) shows that municipal property tax revenues in Colombia significantly reduced multidimensional poverty and generated positive spillovers. Such findings indicate the need for tailored revenue systems and spatially targeted interventions. More broadly, decentralisation contributes to poverty alleviation when

subnational governments combine adequate fiscal capacity with financial autonomy and accountability mechanisms (Agyemang-Duah et al. 2018).

Intergovernmental fiscal transfers, aimed at correcting vertical imbalances, add another layer of complexity. Subnational governments depend heavily on such transfers despite their formal autonomy in managing own-source revenues (Becerra-Vicario et al. 2023). However, their effectiveness in reducing poverty remains debated. Poorly designed transfers can cause a flypaper effect, where unconditional grants disproportionately increase local spending (Melo 2002; Dick-Sagoe et al. 2022; Wati et al. 2022). Other evidence suggests no such effect when spatial dependence and endogeneity are considered (Yu et al. 2016). This underscores the importance of transfer design and the need for further empirical research into the nuances of fiscal dependence.

Context and measurement further influence outcomes. In China, expenditure decentralisation has been associated with increasing inequality, while revenue decentralisation and decision-making autonomy had limited or mixed effects (Yang 2013). In Indonesia, revenues and transfers were found to reduce poverty, but regional expenditures did not(Nursini and Tawakkal 2019). Fiscal transfers can, depending on how they are structured, either foster convergence or widen regional disparities (Raiser 1998)Although there is no universal metric, scholars recommend using multidimensional measures of fiscal decentralisation to better capture its varied impacts.

Finally, spatial dependence is essential for understanding the relationship between decentralisation and poverty. Fiscal capacities often create spillover effects, where grants and revenues in one jurisdiction impact fiscal behaviour and welfare outcomes in neighbouring regions (Vincent and Osei Kwadwo 2022). For instance, research on China's county-level education spending shows that considering spatial dependence can alter previous conclusions, providing evidence of an "anti-flypaper effect." Such findings emphasise the interconnected and spatially embedded nature of fiscal decentralisation, poverty alleviation, and regional development.

2.2.2.2. Fiscal Decentralisation and Regional Economic Dynamics Nexus

Fiscal decentralisation, rooted in federalism theory, shifts decision-making power, resources, and responsibilities over revenue and expenditure from the central government to subnational authorities. Its purpose is to improve allocative and productive efficiency through responsive local preferences, population mobility, and inter-jurisdictional competition in public

service delivery, thereby encouraging economic growth and development (Tiebout 1956; Bahl 1999; Oates 2008; Thiessen 2003; Aray 2018). However, literature presents mixed results regarding its effect on regional growth and convergence. Some studies report positive impacts (Lin and Liu 2000; Gil-Serrate et al. 2011), while others observe negative effects (Davoodi and Zou 1998), and still others find no significant relationship (Cantarero and Gonzalez 2009). Both cross-country and within-country analyses show that outcomes depend on context, institutional capacity, and levels of development.

These inconsistencies highlight the complexity of the transmission mechanisms and the lack of a unifying theoretical consensus. Classical fiscal federalism theory does not establish a direct link between decentralisation and growth, so economic growth and econometric models have examined the relationship indirectly. For example, Barro's (1990) endogenous growth model was extended by Davoodi and Zou (1998) by including public spending levels at national and subnational tiers. Using a Cobb–Douglas production function under balanced growth with a constant tax rate, they demonstrated that long-term per capita output growth depends on the tax rate and how public expenditure is distributed across government levels. Given a fixed government-spending-to-GDP ratio, they argued that reallocating expenditure shares can boost growth if the current distribution deviates from the optimal mix. In this context, the convergence debate centres on whether fiscal decentralisation reduces interregional disparities by enabling lagging regions to adapt spending to local needs or widens gaps by strengthening existing differences in fiscal capacity and institutional quality.

2.2.2.3. Fiscal Decentralisation and Regional Health Outcomes Nexus

At the dawn of the new millennium, decentralisation was promoted to enhance efficiency and responsiveness in public service delivery, prompting many governments to implement decentralised reforms with varying results. The goal was to balance the benefits of central coordination with the flexibility of local autonomy, thereby addressing diverse regional needs and fostering development (Boadway et al. 1994; Oates 2008; 1999). However, assigning responsibilities for essential functions such as health and poverty alleviation within multi-level government remains a persistent policy challenge (Hernandez-Trillo 2016). The success of decentralisation ultimately depends on how these responsibilities are allocated and implemented across different levels of government.

The connection between fiscal decentralisation and health outcomes is theoretically convincing but produces mixed results. Some studies show improvements in health service delivery and outcomes (Robalino et al. 2001), while others highlight negative effects (Jin and

Sun 2011). These contrasting results often depend on contextual factors such as decentralisation design, local administrative and fiscal capacity, and the effectiveness of accountability measures. For example, weak accountability can reduce efficiency and cause delays in service delivery due to externalities and missed economies of scale (Kyriacou and Roca-Sagalés 2024). Furthermore, existing research tends to measure health narrowly, relying on indicators such as mortality or morbidity, while overlooking broader aspects of health development. Spatial dependencies also remain insufficiently examined despite their significance in shaping interregional health outcomes and guiding effective policy formulation. This study addresses these gaps by adopting a multidimensional approach to health outcomes while explicitly recognising spatial interdependence.

Ultimately, fiscal decentralisation's effectiveness in enhancing health outcomes relies on local service delivery and broader intergovernmental fiscal relations, including revenue-raising capacity and the design of fiscal transfers that influence subnational health expenditures.

2.3. Empirical Literature Review (Systematic Literature Review)

As of February 2024, there was a paucity of systematic literature reviews on the relationship between fiscal decentralisation and economic growth, convergence, and their implications for development outcomes like poverty, inequality, health, and citizen well-being. Unlike traditional reviews, a systematic approach ensures objectivity, reliability, and reproducibility (Pollock and Berge 2018; Liberati et al. 2009). Following the PRISMA protocol enhances comprehensiveness and versatility and is suitable for multidisciplinary reviews (Page et al. 2021; Liberati et al. 2009). This study aims to systematically analyse research on fiscal decentralisation and its impact on economic development outcomes since 2010.

Due to the complexity and fragmented knowledge regarding the effectiveness of fiscal decentralisation in fostering economic growth and development outcomes such as poverty and inequality reduction, this research seeks to synthesise existing studies on this topic in developing nations. Specifically, the review looked at the following:

a) Synthesise the existing research on the impact of intergovernmental fiscal transfers and revenue autonomy on regional growth, convergence, and economic development.
b) Identify research gaps on how different levels of fiscal transfers (grants, revenue sharing, and own revenue generation) influence the fiscal relations between the central

and subnational units and whether some mechanisms are more effective than others in fostering growth and convergence.

c) Characterise evolving research on fiscal decentralisation and highlight its insights in the context of convergence or divergence in regional development.
d) Propose research agendas to researchers to fill knowledge gaps on the impact of fiscal decentralisation (fiscal transfers and local revenue) on regional development, convergence, and service delivery in subnational entities of developing countries.

The systematic literature review adopts CIMO (Denyer et al. 2008), PRISMA (Page et al. 2021) (covering planning, search, extraction, and selection processes) and Keyword Co-Occurrence Network Analysis (Lozano et al. 2019; Kiani Mavi et al. 2020) methodology. Section 4 presents the results, including exploratory document analysis through bibliometric techniques and content analysis to identify research themes, gaps, and proposed agendas. These are categorised into six themes: a) Fiscal decentralisation, economic growth, regional disparities, and convergence, b) Intergovernmental fiscal relations (IGFR) and local governance. c) Fiscal decentralisation, environment, and natural resources. d) Fiscal decentralisation and spatial dependence. e) Fiscal decentralisation, poverty, and inequalities. f) Fiscal decentralisation and the effectiveness of foreign aid (official development assistance).

2.3.1. Search Methodology

This section uses the Systematic Literature Review method to plan and manage data. It will discuss Context, Intervention, Mechanisms, and Outcomes (CIMO) logic as applied in the preparation stage of the research process. Other processes discussed include data selection, quality assessment, and extraction.

2.3.1.1 Preparation

The research question was formulated using the Context, Intervention, Mechanisms and Outcomes (CIMO) – logic (Denyer et al. 2008) to ensure that the article search, using keywords, is restricted to study focal areas. Denyer et al. (2008) aver that the 'CIMO-logic' formulates propositions by suggesting that in specific challenging contexts (C), employing a particular type of intervention (I) can activate generative mechanisms (M) to produce desired outcomes (O). This study's context (C) is fiscally decentralised developing countries and their subnational development strategies. This is based on the observation that fiscal decentralisation impacts developed and developing countries differently. The intervention (I) focuses on fiscal tools to implement fiscal decentralisation, including fiscal transfers and own-source revenue (OSR). The fiscal transfers are either conditional or unconditional grants. The mechanisms (M) include

how different structures of fiscal decentralisation influence subnational governments' fiscal capacity, economic growth, and regional development convergence. The Outcome (O) guided in formulating how fiscal decentralisation affects the economic development outcomes, including reducing poverty and inequality and, ultimately, the broader measures of citizens' economic well-being.

The Context, Interventions, Mechanisms, and Outcome (CIMO) Logical Framework is presented in Figure 2-1

The Context, Interventions, Mechanisms, and Outcome (CIMO) Logical Framework

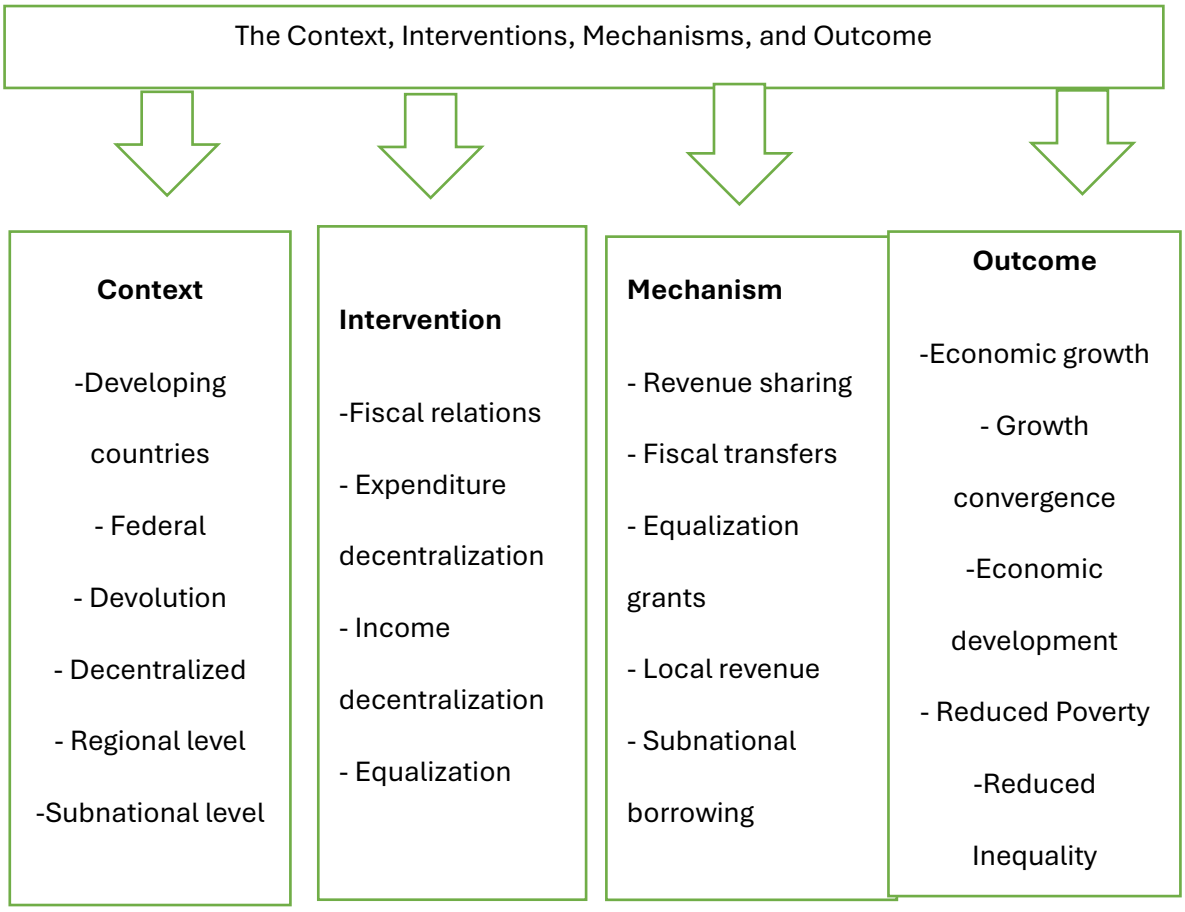


FIGURE 2.1: THE CIMO LOGICAL FRAMEWORK OF KEYWORDS

Source: Authors' elaboration

Following Waddington et al. (2012), we conducted an electronic scoping search using Web of Science, Scopus, and EconLit. Web of Science and Scopus are multidisciplinary databases, while EconLit focuses on social science with an economics bias. Known for its

rigorous selection process, Web of Science ensures high-quality content. Scopus offers advanced search functionalities, comprehensively covering peer-reviewed journals, conference proceedings, and patents. This comprehensive and high-quality article selection process provides a rigorous synthesis outcome.

We devised a search strategy to locate relevant literature from 2010 to 2013. Keywords included fiscal decentralisation and its variants (e.g., local revenue, revenue autonomy) and decentralisation-related terms (e.g., devolution, federal). Economic development outcomes were captured with terms like economic growth, poverty, and inequality, while contextual factors were addressed with terms like developing countries and emerging markets. Boolean operators and wildcards were used to combine these keywords, as shown below:

((((TS=(("fiscal decentral*" or " local revenue" or "own source revenue" or "revenue autonom*" or "revenue share*" or "*fiscal transfer*" or "fiscal grant*" or "fiscal relation*" or "fiscal autonom*"))) AND TS=(("decentral*" or "devol*" or "federal *" or "regional "or "subnational"))) AND TS=(("econ* growth" or "econ* develop*" or "poverty" or "inequality" or "financial well*" or "econ* well*" or "financial health"))) AND TS=(("developing countr*" or " less developed countr*" or "low* income countr*" or "emerging countr*" or "global south" or "emerging markets"))

2.3.1.2 Selection Criteria

The search spanned papers from 2010 to February 2024, limited to the English language and the business and economics domain. Only full-text, peer-reviewed journals were considered. Data was exported to Zotero in Research Information System (RIS) format for management, including merging duplicates (Madjido et al. 2019). Articles were screened based on title and abstract relevance, producing 72 eligible papers. Keyword network analysis was conducted on these papers to visualise patterns and research themes. Only articles from Q1 and Q2 journals were chosen to ensure quality, resulting in 40 articles for final content analysis. Figure 2 shows the PRISMA flow diagram of the process.

2.3.1.3 Quality Assessment

The study focused on original research articles. The results were filtered qualitatively using the prompts for appraising research (Dixon-Woods et al. 2007). The abstracts were read to ensure they aligned with the study goals, and those found risky and not in line with the study

goals were removed from the list. As a restatement, 40 articles published in journals ranked Q1 and Q2 were included in the final review.

2.3.1.3 Data extraction

Data extraction was done by exporting relevant data in a data extraction template. The template fields included bibliographic details, keywords, publisher, an abstract, unit of analysis (country), paradigm, analysis methods, data type, data characteristics, preliminary results, and focus for the study. This was managed in MS Excel for ease of classification and analysis.

Figure 2-2 presents the PRISMA flow chart, which shows the granular steps of how the articles were identified and screened, how many passed the eligibility criteria, and how many were included in the final review.

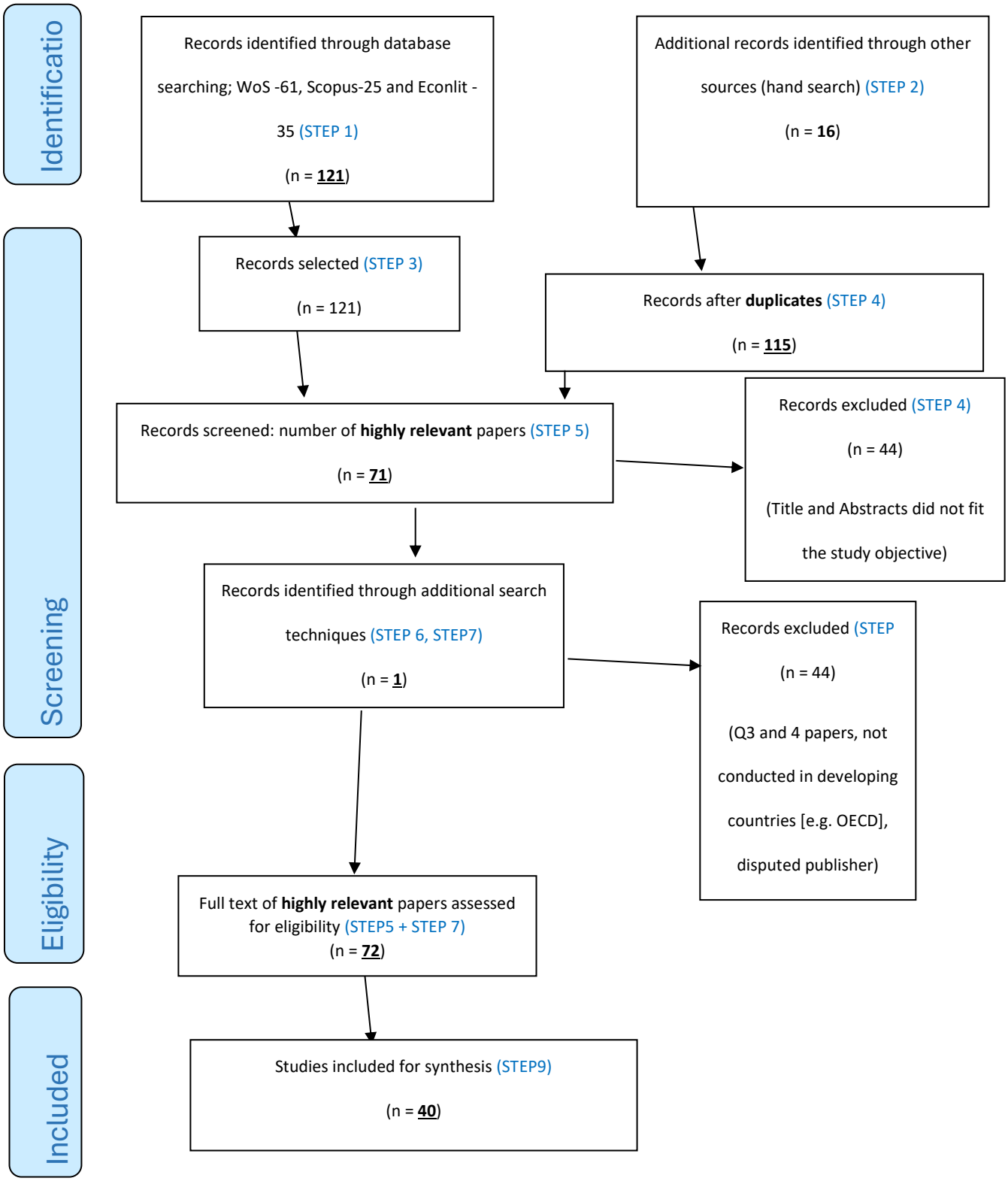


Figure 2-2: PRISMA Flow Chart of document identification, screening for eligibility and inclusion for review

FIGURE 2.2: PRISMA FLOW CHART

Source: Author elaboration

2.3.2 Search Results and Discussions

This section synthesises the selected data, starting with an exploratory document analysis using keyword co-occurrence network analysis. It then delves into content analysis, revealing research themes, identifying gaps, and proposing research agendas within each theme.

2.3.2.1 Keyword Co-Occurrence Analysis (Document Exploratory Analysis)

Researchers increasingly use keyword co-occurrence network analysis to uncover primary research themes, emerging trends, and interconnections among journal articles in systematic literature reviews (Kiani Mavi et al. 2020; Suthar et al. 2021; Tamala et al. 2022). This method helps map topics, visualise relationships among critical concepts, and pinpoint research gaps by exploring weakly linked keywords for further investigation. We conducted a bibliometric analysis on the 72 eligible articles in RIS format. Some keywords had varied spellings and structures but conveyed the same idea, so we standardised them in a thesaurus file. The top ten frequently occurring (more than 15 times) and strongly linked (link strength exceeding 150) keywords include economic development, decentralisation, housing, infrastructure, intergovernmental relations, federalism, secession, institutions, formal and informal sectors, shadow economy, and fiscal decentralisation. These keywords collectively highlight the traditional focus on the relationship between government levels, fiscal decentralisation, and its impact on economic development. Conversely, the bottom ten keywords, occurring at least twice but with relatively strong link strengths (exceeding 20), encompass concepts such as foreign aid, governance, inequality, inflation, international linkages, money, natural resources, primary products, and property rights. These concepts indicate research avenues concerning the connection between fiscal decentralisation and international development partners (foreign aid and external borrowing), local revenue generation from natural resources, and resulting inequalities, which could be focal points for contemporary research.

Figure 4 illustrates a Network visualisation of knowledge dynamics from 2010 to February 2024. Keywords are nodes, and co-occurring words form edges, with link weight indicating the frequency of occurrence together. Research evolution shifts from traditional areas like multi-level government and fiscal decentralisation policy to economic development outcomes, encompassing poverty, inequality, fiscal disparities, the flypaper effect, the environment, and sustainable use of natural resources for local revenue generation.

Figure 2-3: Overlay Network Visualisation of Keywords of the 72 eligible articles

The Keywords Network Analysis

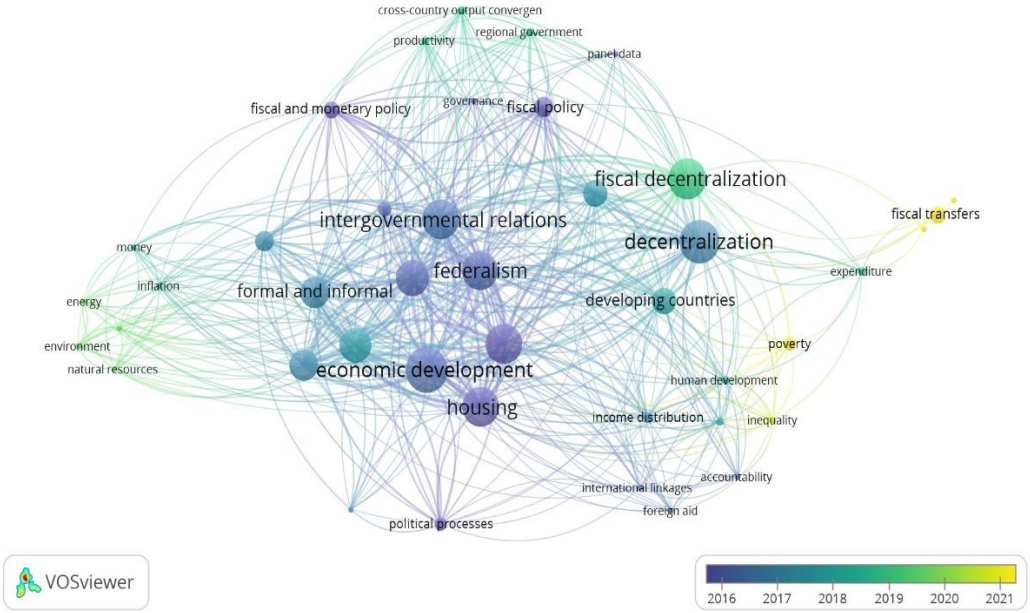


FIGURE 2.3: OVERLAY NETWORK VISUALISATIONS OF KEYWORDS

Source: Authors' elaboration

Figure 2-3: Overlay Network Visualisation of Keywords from the 72 eligible articles. Showing the modularity classes and the evolution of research in fiscal decentralisation from 2016 – 2021 (from blues to yellow colour)

The keyword co-occurrence network identified four main research themes through modularity-based clustering. The first cluster focuses on social and human development policies in decentralised governance systems of developing countries, encompassing keywords related to accountability, fiscal decentralisation, fiscal disparities, flypaper effect, foreign aid, international linkages, human development, migration, inequality, poverty, and developing countries. The second cluster revolves around economic performance and governance structures in decentralised systems, with keywords related to economic growth, intergovernmental fiscal policy, governance, and regional stability (secession). The third cluster centres on the sustainability of economic development and environmental factors in fiscally

decentralised settings, including keywords related to economic growth, energy, environment, natural resources, institutions, and financial well-being. The fourth cluster focuses on infrastructure and economic governance in fiscally decentralised systems, emphasising political processes, property rights, housing, infrastructure, and the regional economy. This cluster is relevant to fiscal decentralisation as it highlights subnational governments' traditional revenue bases, such as property tax and infrastructure charges (Chen 2021; Fossen et al. 2017)

2.3.2.2 Content analysis, discussion, and research agenda

Despite prior bibliometric analysis, we further refined the selection of the 72 eligible articles to ensure quality and minimise bias. Only articles from Q1 or Q2 journals were chosen, resulting in 40 reviewed articles. Table 1 displays the selected journals and their corresponding number of eligible articles. World Development had the highest number of relevant publications (eight), followed by Emerging Markets Finance and Trade (three each). While other journals contributed fewer articles, their impact and prestige remained high. Their widespread geographical distribution suggests diverse perspectives on decentralisation, enhancing inclusivity, knowledge dissemination, and accessibility to localised insights, thereby reducing bias and promoting nuanced perspectives and cutting-edge information distillation.

TABLE 2-1: DISTRIBUTION OF ARTICLES BY JOURNAL

	Journal	SJR Ranking	SJR Score	H-Index	N = Articles
1	World Development	Q1	2.5	206	8
2	Emerging Markets Finance and Trade	Q1	0.83	51	3
3	Regional Studies	Q1	1.76	134	2
4	Journal of Development Studies	Q1	1.18	100	2
5	Journal of African Economies	Q1	0.83	54	2
6	International Tax and Public Finance	Q2	0.69	52	2
7	Government Information Quarterly	Q1	2.32	123	1
8	American Journal of Agricultural Economics	Q1	2.08	126	1
9	Resources Policy	Q1	1.87	95	1
10	Environment And Planning A	Q1	1.59	146	1
11	Journal of Rural Studies	Q1	1.32	124	1
12	International Public Management Journal	Q1	1.2	53	1
13	Applied Geography	Q1	1.14	119	1

14	Frontiers In Environmental Science	Q1	1.01	61	1
15	Journal of Urban Affairs	Q1	0.98	68	1
16	Social Indicators Research	Q1	0.98	126	1
17	Journal of Public Budgeting Accounting & Financial Management	Q1	0.84	19	1
18	China & World Economy	Q1	0.81	35	1
19	Journal of Public Affairs	Q1	0.56	33	1
20	Journal of South Asian Development	Q1	0.2	16	1
21	Growth and Change	Q2	0.72	61	1
22	Economic Systems	Q2	0.7	49	1
23	International Journal of Public Administration	Q2	0.69	52	1
24	Regional Science Policy and Practice	Q2	0.55	17	1
25	Journal of Business Economics and Management	Q2	0.5	45	1
26	Applied Economics Letters	Q2	0.45	60	1
27	Politikon	Q2	0.45	26	1
28	Journal of the Asia Pacific Economy	Q2	0.29	34	1

This study centred on decentralisation in developing countries. The document search process retrieved articles from diverse developing country contexts: Africa (8), Asia (22, with China leading with 13 articles), Europe (2), North America (1), and South America (2). Despite many African nations being labelled as less developed or lower-middle-income, research on fiscal decentralisation often neglects the African context. Regarding article quality, Figure 5 indicates a predominance of publications from Q1 Journals in the selection, affirming the minimisation of bias risk and the inclusion of only high-quality articles.

Figure 2-4: Regional distribution of publications and their rankings

The regional distribution (contextual) of articles among journals and by rankings

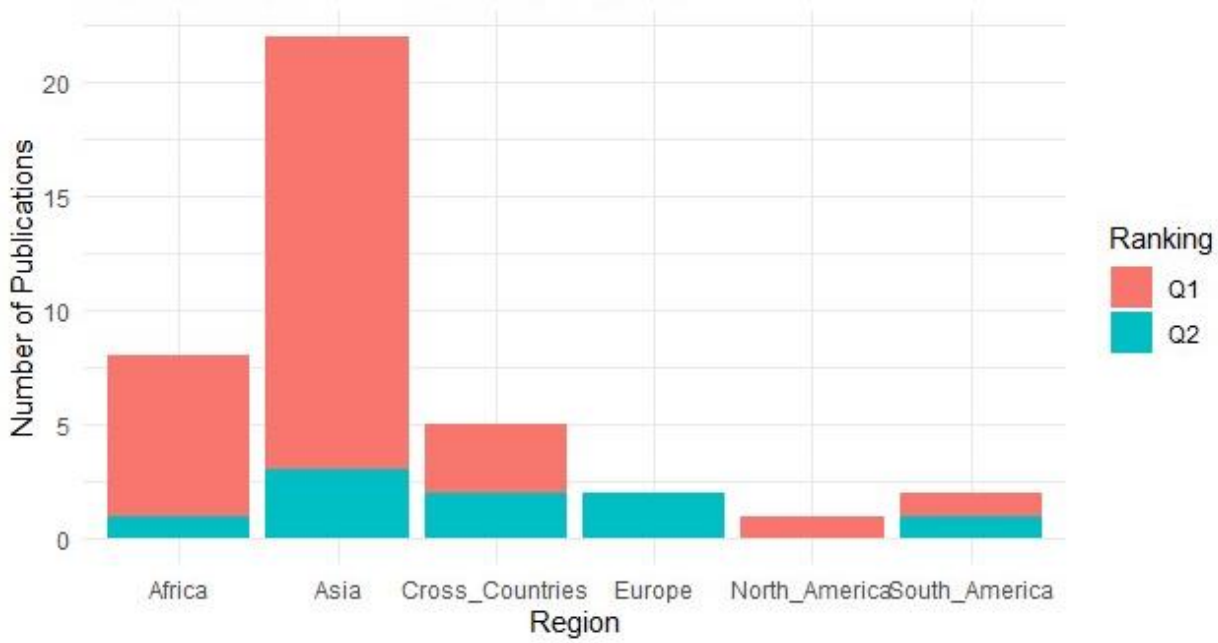


FIGURE 2.4: REGIONAL DISTRIBUTION OF PUBLICATIONS AND RANKINGS

2.3.4. Results of individual studies and discussions

After synthesising studies by reading full articles and extracting data on fiscal decentralisation, geographical context, results, and central thesis, we grouped them into six thematic areas. These areas discuss research gaps and propose future research agendas. The first focuses on regional economic growth, disparities, and convergence. The second centres on fiscal relations between national and subnational governments, mainly resourcing subnational levels for public goods delivery. The third emphasises fiscal decentralisation, environment, and natural resources; the fourth on fiscal decentralisation and spatial dependence; the fifth on fiscal decentralisation, poverty, and inequalities. Lastly, the sixth theme examines fiscal decentralisation and the effectiveness of foreign aid (official development assistance).

2.3.4.1. Fiscal decentralisation on economic growth, regional disparities, and convergence.

This sub-theme examines the effects of fiscal decentralisation on regional economic growth, disparities, and fiscal policy efficacy. Among seven studies focusing on economic development, five are Asia-specific (Ong et al. 2023; Jalil et al. 2014; Yang 2019; Shanmugam and Rangasamy 2024; Hanif and Gago-de Santos 2017), one is cross-country (Im 2010), and one compares China and India (Jin and Rider 2022). The Findings vary, whereby some report a positive relationship (Hanif and Gago-de Santos 2017; Jalil et al. 2014), others a negative correlation (Shanmugam and Rangasamy 2024; Im 2010), and some find no link (Jin and Rider 2022). The authors suggest this correlation's dependency on temporal and developmental

factors. The impact of fiscal decentralisation on economic growth varies across regions, with some experiencing faster growth.

The impact of fiscal decentralisation (FD) on economic growth (EG) varies based on temporal effects, decentralisation tools used (fiscal transfers vs. own-source revenue), and contextual factors like geography and development levels. Studies by Ong et al. (2023) in China and Shanmugam (2024) in India suggest that the influence of fiscal transfers on growth, inequality, and convergence depends on the geographical location of subnational governments, implying club growth and convergence. Moreover, fiscal federalism emphasises subnational revenue autonomy for regional economic growth, enhancing efficiency, accountability, and fiscal responsibility. However, in developing countries, subnational governments need help to generate sufficient revenue for public investment, relying heavily on central government transfers, as seen in South Africa (Hendriks 2017). Yang (2019) examined the relationship between fiscal decentralisation, economic growth, and local revenue generation and the increasing variance in adopting fiscal decentralisation in Chinese cities. The study reveals that tax bases and fiscal capacities are spatially differentiated and depend on several factors, including the predominant sectors and nature of business ownership. Other factors include the efficiency of governance (Zhang and Chen 2014) and the levels of subnational adoption of ICT (e-government) to reduce fiscal deficits (Yan and Lyu 2023). Enhancing subnational fiscal autonomy requires policy standardisation, capacity building, and national government and partner support (Kaye-Essien 2021). Table 2 summarises empirical findings on fiscal decentralisation's impact on economic growth.

TABLE 3-2: EMPIRICAL FINDINGS ON THE RELATIONSHIP BETWEEN FISCAL DECENTRALISATION AND ECONOMIC GROWTH

Author	Methodology	Context	Main Result
(2023)Ong, K.; Matthews, K.; Wang, B. (2023)	Panel vector auto-regressions (PVARs)	China (1994 - 2018)	The effect of FD (fiscal transfers) on growth and inequality depends on geography.
Jalil, Abdul; Feridun, Mete; Sawhney, Bansi L. (2014)	Autoregressive distributed lag bounds tests and pooled mean group estimators	China (1979-2009)	A positive relationship between FD and economic growth in both the short run and the long run

Shanmugam, K; Rangasamy, Shanmugam K. (2024)	Standard growth convergence model for panel data	India (2005-2019)	Fiscal transfers contribute to growth and geographically differentiated convergence.
Hanif, Imran; Gago-de Santos, Pilar (2017)	vector error correction model (ECM)	Pakistan (1972-2010)	A positive correlation between FD and private savings, and economic growth
Im, T. 2010	Random effect model	Cross-countries (1960 - 2007)	A negative relationship between FD and GDP growth depends on the development level of a country.
Jin, Yinghua; Rider, Mark (2022)	Two-step generalised method of moments (GMM) simultaneous equations models	China and India (1985 - 2005)	Expenditure decentralisation does not affect short-run economic growth.
Yang, Shiming (2019)	mixed-method approach	China	FD adoption, efficiency and growth depend on local contexts, such as economic structures.

Research gaps:

The geographical generalisability is limited as most studies mainly focus on the Asian region, with limited representation from other areas such as Africa, Latin America, or Eastern Europe. This raises questions about understanding the impact of fiscal decentralisation on economic growth and regional disparities across different geographical, financial, governance, and cultural contexts. Furthermore, the literature indicates that the effects of fiscal decentralisation on economic growth differ across regions, highlighting the need for research that explores the underlying factors causing this heterogeneity and its implications for policymaking.

Literature highlights the significance of fiscal tools in fostering economic growth and convergence, yet further research remains necessary. Investigating the effects of fiscal decentralisation instruments, such as fiscal transfers versus own-source revenue, on economic outcomes requires addressing challenges related to revenue autonomy at the subnational level. Research aimed at strengthening subnational revenue autonomy and understanding its implications for economic development could bridge this gap.

The literature has referenced spatial dependence and factors affecting fiscal capacities, but spatial dependence itself requires further investigation. Ideas such as the "race to the top" and "race to the bottom," along with revenue capacities, migration trends, and urban clustering, demonstrate interregional spatial dependence. There is observable spatial variation in tax bases and fiscal capacities, driven by factors like dominant sectors, business ownership, and governance effectiveness. Researchers can examine these interactions and their influence on regional economic outcomes.

2.3.4.2. Intergovernmental fiscal relations (IGFR) and local governance

This sub-theme focused on intergovernmental fiscal relations (IGFR) in developing countries, public finance management, and the delivery of responsive public goods. IGFR involves sharing and managing revenue and expenditure competencies vertically and horizontally. In decentralised systems, this includes clarifying expenditure assignment and revenue competencies, resolving vertical imbalances, and addressing horizontal imbalances (Fjeldstad 2001). With fair regional representation, ten articles discuss intergovernmental relations in developing countries. Four focus on single African countries (Hendriks 2017; Caldeira and Rota-Graziosi 2014; Khan et al. 2017; Caldeira and Rota-Graziosi 2014), three on Asian countries (Martinez-Vazquez and Vulovic 2017), one on Europe (Alexeev and Chernyavskiy 2018), one South America (von Haldenwang et al. 2014), and one is a cross-country (Thornton and Adedeji 2010).

Expenditure Assignment:

The articles reviewed did not expressly discuss or allude to the vital role of assigning competencies between the central and subnational governments.

Research gaps:

The research has yet to explore how government functions are assigned between national and subnational levels and their impact on economic growth, poverty reduction, and inequality. Understanding vertical imbalances and their effects on service delivery and financial outcomes is crucial, given their tendency to burden subnational governments with unfunded mandates. The practical application of fiscal federalism theory often needs to be revised to account for assumptions of efficient resource allocation due to factors like capital and labour mobility, communal resource ownership, and vertical imbalances. Investigating concurrent, exclusive, or shared functions between national and subnational levels is essential to uncover challenges and implications for effective governance. Moreover, although the theory has

explored decentralisation's impact on economic stability, understanding practical fiscal perversity and subnational government borrowing roles in stability across diverse contexts still needs to be improved. Further research can delve into how subnational fiscal decisions can destabilise economies and the efficacy of fiscal regulations in debt management. Investigating fiscal decentralisation's link to economic stability, factoring in vertical fiscal imbalances and tax base disparities, is essential.

Revenue Assignment:

Revenue assignment is a vital aspect of intergovernmental fiscal relations (IGFR), comprising four primary elements: the assignment of tax powers for respective levels of government, vertical sharing of revenue between the levels, and horizontal redistribution of shared revenue among decentralised governments (Gurumurthi 1998; Keen 1998; Shome 2021), and clarifying borrowing responsibilities. It is widely acknowledged in fiscal federalism that finance follows functions, which signifies a classification of objectives (Rodriguez-Pose and Vidal-Bover 2022; Bykov and Zimmermann 2018). Revenue assignment should align with expenditure assignment: allocative, stabilisation, and distributive (Boadway et al. 1994; Shah 1994). Although the assignment of revenue and expenditure is heterogeneous, authors such as Broadway et al. (1994) propose revenue assignment principles, emphasising market efficiency, national equity, cost-effectiveness, and fiscal requirements. They suggest centralising taxes on mobile factors for efficiency and progressive taxes for equity, while subnational governments focus on immovable tax bases like property tax. Aligning tax structures with the most informed level of government ensures efficiency, while fiscal accountability mandates matching revenue sources with specific policy objectives.

In the literature reviewed, we note interesting insights from developing countries' subnational governments raising revenue from natural resources (Perez-Sebastian and Raveh 2016; Li et al. 2022) and how to leverage decentralised finance to spur environmental sustainability (Wang et al. 2022). In fiscal federalism, subnational governments excel at levying natural resource taxes due to their proximity and informational advantage. This enables them to understand and manage the environmental impact of resource extraction, aligning with fiscal necessity.

Subnational government borrowing reduces fiscal deficits, funds capital investment, and ensures intergenerational equity (Martinez-Vazquez and Vulovic 2017). However, none of the reviewed articles addressed this topic despite its significance. Subnational borrowing's

theoretical merits are recognised, but its practical challenges remain, particularly in developing countries with weak institutions.

Vertical imbalance arises when subnational governments lack sufficient Own Source Revenue (OSR) to cover their expenditure responsibilities, forcing reliance on central government transfers for service delivery, thus weakening accountability (Hendriks 2017). Developing nations face this imbalance, hindering allocative efficiency and perpetuating dependence on higher-level grants. Addressing vertical imbalance requires a transparent revenue-sharing system to ensure predictability and accountability in fiscal decentralisation discussions. Moreover, subnational governments typically pursue fiscal consolidations through a multi-thronged approach, including reducing their capital spending, increasing their own-source revenues (Thornton and Adedeji 2010), or fiscal transfers from the central government (Sarmah and Panda 2023).

Research gaps.

Literature synthesis highlights several knowledge gaps. First, there needs to be more discussion on subnational borrowing in developing countries despite its significance in fiscal management. Understanding its challenges is crucial, especially in contexts with weak institutions. Second, there is a need for research on how vertical imbalance affects economic outcomes and dependency on higher-level grants, informing transparent revenue-sharing frameworks. Third, a gap exists in applying revenue assignment principles like efficiency and equity, particularly in diverse contexts and regarding natural resource taxation. Finally, research on the effectiveness of fiscal consolidation strategies in achieving sustainability and economic development in developing countries needs to be included.

Equalisation:

It is never in doubt that, in developing countries, fiscal capacities (tax bases and resource capacities) and fiscal needs are heterogeneous and differ geographically, hierarchically in multi-level governments, and horizontally among the lowest subnational levels (Duc Hong Vo et al. 2021). For example, a study on intergovernmental transfers in India's North Eastern (NE) states (1991-2019) found that isolated or marginalised regions heavily rely on central fiscal transfers (Sarmah and Panda, 2023). While such transfers reduce the own-source revenue disparity, significant overall resource-based disparity remains. Designing a fiscal equalisation grants framework in this complexity is challenging, as political imperatives often dictate uniform treatment even among the most unequal subnational entities, and sometimes, historical

development policies and marginalisation between regions and population groups may further complicate this pursuit. For example, a study using data from 1997-2009 indicates that in Senegal, political considerations and patronage, rather than equity, influenced intergovernmental horizontal distribution, undermining the dictates of normative theory on equalisation (Caldeira 2012).

In developing countries, fiscal capacities and needs vary widely geographically, hierarchically, and among subnational levels (Duc Hong Vo et al. 2021; Sarmah and Panda 2023). Crafting equitable fiscal equalisation grants is complex due to political pressures and historical marginalisation, as seen in Senegal, where political considerations often override equity principles in intergovernmental distribution (Caldeira, 2012).

Research gaps.

Developing effective fiscal equalisation in countries with significant regional disparities requires further study. Despite efforts to address revenue gaps through central transfers, substantial disparities persist, complicated by political imperatives and historical policies. Political factors often lead to unequal treatment among subnational entities, undermining equitable allocation. Therefore, research is crucial to develop robust fiscal equalisation frameworks that promote fair resource distribution, especially in marginalised regions.

2.3.4.3. Fiscal decentralisation, environment, and natural resources

The keyword analysis and article review highlighted environment and natural resources as themes in fiscal decentralisation. Prioritising sustainable management aligns decision-making with local needs, fostering efficient resource allocation and accountability. Local governments can leverage environmental assets for economic growth (Akita et al. 2021; Wang et al. 2022). Wang (2022) shows how ecological regulation can drive green development in decentralised setups. Conversely, other studies reveal a negative link between fiscal decentralisation and resource-driven growth (Perez-Sebastian and Raveh 2016; Li et al. 2022).

Research gaps.

The reviewed articles identify several research gaps. Firstly, while some studies focus on fiscal decentralisation's impact on environmental sustainability, further research is necessary to fully understand this relationship, including community-driven approaches and decision-making alignment. Secondly, more investigation is needed on the connection between natural resource abundance, fiscal decentralisation, and economic growth, especially in decentralised countries of the Global South. Thirdly, the role of technological innovations in reducing adverse

effects on economic growth requires additional exploration. Fourthly, grasping how fiscal decentralisation influences shared resource management is essential for promoting sustainable development and effective resource allocation.

2.3.4.4 Fiscal decentralisation and spatial dependence

Spatial dependence influences regional development policies due to the potential spatial spillovers and feedback effects of neighbouring regions' conditions. Fiscal decentralisation policies must consider spatial dependence to optimise economic growth, minimise inequality, and enhance natural resource sustainability. This is based on economic interdependence, fiscal transfer interdependence, mobility of factors, risk sharing, and policy coordination (Vincent and Osei Kwadwo 2022; Chen 2021; Fossen et al. 2017). Table 3 shows the findings of the articles reviewed.

TABLE 2-4: FISCAL DECENTRALISATION AND SPATIAL DEPENDENCE FINDINGS

Authors	Methodology	Focus	Main finding
Fossen, Frank M.; Mergele, Lukas; Pardo, Nicolas (2017)	Spatial econometrics (Panel data: 2000 to 2010)	Spatial expenditure interactions, Commodity price shocks	Spatial interactions in total local public expenditures are insignificant (no race to the bottom).
Chen, Longjin 2021	SFA, Spatial Dynamic Panel Model (Panel data: 1978 -2007)	Spatial interactions of Tax policy	Corporate Income Tax enforcement efficiency is interdependent among Chinese provinces.
Vincent, Rose Camille; Osei Kwadwo, Victor (2022)	Static and dynamic Spatial Durbin models (Panel data: 2003 - 2015)	Spillovers of fiscal grants	A significant existence of ethno-spatial interdependence and positive spillovers in local government expenditure

Research gaps.

We identified research gaps in understanding spatial dependence in fiscal decentralisation across different contexts. Few studies focus on the role of spatial dynamics in enhancing economic growth and resource sustainability, particularly in the Global South. Moreover, only some examine the policy implications of spatial dependence, highlighting the

need for further research into its impact on fiscal policy design and effectiveness in addressing regional disparities.

2.3.4.5 Fiscal decentralisation, poverty and inequalities, service delivery and welfare.

The literature revealed the multifaceted nature of poverty and inequality (Hernandez-Trillo 2016; Sanogo 2019; Rogers 2014; Tang et al. 2024; Huang et al. 2017; Kalirajan and Otsuka 2012)Various dimensions, including social, economic, geographical, and institutional factors, shape the discourse on poverty and inequality in the context of fiscal decentralisation. However, the impact of fiscal decentralisation on poverty has mixed results. While some studies suggest fiscal decentralisation can alleviate poverty and inequality, others caution against poorly designed programmes exacerbating these issues. Understanding subnational governments' capacity is crucial for determining effective decentralisation strategies. Moreover, the literature did not comprehensively address the question of fiscal decentralisation's effect on regional growth and convergence, despite fiscal federalism and new economic geography theories predicting this crucial role. The impact of fiscal decentralisation on citizens' welfare, including improvement in health outcomes, was under-explored.

Research gaps.

The research literature highlights mixed findings on fiscal decentralisation's impact on poverty and inequality. While some studies suggest its potential to reduce them, others warn of negative consequences from poorly designed programs. Further research should clarify these discrepancies and identify conditions for effective poverty reduction and inequality mitigation. Limited focus exists on fiscal decentralisation's direct and indirect effects on poverty and inequality. Only some articles explicitly address these themes, indicating a gap in understanding their relationship. Existing studies often examine specific dimensions of poverty and inequality, needing a comprehensive approach. More integrated research is required to explore how fiscal decentralisation interacts with various factors to shape development outcomes, including economic growth and development, health outcomes improvement and citizens' general economic welfare.

2.3.4.6 Fiscal decentralisation and foreign aid effectiveness (official development assistance)

The bibliometric and content analyses identified foreign aid's role in fiscally decentralised contexts. Recent papers underscore a growing interest in international relations within fiscal decentralisation research. Lessmann et al. (2016) found a negative link between fiscal decentralisation and foreign aid effectiveness across 53 developing nations, noting

institutions' mediating role. Khan et al. (2017) corroborated the role of institutions in aid effectiveness in Ethiopia, noting improved aid effectiveness through upward accountability and citizen participation in decentralised governance. On the other hand, Kaye-Essien's (2021) study in Ghana revealed a positive correlation between official development assistance and enhanced fiscal capacity in decentralised regions, mainly through technical assistance fostering more significant revenue generation. These studies underscore the conflicting results of the role of foreign aid in fiscal decentralisation.

Research gaps.

Significant gaps persist despite recent research on foreign aid in fiscally decentralised countries. While studies have established a negative correlation between fiscal decentralisation and aid effectiveness, the precise mechanisms still need clarification. Institutional quality and intergovernmental competition also play roles, but further investigation is required. Comparative studies across diverse contexts are necessary to identify context-specific factors influencing aid effects in decentralised settings.

2.3.5. Conclusion and Research Agenda

Despite ongoing interest in the effects of fiscal decentralisation on regional economic growth, convergence, and development outcomes such as poverty and inequality reduction, there has not yet been a comprehensive systematic review of the literature since 2010. Research has been spread across multiple disciplines and sectors, especially in developing countries, yet knowledge gaps persist. Additionally, the group of developing countries is diverse, with research primarily focusing on Asian nations such as China, India, Indonesia, and Vietnam, while Africa, home to most developing countries, remains underrepresented. We conducted a systematic literature review to provide insights into how decentralisation fiscal policies influence regional economic dynamics and to guide optimal resource allocation strategies for sustainable public finance management and reducing poverty and inequality. Specifically, we summarise existing research on the effects of intergovernmental fiscal transfers and revenue autonomy on regional growth, convergence, and economic development. This was done within six thematic areas: a) Fiscal decentralisation, economic growth, regional disparities, and convergence. In the context of developing countries, this theme gathered evidence on the impact of fiscal decentralisation on economic development and convergence. b) Intergovernmental fiscal relations (IGFR) and local governance. This theme examined principles and experiences in allocating expenditure (functions) and revenue sharing, including fiscal transfers and revenue bases between national and subnational governments, along with equalisation. c) Fiscal

decentralisation, environment, and natural resources. This emerging area of research focuses on sustainable development. d) Fiscal decentralisation and spatial dependence. e) Fiscal decentralisation, poverty, and inequalities. This key theme centres on fiscal decentralisation policies, illustrating experiences across developing countries. f) Fiscal decentralisation and the effectiveness of foreign aid (official development assistance). This evolving theme was identified through keyword co-occurrence and content analysis as a frontier area of research in fiscal decentralisation within developing nations. Furthermore, we identified research gaps in how various fiscal transfer levels, such as grants, revenue sharing, and own revenue generation, influence fiscal relations between centre and subnational units. We also evaluated the effectiveness of different mechanisms in fostering growth and convergence, grouping findings by thematic areas to benefit researchers and policymakers. Additionally, we characterised the evolving research landscape on fiscal decentralisation, offering insights into regional development convergence or divergence. Lastly, we proposed research agendas to address knowledge gaps relating to the impact of fiscal transfers and local revenue on regional development and convergence in the subnational entities of developing countries, again organised according to thematic areas.

The novelty of this literature lies in the integrative and comprehensive synthesis and analysis of existing literature on fiscal decentralisation in developing countries since 2010, which has not been conducted systematically. By addressing fragmented research and identifying gaps, the study offers a consolidated overview of the impacts of fiscal decentralisation on regional economic growth and development, thereby enriching the existing body of knowledge on this subject. Furthermore, the study proposes research agendas for fellow researchers and policymakers across various thematic areas, suggesting directions for future research to explore and build upon to achieve sustainable development goals such as poverty reduction, decreased inequality, decent work and economic growth, among other social welfare objectives.

CHAPTER THREE: METHODOLOGY

3.1. Introduction

This section explains the empirical methodology and data. The section also discusses the strategy for estimating economic convergence.

Spatial econometric analysis usually involves two steps: exploratory spatial data analysis (ESDA) and confirmatory spatial data analysis (CSDA). The ESDA stage offers empirical proof of the existence and structure of spatial autocorrelation, along with local measures such as Local Moran's I (Anselin, 1995) and the Local Getis–Ord G (Ord & Getis, 1995). These indicators are often supported by visual techniques like choropleth maps, Moran scatterplots, and cluster maps (Cliff & Ord, 1981; Anselin, 1988). Meanwhile, confirmatory spatial data analysis (CSDA) moves beyond exploration by formally testing, defining, and estimating spatial processes within a spatial econometric framework. By directly incorporating spatial effects into the model, CSDA allows for rigorous hypothesis testing about the' size, direction, and statistical significance of spatial spillovers. This is achieved using spatial econometric models (Anselin, 1988; LeSage & Pace, 2009; Elhorst, 2014). It connects descriptive detection with causal inference, ensuring consistent parameter estimation and a theoretically grounded understanding of spatial interdependence (Arbia, 2006).

3.2. Exploratory Spatial Data Analysis (ESDA)

Exploratory Spatial Data Analysis (ESDA) serves multiple interconnected objectives: to detect and describe underlying spatial structures, to characterise and visualise geographical distributions, to explore spatial dependence, to measure spatial heterogeneity, and to identify atypical or influential observations (Anselin 1996; Anselin et al. 2006; Unwin 1996; Unwin and Unwin 1998). ESDA forms the initial phase of spatial econometric research by extending traditional exploratory data analysis principles into the spatial context. It focuses on detecting spatial dependence, heterogeneity, and clustering. Consequently, ESDA's aim in this study is threefold: a) to characterise the spatial distribution of the variables of interest through visual and statistical diagnostics, b) to identify overarching patterns of spatial autocorrelation, and c) to uncover local spatial regimes and outliers. ESDA systematically provides empirical justification for using spatial panel models instead of conventional non-spatial regressions.

ESDA employs statistical and graphical tools to detect and visualise spatial dependence and heterogeneity. These tools are broadly categorised into global measures of spatial autocorrelation, local indicators of spatial association, and visualisation techniques.

3.2.1. Global Measures of Spatial Autocorrelation

Global measures provide a summary statistic describing the degree of spatial association across the study area. They test the null hypothesis of spatial randomness, i.e., that the location of attribute values is independent of spatial arrangement. The commonly used global measures include Moran's I (Moran 1950), Geary's C (Geary 1954), and the Getis–Ord Gi* statistic (Getis and Ord 1992).

3.2.1.1. Moran's I

Moran's I is the most widely used global indicator of spatial autocorrelation (Moran 1950). It measures the correlation between a variable's values and the spatially weighted average of neighbouring values, ranging from -1 (perfect dispersion) to +1 (perfect clustering), with values near zero indicating spatial randomness.

We tested for spatial autocorrelation using the Moran test for all the empirical studies. The Moran I test is a standard tool used in spatial statistics and spatial econometrics to detect spatial autocorrelation, which is the correlation of a variable with itself through space (Kelejian and Prucha 2001). The statistic ranges from -1 to 1. Positive values indicate positive spatial autocorrelation (similar values clustered together), negative values indicate negative spatial autocorrelation (dissimilar values clustered together), and values around zero indicate no spatial autocorrelation. The p-values indicate the probability of observing the Moran I statistic (or one more extreme) under the null hypothesis of spatial randomness. Lower *P*-values suggest more robust evidence against the null hypothesis.

$$I = \frac{N}{W}\frac{\sum_{t=1}^{N}\sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}(y_{it}-\bar{y})(y_{jt}-\bar{y})}{\sum_{t=1}^{T}\sum_{i=1}^{N}(y_{it}-\bar{y})^2} \ldots . (3.1)$$

where $W = \sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}$ is the sum of all elements in the spatial weight matrix W; $\sum_{t=1}^{T}$, the summation of the periods; $\sum_{i=1}^{N}\sum_{J=1}^{N}$, the summation of the spatial entities; w_{ij}, the spatial relationship between entities i and j; $(y_{it}-\bar{y})$, the deviation of y_{ij} from the mean; and $(y_{jt}-\bar{y})$, the deviation of y_{jt} from the mean.

3.1.1.2. Geary's C

Geary's C differs from Moran's I by emphasising differences in attribute values between pairs of neighbouring observations rather than overall covariance (Geary 1954). Its values range between 0 and 2, where values below 1 indicate positive spatial autocorrelation (similar neighbours) and values above 1 indicate negative spatial autocorrelation (dissimilar neighbours).

3.2.1.2. Getis–Ord G Statistic

The Getis–Ord G and G^* statistic detects the extent to which high or low values are spatially concentrated across the study area. Unlike Moran's I, which considers both positive and negative spatial association, the Getis–Ord statistic is particularly suited for identifying clustering of extreme values (Getis and Ord 1992) .

3.2.2. Local Measures of Spatial Autocorrelation (LISA)

While global indices give an overall measure, they may obscure local variations in spatial dependence. Local Indicators of Spatial Association (LISA) enables the detection of local spatial clusters and outliers (Anselin 1995). These local statistics are crucial for identifying spatial heterogeneity, i.e., the non-stationarity of spatial processes, which often leads to spatially explicit econometric models. They include Local Moran's I and Local Getis-Ord Gi*.

3.2.2.1. Local Moran's I

The local version of Moran's I breaks down the global Moran's I statistic into contributions from each spatial unit. It shows whether an observation belongs to a spatial cluster (high–high, low–low) or an outlier (high–low, low–high) (Anselin 1995).

3.2.2.2 Local Getis-Ord G_i^*

The local Getis–Ord Gi* statistic detects statistically significant hotspots (clusters of high values) and coldspots (clusters of low values) (Getis and Ord 1992) . Unlike Local Moran's I, which identifies clusters and outliers, it targets explicitly contiguous zones of spatial concentration.

3.2.3. Visual Tools

Spatial visualisation offers a crucial entry point and an intuitive way to recognise patterns, clusters and outliers. It guides the empirical process by providing understandable representations of spatial processes, starting with basic cartographic methods such as choropleth maps and geovisualisations of raw data (Unwin 1996; Anselin et al. 2006). These visual explorations naturally develop into diagnostic tools like Moran scatter plots and Local Indicators of Spatial Association (LISA) maps, which make spatial autocorrelation and local

clustering easier to interpret (Anselin 1995; Anselin et al. 2006). These exploratory insights are foundational for more formal spatial econometric modelling, including tests for spatial dependence and the development of spatial regression models (LeSage and Pace 2009). Spatial visualisation is thus a methodological link between descriptive mapping and rigorous statistical modelling in ESDA. Visualisation commonly employs choropleth maps, Moran scatter plots, and scatter maps (LISA maps).

3.2.3.1 Choropleth Maps

Choropleth maps are among the most used cartographic tools in ESDA. They are thematic maps where spatial units, such as counties, regions, or districts, are shaded or coloured based on the value of a specific attribute (Griffin, n.d.). By illustrating values across space, choropleths assist in diagnosing the spatial distribution of variables, regional disparities, and spatial outliers. However, choropleths are vulnerable to the modifiable areal unit problem (MAUP) and classification schemes (for example, equal interval, quantile, Jenks natural breaks). Poor classification can hide or amplify patterns of heterogeneity.

3.2.3.2. Moran Scatterplot.

The Moran scatterplot displays standardised variable values on the horizontal axis against their spatial lag (the spatially weighted average of neighbouring values) on the vertical axis (Anselin 1996). The scatterplot is divided into four quadrants corresponding to different types of local spatial association:

a) High-High (HH): A region with high values surrounded by high-value neighbours.
b) Low-Low (LL): A region with low values surrounded by low-value neighbours.
c) High-Low (HL): A high-value region surrounded by low-value neighbours (outlier).
d) Low-High (LH): A low-value region surrounded by high-value neighbours (outlier).

The slope of the regression line fitted to the scatterplot matches the global Moran's I statistic, establishing a direct connection between numerical and visual analysis. Notably, the scatterplot aids in identifying influential observations, local deviations from overall patterns, and potential spatial outliers.

3.2.3.3. Cluster Maps (LISA Maps)

Cluster maps, also referred to in the literature as Local Indicators of Spatial Association (LISA) maps, extend the Moran scatterplot by mapping the geographic locations of statistically significant local autocorrelation (Anselin 1995; Anselin et al. 2006). Like Moran scatterplots, they visually display the following.

a. High-High (HH) clusters: Core areas with high values surrounded by high-value neighbours (hot spots).
b. Low-Low (LL) clusters: Areas with low values surrounded by low-value neighbours (cold spots).
c. High-Low (HL) outliers: Isolated high-value regions in a low-value neighbourhood.
d. Low-High (LH) outliers: Isolated low-value regions in a high-value neighbourhood. Visually display. These maps provide strong evidence of local spatial autocorrelation when used with pseudo-significance levels.

Cluster maps are typically combined with pseudo-significance tests based on permutation procedures (usually 999 or more randomisations of spatial data). This method provides a dependable way to assess whether observed clusters or outliers are statistically meaningful rather than simply the product of random spatial patterns (Anselin 1995). These maps detect spatial clusters and outliers by integrating statistical testing with cartographic presentation. However, the choice of the spatial weights matrix can influence the results.

This study leveraged choropleth maps as an initial diagnostic tool to visualise the spatial distribution of key variables, regional disparities, and potential outliers across counties. To enhance this descriptive overview, LISA cluster maps were employed to identify statistically significant local clusters (high-high and low-low) and spatial outliers (high-low and low-high), thus providing locational detail beyond global measures. Moran's I test was widely applied as a formal statistical measure of global spatial autocorrelation, assessing the extent to which spatial patterns observed deviated from randomness. These tools offered visual insight and statistical rigour, supporting a comprehensive ESDA that informed subsequent spatial econometric modelling.

3.3 Confirmatory Spatial Data Analysis and Econometric Models

This section begins by discussing the baseline non-spatial models. Next, it covers spatiotemporal modelling, including model specifications. Finally, it presents the impact analysis. Owing to the stark disparities in the counties' geographical sizes, we used a contiguity-based (Queens) weights matrix (W) instead of a distance-based weights matrix to capture local spillover effects (LeSage and Pace 2014).

For robustness and guidance in choosing spatial models, we performed the Lagrange Multiplier (LM) test for spatial dependence, following the approach proposed by Anselin (1996).

3.3.1. Non-Spatial Modelling

To ascertain the non-spatial relationship between fiscal decentralisation and the study outcomes (poverty, health, growth, and convergence), we estimated the conventional baseline panel data analysis models: a fixed and random-effects estimator. The baseline non-spatial models are based on various forms of the Ordinary Least Squares (OLS) estimator (including Generalised Least Squares).

Literature demonstrates that while pooled OLS and random-effects estimators can yield identical treatment effect point estimates under certain assumptions, the fixed-effects estimator typically provides different point estimates. Moreover, these estimators differ in their estimated standard errors and variance-covariance matrices, with fixed-effects and random-effects models accounting differently for unobserved heterogeneity (Oaxaca and Dickinson 2016). We conducted the Hausman test to select the appropriate non-spatial model (Baltagi and Liu 2016). A fixed-effects model (Equation 2) assumes that individual-specific characteristics are time-invariant and correlated with the independent variables. In contrast, a random-effects model (Equation 3) assumes that the individual-specific effects are random and uncorrelated with the independent variables. The equations are as follows:

$$y_{it} = \alpha_i + \beta X_{it} + \epsilon_{it}; i = 1 \dots N, t = 1 \dots T, \dots \dots (3.2)$$

$$y_{it} = \alpha + \beta X_{it} + u_i + \epsilon_{it}; i = 1 \dots N, t = 1 \dots T, \dots \dots (3.3)$$

where y_{it} denotes the dependent variable for entity county (i) at a time (t); α, an intercept (subscript i if fixed effect); β, a vector of independent variable coefficients; Xit, the matrix of independent variables for an entity (i) at a time (t); ϵ_{it}, the error term of an entity (i) at a time (t); and u_i, the entity-specific random effect.

3.3.2. Spatial modelling and specifications

Spatial econometric analysis and modelling have gained traction since the recognition of Tobler's First Law of Geography, stating that 'everything is related to everything else, but near things are more related than distant things' (Sui 2004). In response to the realisation that conventional econometrics analysis tools, such as the standard OLS models, do not account for spatial dependence, a myriad of econometricians have proposed and nurtured a strand of

econometrics analysis that incorporates spatial interactions in regional science (Anselin 1988; Anselin et al. 1996; Elhorst 2003).

Following the baseline OLS estimation, spatial Lagrange Multiplier (LM) tests serve as a diagnostic bridge to spatial econometric modelling by detecting and distinguishing different forms of spatial dependence in the residuals. This ensures that spatial effects are empirically justified rather than assumed beforehand. The LM-Lag test assesses the null hypothesis against the alternative of a spatially lagged dependent variable, while the LM-Error test assesses against the alternative of spatial error correlation. Both are score-type statistics based on OLS residuals and are asymptotically distributed as chi-squared. Since the basic LM tests may confound lag and error dependence, robust versions are used: the robust LM-Lag accounts for error autocorrelation, and the robust LM-Error accounts for lag dependence. The decision rule is as follows: if only LM-Lag and robust LM-Lag are significant, Spatial Autoregressive Model (SAR), also known as the Spatial Lag Model (SLM) is preferred; if only LM-Error and robust LM-Error are significant, the spatial error model (SEM) is suitable; and if both robust tests are significant, then a more general model such as SDM/SARAR should be considered, with model simplification guided by likelihood ratio tests or information criteria (Anselin 1988; Anselin et al. 1996).

The SAR/SLM defines spatial dependence through a lagged dependent variable while excluding the spatial lags of the covariates. In this framework, outcomes in a specific region are directly affected by outcomes in its neighbouring regions. Its structural formulation is as follows.

$$y_{it} = \lambda(Wy)_{it} + \sum_k \beta_k X_{kit} + \eta y_{i,t-1} + u_{it} \quad \ldots\ldots (3.4)$$

Where

- y_{it} is the dependent variable for location (i) at a time (t).
- W is the spatial weights matrix.
- $(Wy)_{it}$ is endogenous,
- $\beta_k X_{kit}$ is the matrix of explanatory variables for location (i) at a time (t) with their associated coefficients (β_k),
- $\eta y_{i,t-1}$ is the temporal component, capturing the dependence of the dependent variable for location (i) on its past values
- u_{it} is the composite error term

The Spatial Error Model (SEM), on the other hand, allows the disturbance to follow a spatial autoregressive process, while setting the spatial lag coefficient on the dependent variable to zero. The structural formulation is thus given as;

$$y_{it} = \sum_{k} \beta_k X_{kit} + \eta y_{i,t-1} + u_{it} \ldots\ldots (3.4)$$

With the spatially

$$u_{it} = \rho W u_{it} + \varepsilon_t \ldots\ldots (3.6)$$

$\varepsilon_t \sim (0, \sigma^2 I)$

Whereby;

- $\rho W u_{it}$ is the spatially autocorrelated error component,

Determination of the spatial weights matrix preceded estimation of spatiotemporal econometric models (Elhorst 2014; LeSage and Pace 2009; Anselin 2021; Getis and Aldstadt 2004). The matrix captures spatial autocorrelation, reflecting correlated values between nearby observations, and accounts for spatial heterogeneity, allowing region-specific effects. It also helps analyse spatiotemporal interactions, identifying spatial dependence where shocks or policies in one region affect adjacent areas. We used the Queen's Contiguity criterion to select the spatial weights matrix W, which assigns a value of 1 to regions sharing a border and 0 otherwise, focusing on local spillover effects. Given Kenya's county geography, distance-based weights like K-nearest-neighbour were less efficient (LeSage and Pace 2009). The matrix was row-standardised to ensure equal weight distribution among neighbours by including only first-order neighbours (Queens contiguity) and excluding second-order effects. This simplicity and ability to capture local spillovers aligned with our analysis of how county geography impacts economic performance and convergence.

Spatiotemporal econometric data often exhibit spatial and temporal correlations, leading to unexplained variance when traditional non-spatial panel models are used (Elhorst 2014; LeSage and Pace 2009). To address spatial dependence and potential estimation bias, spatial econometric literature recommends model specifications that explicitly account for spatial interactions within the data (LeSage and Pace 2014; 2009; Elhorst 2003). The Spatial Lag of X (SLX) model is often regarded as an entry point for spatial estimation (Halleck Vega and Elhorst 2015). By including spatially lagged exogenous variables, SLX captures spillover effects transmitted through covariates, but it omits endogenous feedback processes present in

models like Spatial Autoregressive (SAR) or Spatial Durbin Models (SDM). This makes SLX particularly useful for static analysis of local spillovers or as a benchmark model. The model specification of SLX is given in equation 4.1

$$y_{it} = \propto + \sum_{k} \beta_k X_{kit} + \sum_{k} \theta_k (WX_{kt})_i + \eta y_{i,t-1} + u_{it} \quad \ldots . (3.7)$$

Whereby

- $\theta_k WX_{kit}$ capturing the spatial lag of the explanatory variables,

However, when spatial autocorrelation is present in the dependent variable, SLX estimates of local coefficients can be upward-biased due to the omitted spatial lags of the dependent variable. To correct this, the literature recommends the Spatial Durbin Model (SDM), which captures both direct and global spillover effects, or the Spatial Durbin Error Model (SDEM), which accounts for local spillovers transmitted through the error structure spillovers (Furková 2019; LeSage and Pace 2009; Halleck Vega and Elhorst 2015; LeSage and Pace 2014; LeSage 2014; 2014). SDM is most preferable in the literature owing to the aforementioned merits. The SDM equation is given in equation 4.2.

$$y_{it} = \lambda W y_{t,i} + \sum_{k} \beta_k X_{kit} + \sum_{k} \theta_k (WX_{kt})_i + \eta y_{i,t-1} + u_{it} \ldots (3.8)$$

Whereby

- λWy_{it} is the endogenous Cliff-Ord spatial lag component capturing the spatial dependence of the dependent variable for location (i) on neighbouring locations in time (t), where W is the spatial weights matrix.
- u_{it} is potentially simple white noise (no spatial error)

The spatiotemporal Spatial Durbin Model (SDM) can be viewed as an extension of the Spatial Lag of X (SLX) model, augmenting its structure to capture both spatial and temporal dependence in the dependent variable and explanatory variables. It incorporates three key components. First, the endogenous spatial lag term (ρWY) introduces spatially lagged dependent variables, capturing the influence of neighbouring regions' outcomes on the outcome of interest. Second, the spatial Durbin term (θWX) includes spatially lagged independent variables to account for exogenous spillover effects from neighbouring regions' covariates. Third, the temporal lag term incorporates the dependent variable from previous periods, modelling intertemporal persistence and adjustment processes. By integrating these elements,

the spatiotemporal SDM enables the estimation of direct and indirect effects that propagate across space and over time, without relying on a spatially autocorrelated error process.

The dynamic SARAR-SDM is presented in equations 4.3-4.4.

$$y_{it} = \lambda W y_{i,t} + \sum_{k=1}^{K} \beta_k X_{kit} + \sum_{k=1}^{K} \theta_k W X_{kit} + \eta y_{i,t-1} + u_{it} \; ; \ldots\ldots (3.9) \quad and$$

$$u_{it} = \rho W u_{it} + \varepsilon_{it} + v_i \quad \ldots\ldots (3.10)$$

Whereby

- u_{it} is the composite error term
- $\rho W u_{it}$ is the spatially autocorrelated error component,
- εit is the white noise error term
- $v_i \sim N(0, \varphi^2)$ is the random effects component where v_i is the spatial effect for the ith unit, and φ^2 is the variance of these random effects.

Spatial error lags (ρWu) reflect unmeasured regional characteristics or external shocks. Typically, ρ and λ capture different forms of spatial dependence: a positive λ (spatial lag of the dependent variable) suggests positive spillovers, for instance, economic growth in neighbouring counties raises local GCP per capita of the focal county, while a negative λ suggests negative λ indicates competition or a backwash effect. On the other hand, a positive ρ implies unobserved shocks or omitted variables affecting one county positively spill over to neighbouring counties. In contrast, a negative ρ indicates spatial heterogeneity, omitted variables affecting regions in opposing ways, or spatial substitution effects.

3.4. Growth and convergence

We assessed both absolute and conditional convergence in analysing regional economic performance. Absolute convergence posits that regions with lower initial income levels will experience faster economic growth, leading to a uniform steady-state income across all regions. This concept was evaluated by regressing the growth rate of per capita income on its initial level:

$$\frac{1}{T}\log\left(\frac{Y_{i,T}}{Y_{i,0}}\right) = \alpha + \beta \log(Y_{i,0}) + \varepsilon_i \ldots\ldots (3.11)$$

Where

- Yi_0 is the initial Gross County Product per capita (initial GCPpc)
- Y_{iT} is the GCPpc at the end of the period
- T is the length of time
- β is the measure of the speed of convergence.

A negative and significant β indicates convergence, as poorer regions grow faster than richer ones.

Conditional convergence, in contrast, acknowledges that regions may have different steady-state income levels due to varying structural factors such as investment rates, human capital, and fiscal policies. This model tests whether regions converge to their respective steady-state levels by including fiscal and demographic variables that could influence income levels:

$$\text{Growth Rate}_{it} = \alpha + \beta\log(\text{InitialGCP}_{it}) + \gamma_1 X_{1,it} \ldots + \gamma_n X_{n,it} + u_{it} \ldots\ldots\ldots (3.12)$$

Where $X_{1,it} \ldots + X_{n,it}$ are other variables that affect the region's steady-state income levels, and $\gamma_1 \ldots + \gamma_n$ are the coefficients for these variables.

By incorporating these variables, we assessed whether regions converge to their unique steady-state income levels, accounting for economic structure and policy differences. These convergence processes helped evaluate the effectiveness of fiscal decentralisation and regional development policies in promoting equitable economic growth.

Both theoretical and empirical regional growth models suggest that spatial spillovers can drive "spatial club convergence", where regions with similar initial conditions and structural characteristics converge toward the same economic growth rate (Chenglin et al. 2013; Ahmad and Hall 2017). Models like the Spatial Durbin Model (SDM) and Spatial Autoregressive with Autoregressive Disturbances (SARAR) are well-suited for capturing global spillovers, while the Spatial Durbin Error Model (SDEM) model better capture local spillovers (Furková 2019; J. LeSage and Pace, 2009; Halleck Vega and Elhorst, 2015; J. P. LeSage and Pace 2014).

To capture both spatial and temporal persistence, we introduced lagged variables. This distinguishes persistent effects from current variations and addresses spatiotemporal dependencies. A significant lag of the dependent variable ($\eta y_{i,t-1}$) reflects temporal autocorrelation and path dependence relevant to slow-evolving patterns like economic growth. Simultaneity concerns can arise when incorporating spatial lags of the dependent variable (y)

from the same period. However, these can be addressed by a spatiotemporal lag or computing direct, indirect, and total impacts to interpret spatial relationships (Kopczewska et al. 2017). The spatial spillovers and mitigation of simultaneity concerns can also be tested by evaluating the significance of spatial lags of Durbin components for spatially lagged independent variables (Elhorst 2010; 2014; LeSage and Pace 2009).

3.5. Data and description of variables

This study employs spatiotemporal analysis of balanced fiscal and demographic datasets from Kenya. Other data include health indicators from the World Health Organisation's Global Burden of Disease database.[1] Fiscal data was compiled from reports from the Office of the Controller of Budget.[2] Economic indicators (Gross Value Added) were sourced from the Kenya National Bureau of Statistics. Data management and analysis were conducted using packages such as plm, splm, tmap, ggplot2, tidyverse, sp, and spdep, among others, available in the R and R Studio software ecosystem.

The indicators for fiscal decentralisation, including OSR, equitable share, conditional and unconditional grants, capital expenditure (Capex), and operations expenditure (Opex), were normalised at the per capita levels.

3.5.1. Description of variables

The indicators for fiscal decentralisation, including OSR, equitable share, conditional and unconditional grants, capital expenditure (Capex), and operations expenditure (Opex) were normalised at the per capita levels.

3.5.1.1. Poverty

Poverty and inequality are multi-faceted social issues that vary in definitions, measurements, depth, breadth and duration (Kwadzo 2015). Poverty typically refers to a state or condition in which individuals or communities lack the resources and capabilities to meet their basic needs for a decent standard of living. This often includes food and non-food necessities, such as food, shelter, clothing, education and healthcare. Poverty can be measured in various ways, including income levels, access to basic services and overall quality of life. Various approaches to understanding poverty exist in the literature underpinned by the 'monetary, capability, social exclusion, and participatory' milieu (Laderchi et al. 2003). This study will not delve into the measurement debate but will adopt the validated regional statistics

[1] Global Burden of Disease Collaborative Network, Global Burden of Disease Study 2019 (GBD 2019) Results (2020, Institute for Health Metrics and Evaluation – IHME) https://vizhub.healthdata.org/gbd-results/
[2] See reports at https://cob.go.ke/reports/consolidated-county-budget-implementation-review-reports/

as published by the Kenya National Bureau of Statistics, where poverty was measured in tandem with the decomposable poverty measures (Foster et al. 1984), wherefore

$$\boldsymbol{p(\propto) = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{z-yi}{n}\right)^{\alpha} I(yi < z)\ldots\ldots (3.13)}$$

where P denotes the poverty level; N, size of the population; y_i, ith individual welfare level; z, poverty line; α, poverty sensitivity indicator; and I(.), indicator constraint function taking the value 1 when the condition is satisfied and 0 when not satisfied. Please see the report for more information on the computation of the regional poverty values.

3.5.1.2 Health outcomes measurement

The literature defines health outcomes as physical and psychological well-being, considering the length and quality of life. Health outcomes can be categorised into three components: morbidity, mortality, and health development, each represented by specific indicators. No single measure or index adequately encapsulates health outcomes. Consequently, this study constructs indices for mortality, morbidity, health development, and composite health outcomes using Principal Component Analysis (PCA), which transforms correlated health indicators into a smaller set of uncorrelated components representing the underlying dimensions of health outcomes. We used each PCA's first principal component (PC1) as an index representing the underlying latent construct.

The morbidity index was constructed from indicators that include incidence or prevalence of major communicable and non-communicable diseases such as cancer, malaria, HIV, TB, anxiety, depression, and Non-Communicable Diseases (NCDs). The mortality index was constructed from indicators that include crude deaths, infant mortality rate (IMR), under-5 mortality rate (U5MR), maternal mortality and life expectancy at birth (LEB) for both sexes. The health development index combines positive health indicators (LEB for both sexes), reproductive indicators (fertility), mental health (general measure), and child nutrition (stunting). All variables are standardised via z-transformation, thus

$$Z_{it} = \frac{X_{it} - \overline{X_t}}{S_t} \ldots\ldots (3.14)$$

Where X_{it} is the value of indicator i at time t, $\bar{X}_t$ is the mean, and S_t is the standard deviation

The PCA was applied on the scaled indicators, whereby the first principal component (PC1) was extracted as depicted below

$$PC_{1,t} = \sum_{i} \lambda_i Z_{it} \ldots\ldots (3.15)$$

Appropriate sign adjustment was done, for example, since higher mortality values imply worse outcomes (but life expectancy implies better outcomes), the sign of the index is flipped if the mean PCA loading for the LEB variables is positive, ensuring that a higher index value depicts a worse mortality burden.

The Composite Health Outcome Index was constructed using PCA from the three previously constructed indices of Mortality, Morbidity, and Health Development.

3.5.1.3 Measurement of regional economic performance and fiscal decentralisation.

The literature provides various indicators for measuring regional economic performance. Notable indicators are the Regional Gross Value Added (GVA), which measures the value of goods and services produced in a region adjusted for the costs of intermediate inputs (Oguz and Knight 2010; Wosnitza and Walker 2008), and Regional Gross Domestic Product (RGDP), representing the total monetary value of all goods and services produced within a specific region over a specified period. However, the RGDP is preferred for analysing the overall economic performance and size of a region or comparing economic outputs and quality of life between regions or countries (Sánchez et al. 2018). In Kenya, the Gross County Product (GCP) disaggregates the national Gross Domestic Product (GDP) by county, highlighting each county's contribution to the national economy. Equally, fiscal decentralisation is typically measured through revenue and expenditure, providing a comprehensive view of financial autonomy and distribution of fiscal responsibilities among subnational governments.

3.5.1.3.1. Fiscal decentralisation: revenue.

The commonly used fiscal decentralisation metrics in the literature include (a) the share of revenue raised or received by subnational governments as a proportion of general government revenue and (b) the share of subnational government spending as a proportion of general government expenditure (Lin and Liu 2000). These ratios are typically applied in studies conducted in industrialised nations, where fiscal decentralisation often correlates with higher levels of development, effectively functioning as a "superior good" (Martinez-Vazquez and McNab 2003). However, we adapted these traditional ratios in this study, recognising that their relevance might be limited in a developing country like Kenya, which exhibits different institutional and economic structures than those in the Global North. Instead, we employed logged actual subnational per capita revenue and expenditure as more contextually appropriate

measures. This approach acknowledges the relatively homogenous institutional framework within the country, shaped by macroeconomic policies that apply uniformly across regions.

3.5.1.3.2. Fiscal decentralisation: Expenditure

Public expenditure decentralisation is crucial in shaping regional economic growth and convergence. By allowing local governments to tailor spending to the specific needs of their regions, fiscal decentralisation can help reduce regional disparities and promote more balanced economic development (Barro and Sala-i-Martin 1992). The impact of decentralisation is typically examined through two main categories of public expenditure: capital (development) and operational (recurrent) expenditure. Each type of expenditure influences economic outcomes differently, and its effects can vary based on the efficiency of its implementation and the specific context of the regions involved. For instance, Deverajan et al. (1996) proffer that the composition of public expenditure is crucial as there is a threshold beyond which productive (development) public spending does not affect economic growth.

However, it is crucial to note that our analysis excluded the direct expenditures of the national government in the regions (counties). This is because, in Kenya, like in many other developing countries, the national government directly funds significant capital projects through various sector ministries and specialised development agencies. Including this expenditure could distort the analysis of fiscal decentralisation at the county level. Thus, to maintain the focus on subnational fiscal activities, national government spending was netted out, allowing for a more precise assessment of the impact of local revenue and expenditure on economic performance within counties.

3.5.1.3.1.1 Capital (Development) Expenditure (Capex).

Capital expenditure, encompassing long-term investments in infrastructure and physical assets, is crucial for enhancing productivity and economic growth. Decentralising capital expenditure allows local governments to tailor investments to regional needs, potentially improving public spending efficiency. However, the growth impact of decentralised capital investment is not always straightforward, as its success hinges on the subnational governments' capacity to manage and implement projects effectively. Inefficiencies such as delays, misallocation, or cost overruns can reduce the returns on these investments (Keefer and Knack 2007). Moreover, the long gestation periods of many projects delay their growth impact, complicating short-term assessments. In developing countries, weaker local institutions may result in politically driven investments that do not align with regional priorities (Faguet 2004).

Furthermore, spatial dependencies mean inefficient capital allocation in one region can create negative spillover effects, exacerbating regional disparities rather than promoting convergence (Elhorst 2014).

3.5.1.3.2. Operational Expenditure (Opex)

Recurrent expenditure, covering costs like salaries, maintenance, and daily operations, is crucial for running government services. Decentralising this expenditure allows subnational governments to align resources with local needs , improving public service efficiency and fostering economic growth (Martinez-Vazquez and McNab 2003). Its positive impact on sectors like education and healthcare is well-established, where consistent funding drives long-term development (Barro 1991). Decentralised recurrent expenditure can lead to immediate and sustained improvements in economic performance by ensuring essential services are adequately funded and managed locally. It often has a quicker economic impact than capital expenditure.

3.5.1.4. Regional demographic characteristics controls.

We controlled regional demographic characteristics, significantly impacting economic growth and convergence in decentralised fiscal systems. Factors like population dynamics and human capital development influence the effectiveness of decentralised policies and shape regional disparities. Regions with shrinking populations may face economic decline without targeted interventions, while those with strong human capital development can leverage devolution for faster growth and convergence (Rodríguez-Pose and Ezcurra 2010). Population density is also a key determinant of regional performance, with high density driving agglomeration economies that boost productivity through efficient resource use and innovation spillovers. However, congestion and higher costs can diminish these benefits (Ciccone and Hall 1996). Migration flows further affect regional disparities, as in-migration boosts economic activity while out-migration can lead to labour shortages and declining growth (Rodríguez-Pose and Crescenzi 2008). Human capital development, mainly through education, is crucial for regional growth and convergence, as higher transition rates to secondary school indicate a more skilled workforce, attracting investment and innovation (Barro 2001). Local governments' ability to manage education effectively in decentralised systems is critical for the success of devolution, as well-managed educational investments foster human capital growth, reduce regional disparities, and drive economic convergence (Luintel et al. 2020; Matsumoto 2019)

CHAPTER FOUR: EMPIRICAL RESULTS (STUDY 1)

Role of Fiscal Decentralisation in Poverty Reduction: Spatiotemporal Evidence from Kenya's Devolution Framework

(This chapter is based on our published article - Muthama, Wencelaus Musyoka and Gál, Zoltán. (2025). Role of fiscal decentralisation in poverty reduction: spatio-temporal evidence from Kenya's devolution framework. Regional Statistics 15(2):292-320 DOI: 10.15196/RS150205)

4.1. Introduction

The global trends of rising income inequality, poverty rates and regional economic disparities have underscored the urgency of understanding the role of fiscal decentralisation in addressing these pressing challenges. As evidenced by the literature review, a surge in research has focused on unravelling the intricate relation between fiscal decentralisation, poverty alleviation and broader economic development. However, amidst the theoretical debates and empirical studies, there remains a considerable lack of consensus regarding the effectiveness of fiscal decentralisation in reducing poverty and inequality. This ambiguity highlights the critical need for further empirical investigations to inform evidence-based policymaking and address the multifaceted challenges developing nations face. The theoretical perspectives on decentralisation, ranging from redistribution to efficiency, highlight the issue's complexity, necessitating nuanced and context-specific analyses. Furthermore, the empirical evidence, as outlined in the literature review, presents conflicting and inconclusive findings, showing the need for deeper exploration into the mechanisms and impacts of fiscal decentralisation.

Considering the diverse perspectives and mixed results in the literature, there is a compelling motivation to delve deeper into the subject matter. Understanding the implications of fiscal decentralisation on poverty, inequality and regional disparities is important for policymakers and for advancing the global agenda of sustainable development. By conducting rigorous empirical research, we can elucidate the nuanced dynamics at play, identify best practices and pave the way for targeted interventions that promote inclusive growth and equitable development. This research seeks to contribute to the existing body of knowledge by examining the impacts of fiscal decentralisation on poverty reduction, particularly in the context of Kenya's recent experience with devolution. Through spatial econometric techniques and a comprehensive analysis of spatial interdependencies among its 47 counties, this study aims to

provide actionable insights to inform policy formulation, improve governance practices and ultimately contribute to sustainable development goals. The **hypotheses** of the study includes;

a) H2a: Own-source revenue (OSR), equitable share, and conditional grants have heterogeneous effects on poverty reduction across counties
b) H2b: These effects exhibit spatial spillovers and inter-county feedback mechanisms.

4.2. Models and Data

This section presents the data and measurements of the critical variables, exploratory spatial data analysis (ESDA) visualisation and confirmatory spatial data analysis (CSDA) results.

4.2.1. Data

For comparability, this study employs 2019–2021 administrative datasets collected from various state agencies in Kenya, including the Kenya Bureau of Statistics, the National Treasury, the Office of the Controller of Budget and the Commission on Revenue Allocation. Poverty data are typically measured using household surveys. However, these surveys have not been annual and, in some cases, were collected intermittently and with a considerable time lag (in some cases 10 years), which limits research and policymaking by using outdated data. Nevertheless, this research applies the available (2019–2021) Kenya Continuous Household Survey Programme data[3]. It is comparable to other datasets collected in the same period such as the fiscal, demographic and other economic indicators.[4]Fiscal data were collected from administrative data and various reports of the Office of the Controller of Budget. We use MS Excel and the R software packages for data management, visualisation, and analysis. Table 3-1 describes variables and data sources.

TABLE 3-1: VARIABLE DESCRIPTION AND SOURCES OF DATA

#	Variable	Description	Data source
		Dependent Variables	
1	TotalPov	Total (overall poverty)	KNBS[5]
2	ChildPov	Child poverty (0–17 years)	KNBS
3	YouthPov	Youth Poverty (18–35 years)	KNBS
4	AdultPov	Adult Poverty (36–59 years)	KNBS
5	RetireePov	Retiree Poverty (60–69 years)	KNBS
6	SeniorPov	Senior Citizens' Poverty (70+ years)	KNBS

[3] See the Kenya Poverty Report–2021 https://www.knbs.or.ke/download/the-kenya-poverty-report-2021/
[4] See the Economic Survey 2022 https://www.knbs.or.ke/economic-survey-2022/
[5] See https://www.knbs.or.ke/kenya-poverty-reports/

		Fiscal Decentralisation Variables	
7	equit_pc	Equitable share per capita (revenue raised nationally is shared (a) vertically between the National and County Governments and (b) horizontally among county governments using a defined formula.)	OCOB[6]
8	OSR_pc	Own-Source Revenue per capita	OCOB
9	grants_pc	Conditional and unconditional grants per capita	OCOB
10	Capex_pc	Capital (development) expenditure per capita	OCOB
11	Opex_pc	Operations (recurrent) expenditure per capita	OCOB
12	DeceRevPc	Revenue Decentralisation – Autonomy ((Actual OSRpc/Total Revenue pc)*100)	
13	DepeRatio	Fiscal grants dependency (Actual OSR/(Total Revenue – Actual OSR)*100)	
		Control Variables-Regional Characteristics	
14	GCPpc	Economic-Gross County Product per capita (2016)	KNBS[7]
15	Transrate	Demographic-Secondary School transition rate	KNBS[8]

4.2.2. Spatial distribution of fiscal decentralisation

The overall poverty distribution is shown in Figure 3-1, while disparities in county population and land size are noted, as illustrated in Appendix A.

[6]See fiscal reports at https://cob.go.ke/reports/consolidated-county-budget-implementation-review-reports/

[7] See report at https://www.knbs.or.ke/wp-content/uploads/2024/05/Gross-County-Product-2023-min.pdf

[8] See Statistical Abstract at https://www.knbs.or.ke/wp-content/uploads/2023/09/2022-Statistical-Abstract.pdf

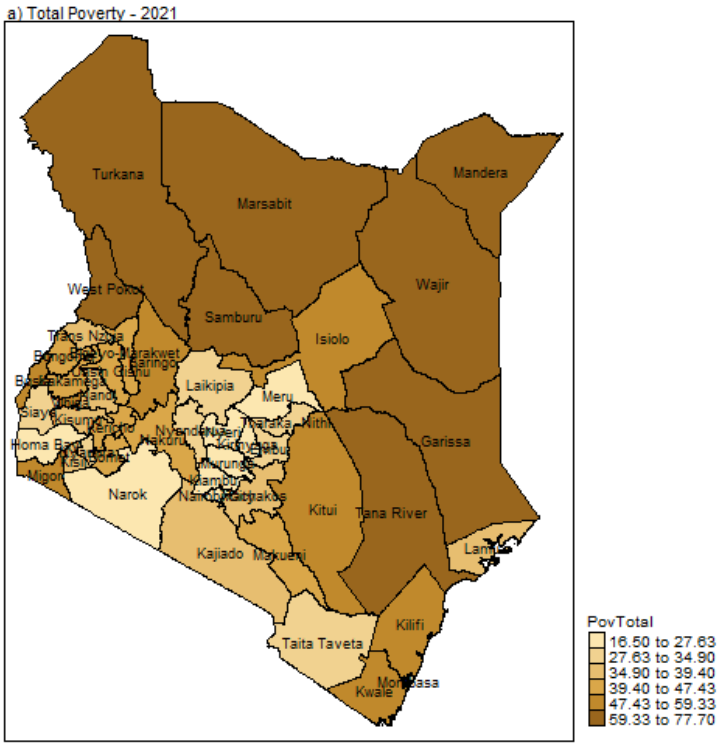


FIGURE 4-1: CHOROPLETH MAP OF POVERTY DISTRIBUTION -2021

Figure 4-2: Choropleth map of the poverty distribution in the Countries of Kenya (2021).

Overall, poverty, measured based on household consumption, is spatially distributed with huge disparities. Nairobi, Kenya's commercial and capital city, has the lowest poverty rate (16.7) and other counties in central Kenya such as Kirinyaga, Kiambu, Narok, Meru and Nyeri. The counties with the highest poverty rates are in the Arid and Semi-Arid lands (ASAL) in northern Kenya, such as Marsabit, Wajir, West Pokot, Samburu, Garissa, Tana River, Mandera, and Turkana.

4.3. ESDA

The choropleth maps are used to visualise the geospatial clustering or observations.

4.3.1.1 Geospatial clustering of poverty and fiscal decentralisation

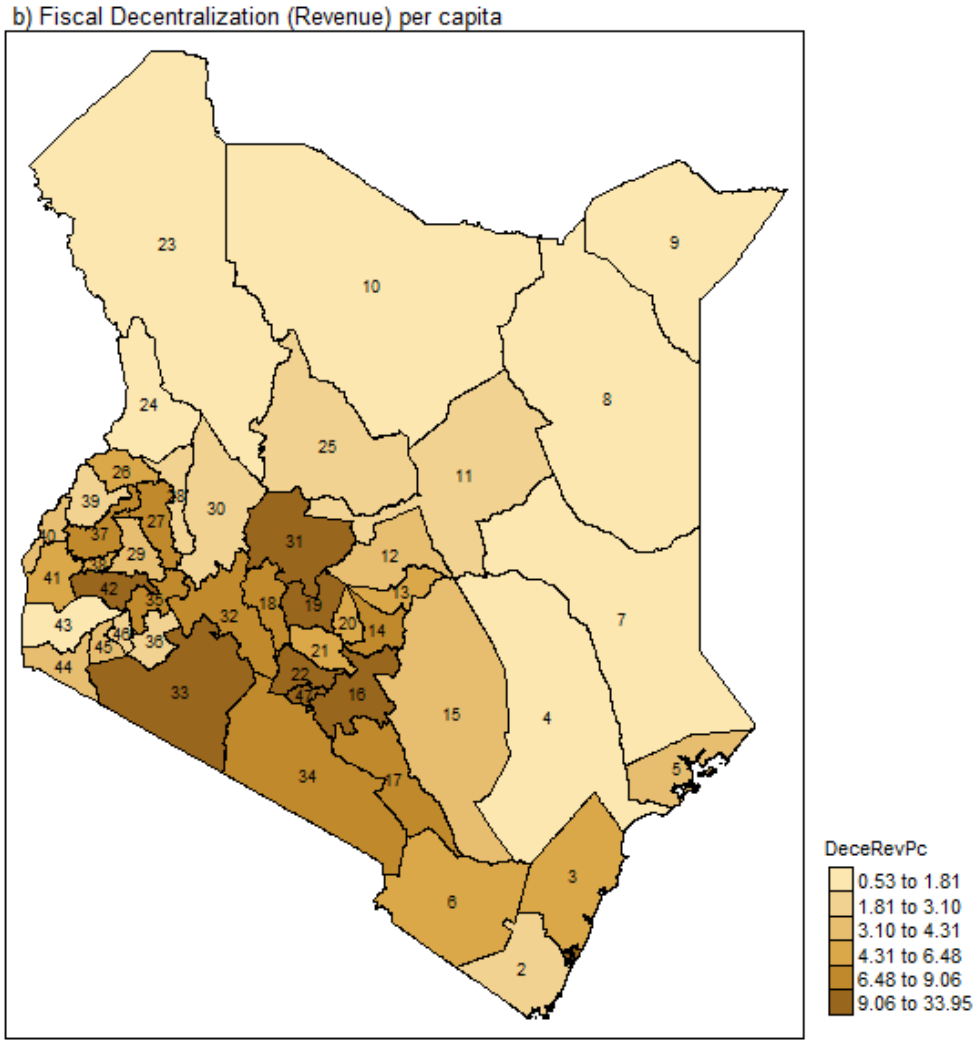


FIGURE 4-2: SPATIAL DISTRIBUTION OF FISCAL DECENTRALISATION (REVENUE) IN KENYA

Figure 4-2: Spatial distribution of fiscal decentralisation (revenue) in Kenya (2021)

Figure 4-2 depicts fiscal decentralisation (revenue autonomy) per capita (b) as spatially distributed. Compared to Figure 3-2, on the spatial distribution of poverty, the wealthier counties (16.5–27.63 poverty rates) agglomerate around the central region. These counties also have smaller land sizes per square kilometre than counties with the highest poverty rates. The counties with high poverty levels (59.33–77.7) are in the north and east, with large land sizes. Conversely, fiscal decentralisation (revenue) per capita is lowest (0.53–1.81) in the poorest counties and relatively high in the wealthier counties (9.06–33.95). This implies an inverse relationship between poverty and fiscal decentralisation. The clusters form similarly to the poverty rates. In general, poverty rates are higher than fiscal decentralisation per capita.

4.3.1.2 Demographic distribution of poverty in Kenya

We accounted for the demographic distribution of poverty by using age. We divided the population into five clusters, including children (0–17 years), youth (18–35 years), adults (36–59 years), retirees (60–69 years) and senior citizens/the aged (70+ years). As will be demonstrated, these age groups are impacted differently by applying government fiscal policies, particularly fiscal decentralisation. The necessity of age-specific fiscal policies is clear, as the poverty levels of these groups also differ spatially and in magnitudes, and they spread depending on the counties of residence.

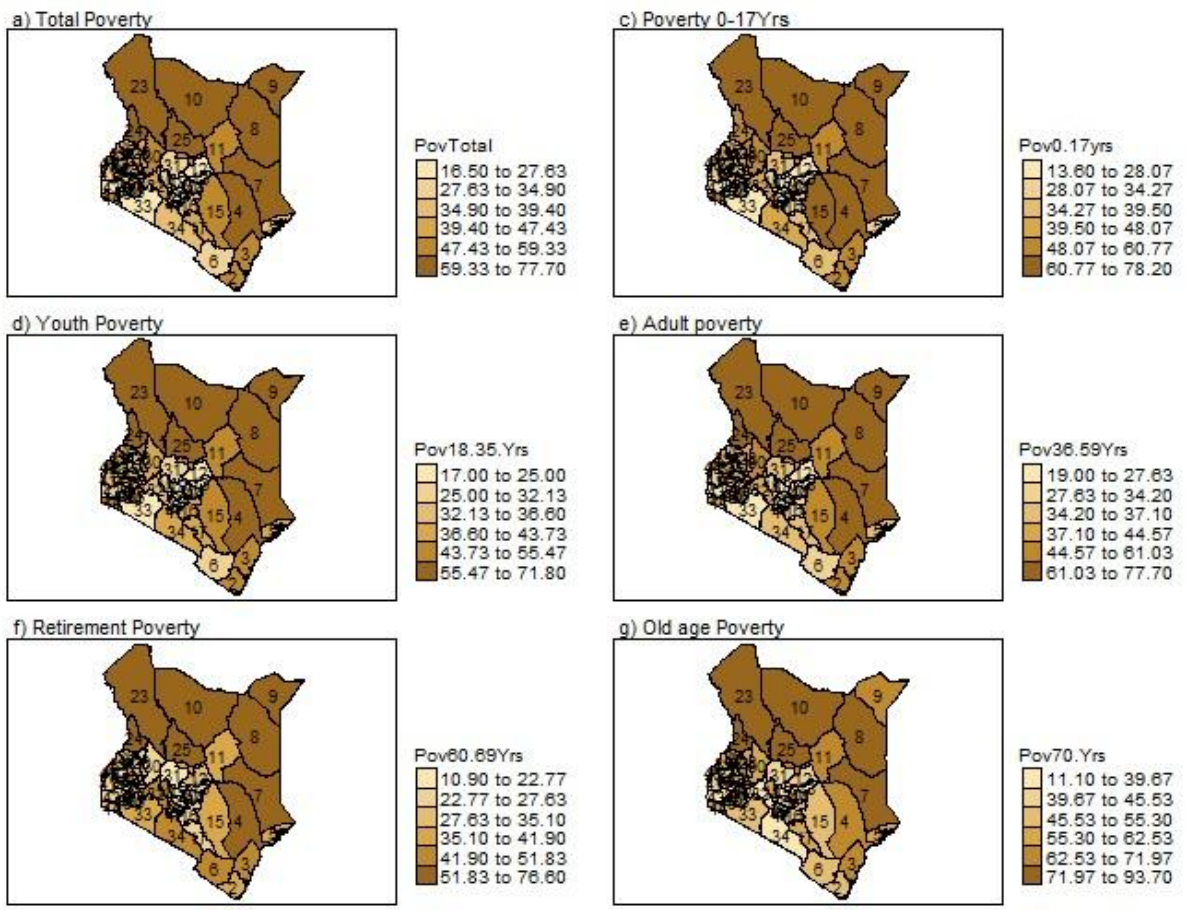


FIGURE 4-3: SPATIAL DISTRIBUTION OF POVERTY BY AGE CATEGORIES 2021

Figure 4-3 presents Kenya's spatial distribution of poverty according to age and demographic characteristics. Though the clustering and divergence follow a similar pattern to total poverty, some pertinent issues come into play. For example, whereas the range of poverty in retirement is 10.9% - 76.6%, that of the elderly (old age) ranges from 11.1% to 93.7%, an indicator of the deplorable condition of the elderly. In addition, the intensity of poverty may differ with age group in a given county; for example, county number 9 (Mandera) records less intensity in old age poverty compared with the other age groups.

4.4. CSDA and Models

Using a balanced spatial panel dataset (2019–2021) from Kenya, we analysed the relationship between fiscal decentralisation and poverty indicators using a scatterplot and a basic panel analysis model. The indicators for fiscal decentralisation were normalised at the per capita levels, including OSR, equitable share, conditional and unconditional grants, capital expenditure (Capex) and operations expenditure (Opex). The poverty indicators include total poverty, child poverty (0–17 years), youth poverty (18–35 years), adult poverty (36–49 years), retiree poverty (50–60 years) and senior citizen poverty (70+ years). The results are presented in Figure 8. Most indicators show a normal distribution, with a few having moderate right or left skews from their tails. The correlations and statistical significance among the poverty indicators are extremely high. There is also a significant correlation between poverty and fiscal decentralisation indicators, although the significance varies among age categories. As poverty is the focus of this research, the analysis will consider each age category in separate regressions to elucidate the nuanced dynamics of fiscal decentralisation on poverty

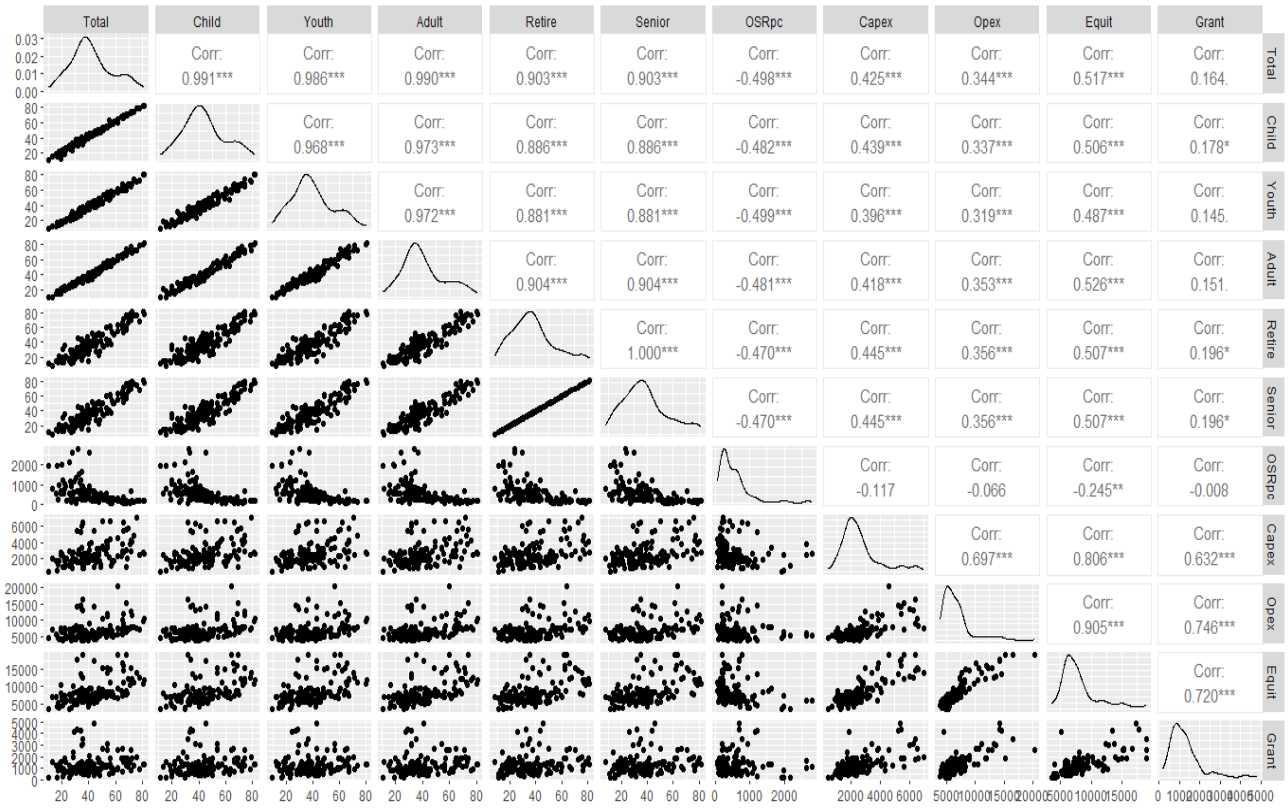


FIGURE 4-4: CORRELATION SCATTERPLOTS (2019-2021)

To ascertain the non-spatial relationship between fiscal decentralisation and poverty, we estimated the conventional panel data analysis models: fixed-effects estimator and random-effects estimator. Research demonstrates that while pooled OLS and random-effects estimators

can yield identical treatment effect point estimates under certain assumptions, the fixed-effects estimator typically provides different point estimates. Moreover, these estimators differ in their estimated standard errors and variance-covariance matrices, with fixed-effects and random-effects models accounting differently for unobserved heterogeneity (Oaxaca and Dickinson 2016). We conducted the Hausman test to select the appropriate non-spatial model (Baltagi and Liu 2016).

4.4. Results and Discussion

This section provides a comprehensive discussion of the estimated econometric models' results. To provide a comprehensive view, it first presents the results of the non-spatial model before presenting the spatial econometric models.

4.4.1 The Moran I results

The Moran I test results (Table 4-2) indicate that total poverty, child poverty, youth poverty, adult poverty, retiree poverty and senior citizen poverty have significant positive spatial autocorrelation in the residuals. This implies that poverty levels tend to cluster geographically. However, the intensity of clustering differs across demographic groups, where total, child, youth and adult poverties have very strong spatial autocorrelation and retiree and senior citizen poverties indicate moderate spatial autocorrelation.

TABLE 4-2: MORAN I TEST RESULTS

Type of poverty	Moran I statistic	Standard deviation	*P*-value	Interpretation
Total Poverty	0.2956	5.5895	2.2E – 08	Strong positive spatial autocorrelation; high/low poverty clusters together
Child Poverty	0.2307	4.3944	4.467E – 13	Significant positive spatial autocorrelation; spatial clustering of child poverty
Youth Poverty	0.3588	6.7566	2.2E – 16	Strong positive spatial autocorrelation; high clustering of youth poverty
Adult Poverty	0.2503	4.7553	9.91E – 07	Significant positive spatial autocorrelation; spatial clustering of adult poverty
Retiree Poverty	0.1392	2.7006	0.009965	Moderate positive spatial autocorrelation; some spatial clustering of retiree poverty
Senior Citizen Poverty	0.3708	6.9672	1.616E – 12	Significant positive spatial autocorrelation; spatial clustering of adult poverty

The results show positive Moran I statistics and extremely low *P*-values, indicating strong evidence against the null hypothesis of spatial randomness. This implies the presence of significant positive spatial autocorrelation, which estimates spatial models as statistically justified.

4.4.2 Results of the non-spatial fixed model

We estimated fixed-effects and random-effects models. The two models depicted sharp contrasts in how the predictors of fiscal decentralisation drive and inhibit poverty alleviation in totality and across demographic age categories. The results of the random-effects models presented in Appendix C-1 indicate that OSR, grants, GCP per capita and secondary school transition rate significantly reduce poverty. Furthermore, the significance levels vary when the model is applied to the various age categories. Other fiscal decentralisation measures (revenue and expenditure) gain or lose significance in poverty alleviation. Alternatively, the fixed-effects model emphasises the equitable share as the most significant driver in overall poverty alleviation across the poverty levels measured.

The Hausman test ($P < 0.001$) showed that fixed-effects models were the most appropriate non-spatial models. They effectively account for individual heterogeneity in the data. Table 6 presents the fixed-effects model results. Although the models are consistent in that fiscal transfer-based revenue measures such as equitable share and grants are the most significant in poverty reduction, the significance intensity varies among the age categories. OSR and expenditure-based fiscal decentralisation indicators were insignificant. Moreover, capital expenditure and secondary school transition seemed to aggravate poverty in some categories, albeit at a 10% significance level. The results conflict with the allocative efficiency tenets of fiscal federalism theory and thus justify further investigations into the dynamics of fiscal decentralisation in poverty alleviation (Nath and Madhoo 2022; Oates 2008). Furthermore, these models did not account for spatial dependence, and it will be intriguing to determine the role of spatial dependence in poverty alleviation when fiscal tools are applied. In the following subsection, we will test spatial autocorrelation and spatial models to elucidate these dynamics.

TABLE 4-3: NON-SPATIAL FIXED-EFFECTS MODEL (ASPATIAL)

Variable	Total	Child	Youth	Adult	Retiree	Senior citizens
log(OSR_pc)	0.5265 (2.2764)	0.0426 (2.3257)	−0.2311 (2.6490)	0.6947 (2.4167)	0.1485 (3.4885)	0.5279 (4.6899)
log(equit_pc)	−36.3047*** (7.9055)	−39.5285*** (8.0765)	−46.7966*** (9.1991)	−32.6774*** (8.3924)	−48.3206*** (12.1147)	10.0971 (16.2869)

Variable	Total	Child	Youth	Adult	Retiree	Senior citizens
log(grants_pc)	−4.4387*	−3.1133	−5.1653*	−4.8801**	−4.0117	−6.4700
	(1.7180)	(1.7551)	(1.9991)	(1.8238)	(2.6327)	(3.5394)
log(Capex_pc)	3.3060	5.1967*	2.5388	3.0388	2.6587	−2.7724
	(2.1264)	(2.1724)	(2.4743)	(2.2573)	(3.2585)	(4.3808)
log(Opex_pc)	1.3515	1.4511	−0.1659	3.1227	−7.0787	15.2028
	(6.2164)	(6.3509)	(7.2337)	(6.5993)	(9.5264)	(12.8072)
log(GCPpc)	31.9723	27.3749	30.3060	33.0063	19.3894	100.6747*
	(18.9609)	(19.3711)	(22.0637)	(20.1288)	(29.0567)	(39.0635)
log(transrate)	12.6271*	5.7303	17.9290**	15.3782**	12.6443	40.3680***
	(5.1388)	(5.2500)	(5.9798)	(5.4554)	(7.8750)	(10.5871)

4.4.3 Spatial econometric model results

This section will discuss the results of two spatial panel models: the SLX and SPEM-FE.

4.4.3.1 SLX model

As a point of departure, we analysed six different SLX models to understand the factors influencing poverty across various demographic groups: total, child, youth, adult, retiree and senior citizen poverties. We also sought to account for the effects of direct and indirect spatial interactions (spillover and feedback). The results are reported in Table 7.

The models are consistent in that OSR (revenue decentralisation) and targeted grants (conditional and unconditional) are the most significant fiscal decentralisation measures for alleviating poverty. In addition, the lags of OSR and grants are significant, albeit at reduced significance, implying local spillovers and feedback effects. Surprisingly, the equitable share is insignificant, even at the lagged level in these models.

On the expenditure side of fiscal decentralisation, capital expenditure had mixed results. Regarding direct effects, it was 10% significant in the child, retiree and senior citizen models but not the other models. Moreover, the lag.log (Capex) is negative and significant, which implies that development expenditure in the neighbouring counties had the potential to reduce poverty in the local county. Meanwhile, operations expenditures were insignificant in poverty alleviation in local and neighbouring counties.

The regional economic and demographic characteristics measured by GCP per capita and secondary school transition rate are negative and significant, highlighting them as vital strategies for reducing poverty across all demographic groups of the local and neighbouring counties.

As expected, the spatial autocorrelation ('rho') is generally small and negative across the models, suggesting that the impact of the independent variables in nearby regions leads to dissimilar poverty rates to some extent. While some spatial lagged predictors are significant, the overall spatial autocorrelation is relatively low.

TABLE 4-4: REGRESSION OUTPUT RESULTS OF THE EFFECTS OF FISCAL DECENTRALISATION ON POVERTY IN KENYA BY AGE

SLX final output fiscal decentralisation and poverty in Kenya

	Dependent variable:					
	Total	Children	Youth	Adult	Retiree	Senior
	slx1	slx2	slx3	slx4	slx5	slx6
	(1)	(2)	(3)	(4)	(5)	(6)
log(OSR_pc)	−5.541***	−5.226***	−5.937***	−5.199***	−6.172***	−4.549**
	(1.544)	(1.594)	(1.578)	(1.578)	(1.873)	(2.291)
log(equit_pc)	9.914	4.940	7.893	10.551	−1.253	44.101***
	(7.460)	(7.711)	(7.604)	(7.625)	(9.066)	(11.100)
log(grants_pc)	−4.718**	−3.308	−4.968**	−6.416***	−4.541*	−7.062**
	(2.044)	(2.114)	(2.079)	(2.088)	(2.480)	(3.044)
log(Capex_pc)	3.182	4.828*	3.676	2.603	6.363*	−5.706
	(2.705)	(2.799)	(2.743)	(2.755)	(3.261)	(4.004)
log(Opex_pc)	0.732	1.188	1.829	2.033	3.148	−12.020
	(6.197)	(6.400)	(6.312)	(6.341)	(7.564)	(9.222)
log(GCPpc)	−11.496***	−12.414***	−10.647***	−12.331***	−13.119***	−4.006
	(3.125)	(3.223)	(3.196)	(3.194)	(3.779)	(4.630)
log(transrate)	−2.812***	−3.142***	−2.524**	−3.081***	−5.063***	−0.711
	(0.997)	(1.028)	(1.017)	(1.019)	(1.212)	(1.480)
lag.log(OSR_pc)	−8.434**	−7.023*	−10.374***	−7.881**	−6.284	−6.622
	(3.732)	(3.845)	(3.812)	(3.805)	(4.535)	(5.487)

lag.log(equit_pc)	12.524	12.803	15.062	10.927	−2.602	12.972
	(15.862)	(16.385)	(16.157)	(16.220)	(19.292)	(24.115)
lag.log(grants_pc)	8.234*	9.589**	6.391	7.580*	6.485	12.651*
	(4.453)	(4.601)	(4.539)	(4.561)	(5.413)	(6.633)
lag.log(Capex_pc)	−15.242**	−16.642***	−11.680*	−13.417**	−11.473	−20.382**
	(6.043)	(6.255)	(6.165)	(6.175)	(7.358)	(9.042)
lag.log(Opex_pc)	13.235	9.509	11.273	16.014	29.046*	13.844
	(13.075)	(13.510)	(13.331)	(13.383)	(15.951)	(19.456)
lag.log(GCPpc)	14.265*	11.634	20.778***	15.663*	10.343	13.584
	(7.926)	(8.201)	(8.038)	(8.092)	(9.550)	(11.503)
lag.log(transrate)	4.481*	3.411	5.832**	4.749*	5.361*	4.421
	(2.385)	(2.471)	(2.423)	(2.440)	(2.922)	(3.524)
Constant	−135.897	−73.471	−181.194*	−168.493	−93.816	−299.003*
	(104.114)	(107.791)	(106.082)	(106.370)	(126.630)	(155.910)
Observations	141	141	141	141	141	141
Log likelihood	−507.891	−512.432	−510.288	−510.608	−534.542	−563.736
$Sigma^2$	77.684	82.978	80.670	81.187	114.849	172.160
Akaike Inf. Crit.	1,049.782	1,058.864	1,054.577	1,055.217	1,103.084	1,161.472
Wald test (df = 1)	4.154**	3.666*	3.037*	2.454	0.203	2.960*
LR test (df = 1)	3.592*	3.122*	2.768*	2.222	0.187	2.628
Note:						*P**P***P < 0.01

4.4.3.2. Spatial panel fixed–effects error model (SPEM-FE)–individual effects

The results of six models of the SPEM-FE are shown in Table 5. These six models estimate the relationship between overall poverty (overall and poverty across various age categories) and independent variables (fiscal decentralisation and regional characteristics) across different counties and fiscal years in Kenya while accounting for spatial autocorrelation in the error

terms. The spatial autocorrelation is captured by the spatial error parameter (lambda). The models use fixed effects to control unobserved heterogeneity across counties. The results indicate an extremely significant spatial error parameter (0.723147, $P < 0.001$), implying that the errors in one county correlate with the errors in neighbouring counties.

Regarding fiscal decentralisation, it is noted that transfer-based fiscal tools such as equitable share and grants (conditional and unconditional) are the only negative and significant variables in several models, indicating their importance in explaining the variation in poverty alleviation. However, the strength of significance varies across the age categories. While the equitable share is insignificant in predicting overall poverty, a 1% increase in equitable share reduces poverty among vulnerable groups—children, retirees and senior citizens—by 25%, 41% and 41%, respectively. It is intriguing to note that a 1% increase in conditional and unconditional grants reduces the overall youth and adult poverty by 2.31%, 2.32% and 2.94%, respectively. This implies that whereas the equitable share impacts the vulnerable groups the most, grants effectively reduce poverty among the active (working) population.

The other fiscal decentralisation variables, such as the OSR, capital and recurrent expenditure and regional characteristics (economic and demographic), were not significantly correlated with poverty alleviation in the SPEM-FE models, as shown in Table 4-5.

TABLE 4-5: SPATIAL PANEL FIXED–EFFECTS ERROR MODEL (SPEM-FE) OUTPUTS

Coefficients	Total	Child	Youth	Adult	Retiree	Senior citizen
Lambda	0.7231*** (0.0636)	0.5296*** (0.0890)	0.7002*** (0.0671)	0.7094*** (0.0657)	0.2248 (0.1163)	0.5487*** (0.0868)
log(OSR_pc)	0.0034 (1.2470)	−0.3766 (1.5513)	−0.7752 (1.4874)	0.3629 (1.3003)	−0.5429 (2.6290)	0.2662 (3.1253)
log(equit_pc)	−12.5034 (8.3645)	−25.7005** (8.4002)	−18.0798 (9.7330)	−16.9722* (8.5944)	−41.7530*** (10.6781)	−20.2541 (0.2411)
log(grants_pc)	−2.3115* (1.1305)	−2.3187 (1.3575)	−2.9424* (1.3442)	−2.4380* (1.1766)	−3.7051 (2.1185)	−1.7735 (2.7461)
log(Capex_pc)	−0.4192 (1.2308)	1.8763 (1.5265)	−1.1365 (1.4686)	0.4702 (1.2837)	2.6144 (2.5228)	−4.44206 (3.0771)
log(Opex_pc)	4.9346 (3.7219)	6.1622 (4.5342)	5.3870 (4.4299)	5.8964 (3.8760)	−9.1999 (7.3862)	13.4462 (9.1557)
log(GCPpc)	12.9013 (11.7989)	14.4966 (13.9638)	9.2420 (13.9864)	8.6126 (12.2574)	20.8434 (22.4002)	66.6033* (28.258)

Coefficients	Total	Child	Youth	Adult	Retiree	Senior citizen
log(transrate)	−4.1846 (3.2849)	−5.6832 (3.9740)	1.6058 (3.9089)	−0.3269 (3.4205)	7.4175 (6.2826)	13.3771 (8.0339)

4.5. Discussion

This study has comprehensively analysed the role of fiscal decentralisation in poverty alleviation, determining whether spatial spillovers and feedback effects matter in line with the postulates of Tobler's First Law of Geography. Using balanced fiscal, economic, demographic, poverty and spatial datasets from Kenya for 2019–2021, we have demonstrated that poverty is spatially and demographically differentiated. The ESDA choropleth maps have indicated spatial clustering and intriguing patterns. When poverty is spatially compared with fiscal policy interventions, such as revenue autonomy (Figure 2), it is apparent that there is an inverse correlation between the two. This syncs with previous research that generally found that subnational revenue decentralisation and autonomy correlate with poverty reduction (Sanogo 2019). Furthermore, the ESDA shows that the severity of poverty is not only spatially dependent but also varies by age category. This highlights the importance of identifying the poor and their spatial characteristics in intergovernmental relations strategies, such as fiscal decentralisation, to alleviate poverty (Bird et al. 1995; Mutiarani and Siswantoro 2020).

Previous research on the effects of fiscal decentralisation and poverty yielded mixed results (Karim and Khan 2020; Cristian F. Sepulveda and Martinez-Vazquez 2011; Shahzad and Yasmin 2016). This research sheds some light on the conundrum of what drives different results regarding the effectiveness of fiscal decentralisation and intergovernmental fiscal relations in addressing the complex challenges of poverty. This research shows that mixed results can arise from various factors, including the data and measurement of fiscal decentralisation, choice of fixed or random effects, selection of spatial models and whether global or local spatial interactions are considered. Extant literature highlights the lack of a single universally agreed measurement of fiscal decentralisation (Martinez-Vazquez et al. 2017). However, in line with previous empirical practice, we selected fiscal decentralisation from revenue (OSR, equitable share and grants) and expenditure (Rodden 2002). The results across all models, including non-spatial and spatial panel models, with fixed and random effects, consistently demonstrated that revenue-based indicators exhibited significant statistical relationships. In contrast, expenditure indicators did not exhibit consistent significance to poverty alleviation. The statistical significance of these indicators varies between fixed- and random-effects models. Random-

effects models highlight the significance of regional characteristics (economic and demographic), whereas fixed-effects models consistently attribute significance to revenue-based indicators.

The results also vary depending on whether spatial interactions are included in the model, suggesting that spatial dependence significantly affects the analysis. This suggests that for comprehensive policy recommendations, it is crucial to consider spatial spillovers and feedback effects, including the scale of these effects (global versus local). For example, the SLX model has shown that a percentage increase in OSR will reduce overall poverty by 5.54%. Consequently, it would directly reduce poverty in the local county for child (5.23%), youth (5.93%), adult (5.20%), retiree (6.17%) and senior citizen (4.55%) poverties. From the local spillover and feedback effects, the model shows that a percentage increase in the OSR in the neighbouring county will reduce overall poverty in the local county by 8.43%, whereby child poverty will be reduced by 7.02%, youth by 10.37% and adult by 7.88%.

The robustly estimated SPEM-FE provides invaluable insights into the interplay between fiscal decentralisation in Kenya's devolutionary framework and poverty alleviation. The models' significant lambda ($P < 0.001$) indicates strong spatial dependency in the error terms. The models show that equitable shares and grants are pivotal in overall and age category–specific poverty alleviation. This interplay has been supported by previous research in Ethiopia, which found that the effective application of grants reduces poverty (Khan et al. 2017). Moreover, the equitable share, mainly an unconditional transfer from the national government, has the highest significance and impact in the overall and age-specific poverty. For example, a 1% increase in equitable share reduces adult poverty by 16.97% and retiree poverty by 41.76%. In comparison, a 1% increase in grants reduces adult poverty by 2.44% and retiree poverty by 3.71%. This supports the fiscal federalism theory that revenue and spending autonomy significantly reduce poverty (Agyemang-Duah et al. 2018). The OSR, capital expenditure and operations expenditure are insignificant. This can be attributed to several factors, including the huge revenue potential gap in the counties of Kenya[9]. Furthermore, the national government still makes significant regional development expenditures through specialised agencies, such as the Regional Development Authorities and the National Government Constituencies

[9] See report in https://documents1.worldbank.org/curated/en/280021585886703203/pdf/Own-Source-Revenue-Potential-and-Tax-Gap-Study-of-Kenya-s-County-Governments-Final-Report.pdf

Development Fund, which, though performing devolved functions, make assessing their contribution to poverty reduction through this fiscal dataset challenging.

4.6. Conclusion

This study analysed the role of fiscal decentralisation in poverty alleviation in Kenya from 2019 to 2021, focusing on spatial spillovers and feedback effects. Our findings indicate that poverty is spatially and demographically differentiated, with significant spatial clustering. Furthermore, the EDSA and CSDA exhibit an inverse correlation between poverty and revenue autonomy, consistent with previous research. By empowering subnational governments with greater revenue autonomy, regions can implement targeted initiatives for poverty alleviation across the population demographics. Fostering fiscal decentralisation alongside a nuanced understanding of regional dynamics can promote more sustainable and inclusive pathways towards poverty reduction and equitable development.

Empirical results on the effects of fiscal decentralisation on poverty alleviation vary depending on how fiscal decentralisation is measured, whether fixed or random effects are considered and if spatial interactions are included in the model. Unlike expenditure indicators, revenue-based indicators (OSR, equitable share and grants) consistently showed significant relationships with poverty reduction. The SLX model demonstrated that a 1% increase in OSR reduces overall poverty by 5.54%, with reductions across various age groups. In addition, local spillover effects revealed that a 1% increase in OSR in neighbouring counties reduces overall poverty by 8.43%. The SPEM-FE highlighted the importance of equitable shares and grants in alleviating poverty across different age groups. For example, a 1% increase in equitable share reduces adult poverty by 16.97% and retiree poverty by 41.76%, whereas a 1% increase in grants reduces adult poverty by 2.44% and retiree poverty by 3.71%. This research shows that fiscal decentralisation is crucial for poverty reduction, mainly through revenue-based indicators. However, the effectiveness of capital and operations expenditure remains inconclusive, likely due to regional revenue disparities and significant national government expenditures

This research contributes to the knowledge of fiscal federalism by examining the effects of fiscal decentralisation on poverty reduction in the context of the Global South. The results of this study thus hold global relevance, particularly in developing countries. Understanding the nuanced regional dynamics provides actionable insights for targeted policy formulation, improves governance practices and ultimately contributes to sustainable development goals (Mutiarani & Siswantoro, 2020). The results of the models indicate significant spatial

autocorrelation. Future studies can explore what other regional characteristics drive, inhibit or moderate the application of fiscal policy tools for poverty alleviation.

4.6.1 Hypothesis Outcomes

H4a: Own-source revenue (OSR), equitable share, and conditional grants have heterogeneous effects on poverty reduction across counties

The results provide partial support for this hypothesis. Equitable share demonstrates strong and statistically significant heterogeneous effects across age groups, while conditional grants exhibit moderate and selective heterogeneity. In contrast, OSR is statistically insignificant indicating limited relevance for poverty reduction.

H4b: These effects exhibit spatial spillovers and inter-county feedback mechanisms.

This hypothesis is supported. The consistently large and statistically significant spatial dependence parameter (lambda) across most demographic groups indicates strong inter-county spillovers in poverty outcomes. While the retiree group shows weaker spatial dependence, the overall evidence confirms the existence of spatially transmitted effects, validating the role of spatial interdependence in shaping county-level poverty dynamics.

CHAPTER FIVE: EMPIRICAL RESULTS (STUDY 2)

The Nexus Between Fiscal Decentralisation and Regional Economic Dynamics: A Spatio-Temporal Econometric Analysis within Kenya's Devolution Framework

5.1. Introduction

This research used the SARAR-SDM model to examine the complex dynamics within a spatiotemporal econometric framework of Kenya's fiscal decentralisation in promoting regional economic performance and convergence during the first ten years of devolution (2013 to 2023). It assesses whether the devolutionary approach has effectively promoted regional economic performance. Moreover, the role of geographical variations in implementing intergovernmental fiscal relations and their impact on achieving regional economic convergence, including regional spillover effects and convergence among Kenya's 47 counties, is evaluated for convergence and regional development. The paper documents evidence of absolute and conditional convergence attributable to fiscal decentralization.

To our knowledge, no study on regional economic performance and convergence in Sub-Saharan Africa, particularly in Kenya, has accounted for the role of spatial dependence in fiscal decentralization and economic performance. This paper addresses this gap - focusing on revenue and expenditure indicators. The study examines the long-term impacts of fiscal decentralisation on economic growth and identifies the endogenous fiscal factors that drive regional economic performance. Additionally, it tests whether county-level economic growth in Kenya exhibits convergence, suggesting that poorer counties are catching up with richer ones since the advent of devolution in 2013.

The **hypotheses** of the study are

H5a: Fiscal decentralisation positively influences county-level economic performance, with significant spatial spillover impacting neighbouring counties.

H5b: Kenyan counties exhibit absolute β-convergence under devolution.

H5c: Conditional convergence provides a better fit than absolute convergence when controlling for structural and fiscal heterogeneity.

This study leverages spatial econometrics using a balanced spatial panel of Kenya's 47 counties from 2013 to 2023. The methodology proceeds as follows: First, we present the

description of variables and data sources, the descriptive statistics, a test for spatial dependence and an Exploratory Spatial Data Analysis (ESDA) using choropleth maps. Second, a Confirmatory Spatial Data Analysis (CSDA) where the spatial econometrics models and specification tests are discussed. Third, testing the convergence hypothesis. The modelling and analysis were done using the SPLM package available in R software (Millo and Piras 2012).

The dependent variable is the Gross County Product (GCP) per capita. Appendix D-T1 presents data sources and variable descriptions.

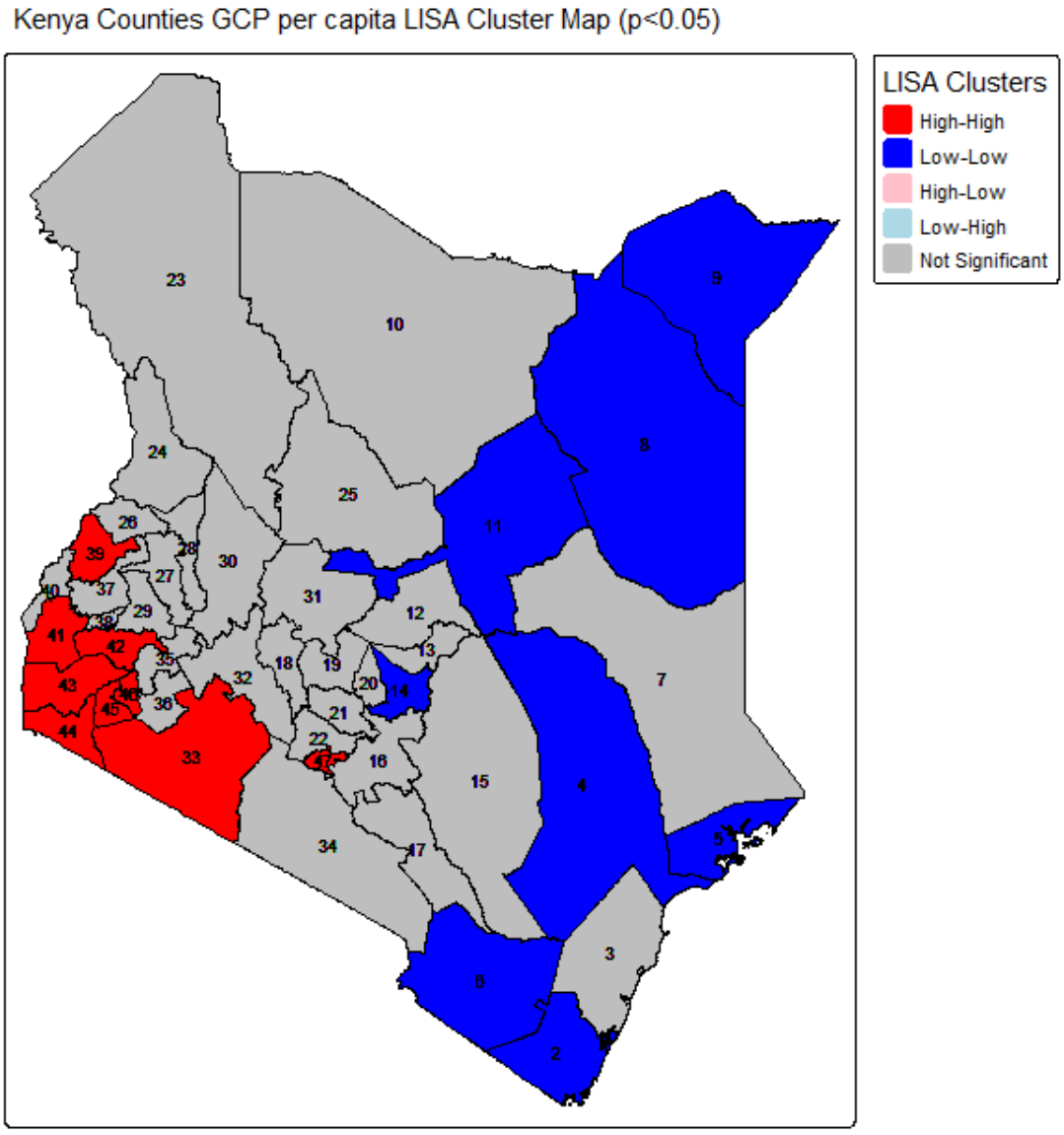
5.2 Descriptive statistics

Appendix D-T2 provides the summary statistics, while the “ggpairs" scatter plot in Appendix D—F1 offers a comprehensive overview of the relationships and distributions among the dependent and independent variables. It illustrates each variable's distribution, identifies outliers and skewness, and displays the strength, direction, and statistical significance of correlations between the variables used in this study.

5.3. Exploratory Spatial Data Analysis

5.3.1. Test for Spatial Dependence

We estimated the Global Moran’s I and Local Indicators of Spatial Association (LISA) to test spatial association and visualise the results in choropleth maps. Global Moran’s I ($I=0.186$, $p<0.001$) indicates a significant positive spatial autocorrelation. LISA, which measures local spatial autocorrelation at each county level to detect economic clusters and outliers, helps identify counties needing targeted policy interventions. Based on the significance levels, the results are visualised in a choropleth map in Figure 5-1.



Source: Authors' Visualisation

Note: 1=Mombasa, 2=Kwale, 3=Kilifi, 4=Tana River, 5= Lamu, 6=Taita Taveta, 7 = Garissa, 8=Wajir, 9 = Mandera, 10= Marsabit, 11 = Isiolo, 12 = Meru, 13 = Tharaka -Nithi, 14 = Embu, 15 = Kitui, 16 = Machakos, 17 = Makueni, 18 = Nyandarua, 19 = Nyeri, 20 = Kirinyaga, 21 = Murang'a, 22 = Kiambu, 23 = Turkana, 24 = West Pokot, 25 = Samburu, 26 = Trans Nzoia, 27 = Uasin Gishu, 28 = Elgeyo-Marakwet, 29 = Nandi, 30 = Baringo, 31 = Laikipia, 32= Nakuru, 33 = Narok, 34 = Kajiado, 35 = Kericho, 36 = Bomet, 37 = Kakamega, 38 = Vihiga, 39 = Bungoma, 40 = Busia, 41 = Siaya, 42 = Kisumu, 43 = Homa Bay, 44 = Migori, 45 = Kisii, 46 = Nyamira, 47 = Nairobi City

Figure 5-1: LISA Map Cluster Map on GCP per Capita FY 2013/14 – 2022/23

b) We used a contiguity-based (Queens) weights matrix (W) to capture local spillover effects instead of a distance-based weights matrix (LeSage and Pace 2014), owing to the stark disparities in geographical sizes of the counties.

Figure 5-1 shows spatial heterogeneity and a clustering of high or low GCP per capita values relative to the national average and their neighbours. The High-High clusters, notably including Nairobi, Kisumu, Siaya, Migori, Narok, Kisii, and Nyamira, suggest a positive spatial association, indicating areas where economically performing counties reinforce each other through agglomeration economies, urban linkages, and regional spillovers. This spatial clustering suggests the western corridor is developing as a convergence frontier, likely driven by public investment in a region historically marginalised due to opposition politics, regional trade integration, improved infrastructure, expanding urban economies (such as Kisumu as a secondary city), and the effects of devolution. Conversely, Low-High clusters such as Wajir, Mandera, Tana River, and Isiolo form spatial poverty traps, reflecting persistent underperformance reinforced by neighbouring counties facing similar economic challenges, particularly infrastructure deficits, weak fiscal capacity, and geographical marginality. The absence of significant clustering in several other counties (e.g., Uasin Gishu, Nakuru, Kiambu, Kitui, Marsabit) suggests localised or idiosyncratic growth patterns, with economic performance not strongly aligned with neighbouring areas. These findings highlight the uneven spatial distribution of regional economic development in Kenya, highlighting the need for targeted regional policies and strategically integrating neutral counties into regional value chains to promote broader spatial convergence.

For robustness and guidance in choosing spatial models, we performed the Lagrange Multiplier (LM) test for spatial dependence, following the approach proposed by Anselin (1996). Table 5-1 results reveal significant spatial lag and spatial error dependence. However, the spatial lag dependence (LM = 70.124) is notably stronger than the spatial error dependence (LM = 22.129). Nevertheless, the choice of the model is informed by further robust checks and tests.

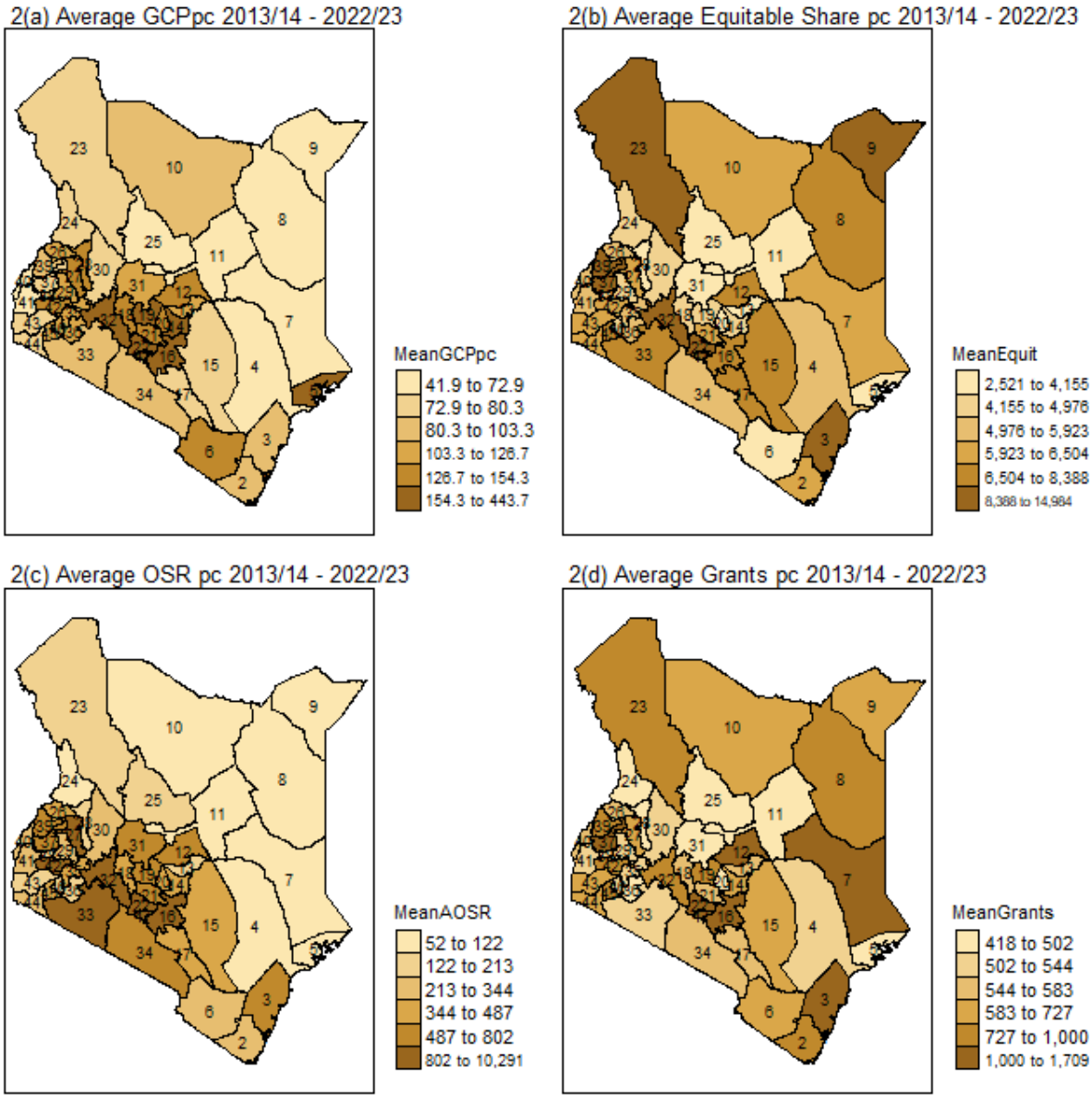
Table 5-1: Lagrange Multiplier Test for Spatial Dependence (FY 2013/14 – 2022/23)

Test	LM Statistic	p-value	Interpretation
LM Test for Spatial Error Dependence (LM error)	20.047	7.56E-06	Significant spatial error dependence
LM Test for Spatial Lag Dependence (LM lag)	68.042	2.20E-16	Significant spatial lag dependence
Robust LM Test for Spatial Error Dependence (Robust LM error)	22.129	2.55E-06	Spatial error dependence persists after accounting for lag dependence.

Robust LM Test for Spatial Lag Dependence (Robust LM lag)	70.124	2.20E-16	Spatial lag dependence persistence after accounting for error dependence

The choropleth map in Figure 5-2 depicts the spatial distribution and disparities in the average annual economic performance, equitable share, Own Source Revenue (OSR) and Grants in the Kenyan Counties. It also shows the heterogeneity in geographical sizes and economic performance, whereby vast counties in the north, such as Turkana, Marsabit, Wajir, Mandera, Garissa, Isiolo, and Samburu, notably have low performance and OSR. These counties are in the Arid and Semi-Arid Lands (ASAL) ecological zones and were historically marginalised. Conversely, the central and western counties are relatively smaller but record the highest economic activity and OSR. The spatial clusterings of the economic performance imply potential spatial club convergence tendencies where counties in similar ecological zones, such as the highlands, tend to have similar economic performance. Regarding national transfers-based revenue, the ASAL Counties received relatively high amounts of equitable share and grants (conditional and unconditional transfers). This contrasts with economic performance and revenue autonomy, which implies a possible crowding out of economic activity and local revenue through national transfers.

Fig 5-2. Spatial distribution of average per capita annual economic performance and revenue-based indicators

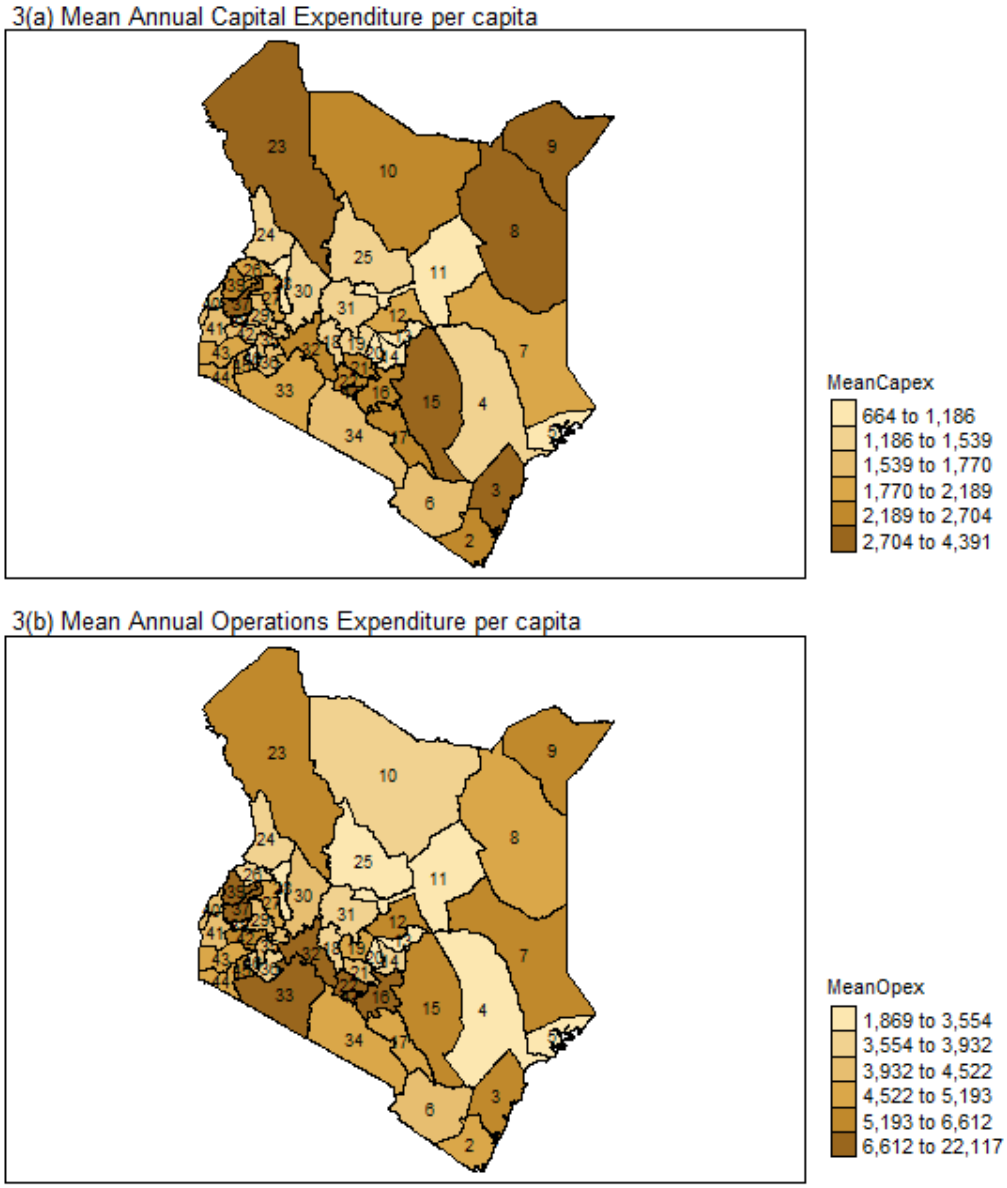


Source: Authors' visualisation

Figure 5-3 (a) and (b) depict the spatial distribution of expenditure-based indicators, including capital expenditure (Capex) and operations expenditure (Opex). The analysis contrasts that the ASAL Counties (Northern Kenya and the Coast) have committed the highest resources in capital expenditure per capita yet have low economic performance. This implies that the gains from capital expenditure have not been significantly apparent in the review period which can be attributed to the low amounts of funds spent on capital projects compared to operational expenditure, historical marginalisation of the ASALS, long gestation periods of the capital projects and the disparities in land mass. The spatial distribution of the Operations Expenditure per capita follows a similar pattern to the GCP per capita and OSR per capita. This indicates a

spatial correlation between operational expenditure and economic activity, highlighting its potential as a fiscal policy tool to stimulate economic performance in Kenya's counties.

Fig 5-3: Spatial distribution of Average expenditure (FY 2013/14- 2022/23)



. Source: Authors' visualisation

5.3. Confirmatory Spatial Data Analysis and Econometric Models (Results and Discussion)

This section begins by discussing the baseline non-spatial models. Next, it covers spatiotemporal modelling, including model specifications. Finally, it presents the absolute and conditional convergence evidence.

5.3.1 Non-Spatial Econometric Models

The estimates from the non-spatial models (Pooled OLS, Fixed Effects, and Random Effects) are presented in Table 5-2. The Hausman and F-tests rejected the random effects and pooled OLS models, respectively, confirming the fixed effects model as the most robust, with a goodness of fit of 60 per cent.

The non-spatial results show that local revenue-based fiscal decentralisation, measured by OSR per capita, positively influenced regional economic performance across all models. However, grants-based revenue, including the equitable share and conditional transfers, showed no significant effect, which is consistent with previous research (Furceri 2005). For expenditure-based decentralisation, Operational Expenditure was positively associated with GCP per capita, while Capital Expenditure had a negative effect, suggesting it may lower economic output as suggested by other authors (Barro and Sala-i-Martin 1992). For the controls, Population Density correlated positively with GCP per capita, indicating higher output in more densely populated counties. The Educational Transition Rate also positively affected GCP, suggesting an economic benefit from a more educated workforce. The Crime Index was insignificant and excluded from further analysis.

The Pesaran CD test showed significant cross-sectional dependence ($z = 16.161$, p-value $< 2.2e\text{-}16$), indicating that economic performance across counties is interconnected, possibly due to national policies, geographical proximity or spatial spillovers (Pesaran 2015; Chudik et al. 2011). The pronounced cross-sectional dependence underscores the potential for spatial spillover effects, where fiscal decentralisation measures or regional characteristics in one county may affect neighbouring or economically interconnected counties. The baseline non-spatial panel models thus overlooks spatial effects, leading to biased results in the presence of spatial dependence (Anselin 1988; Elhorst 2014)

Table 5-2: Non-spatial models of the effects of fiscal decentralisation on economic performance (FY 2013/14 – 2022/23).

Variable	Pooled Model	Fixed Effects Model	Random Effects Model
Intercept	0.1309 (0.3023)	-	2.1567 *** (0.1305)
log(Equitable share per capita)	-0.0210 (0.0211)	-0.0023 (0.0050)	-0.0025 (0.0053)
log(Total conditional grants per capita)	0.0056 (0.0158)	0.0048 (0.0037)	0.0050 (0.0039)

Variable	Pooled Model	Fixed Effects Model	Random Effects Model
log(Own-Source Revenue per capita)	0.2509 ***	0.0270 **	0.0402 ***
	(0.0166)	(0.0089)	(0.0091)
log(Capital expenditure per capita)	-0.0506 *	-0.0109 *	-0.0135 *
	(0.0205)	(0.0051)	(0.0054)
log(Operations expenditure per capita)	0.2197 ***	0.1768 ***	0.1672 ***
	(0.0437)	(0.0146)	(0.0128)
log(Crime Index)	0.2446 ***	-0.0074 (0.0115)	0.0046 (0.0120)
	(0.0265)		
log(Population density)	0.1225 ***	0.1230 **	0.1677 ***
	(0.0098)	(0.0470)	(0.0191)
log(Transition to Sec. School rate)	-0.0461 ***	0.0143 **	0.0126 **
	(0.0134)	(0.0045)	(0.0048)
Model Summary			
Total Sum of Squares	98.09	2.6379	3.1531
Residual Sum of Squares	23.86	1.0444	1.319
R-Squared	0.75676	0.60407	0.58169
Adj. R-Squared	0.75253	0.55255	0.57443
F-statistic / Chisq	179.277 on 8 and 461 DF	79.1446 on 8 and 415 DF	641.063 on 8 DF
p-value	< 2.22e-16	< 2.22e-16	< 2.22e-16
N	47	47	47
N	470	470	470
T	10	10	10

Notes: Standard errors are shown in parentheses.

Significance: *** p < 0.001, ** p < 0.01, * p < 0.05, . p < 0.1,

5.3.2 Spatiotemporal Econometric Models (Spatial Lag of X [SLX], SDM and SARAR-SDM)

The results are presented in Table 5-3. Across the three specifications, results consistently indicate that county economic performance in Kenya is shaped by both local fiscal-demographic fundamentals and spatial interdependencies, though the nature and magnitude of these effects vary with model structure. The Spatial Lag of X (SLX) captures only exogenous spillovers, revealing strong positive local effects of own-source revenue and operations expenditure, a negative short-run impact of capital expenditure, and limited but suggestive neighbouring-county influences. Introducing endogenous spatial dependence in the Spatial Durbin Model (SDM) substantially alters these relationships, with a significant positive spatial lag ($\lambda = 0.51$) indicating that counties' economic performance is closely linked to that of their

neighbours, while some direct effects, such as population density, reverse sign once feedback effects are accounted for. The SARAR–SDM further extends this framework by incorporating spatial autocorrelation in the disturbances, producing the strongest spatial feedback ($\lambda \approx 0.73$) and revealing that unobserved shocks are also spatially structured ($\rho < 0$), potentially reflecting inter-county policy offsets. This specification uncovers more pronounced fiscal spillovers, particularly from neighbouring own-source revenue and operations expenditure, alongside stronger competitive effects from high-density areas. Collectively, the progression from SLX to SDM and SARAR–SDM demonstrates that ignoring spatial dependence risks biased inference, and that a dual-dependence model such as the SARAR–SDM offers the most comprehensive representation of Kenya's spatial-economic dynamics, where growth is simultaneously driven by local fiscal capacity, regional policy diffusion, and shared structural conditions.

The core policy implication is that Kenya's devolution framework should be structured to harness positive spatial externalities by fostering coordinated investment and service delivery in regions with high potential, such as economic corridors and growth hubs. Simultaneously, regionally coordinated fiscal strategies are essential to mitigate inefficiencies from negative cross-county externalities, particularly in border areas and asymmetrically developed regions where uncoordinated interventions can lead to spatial inefficiencies. Moreover, the significant negative spatial error terms (ρ) aross all models imply unobserved spatially correlated shocks (e.g. latent spatial processes such as unmeasured institutional quality, informal trade, cross-border labour mobility, or regional infrastructure networks, human resource capacity, ecology and climate) or policy misalignments are negatively diffused across counties, attributable to fiscal competition or systemic resource misallocations. Addressing spatial error dependence requires targeting institutional and structural asymmetries, including disparities in capacity, governance, or infrastructure that spatially diffuse inefficiencies. For instance, intergovernmental transfers could be redesigned to internalise these spatial externalities. Controlling endogeneity thus provided a robust case for causal interpretation, reinforcing the fiscal decentralisation-growth nexus under spatial interdependence.

Table 5-3: Results for SLX, SDM, and SARAR-SDM Models, FY 2013/14–2022/23

Variable / Parameter	GMM - SLX (Panel FE)	ML SDM (Panel FE)	ML SARAR-SDM (Panel FE)
log(Equitable share per capita)	–0.0073	-0.0036	-0.0037
	(0.0234)	(0.0041)	(0.0036)
log(Total conditional grants per capita)	0.0287	0.0035	0.0012
	(0.0173)•	(0.0031)	(0.0023)
log(Own Source Revenue Per capita)	0.3364***	0.0174*	0.0140*
	(0.0178)	(0.0074)	(0.0064)
log(Capital expenditure per capita)	–0.0729**	-0.0079•	-0.0108***
	(0.0223)	(0.0043)	(0.0031)
log(Operations expenditure per capita)	0.1894***	0.1253***	0.0919***
	(0.0488)	(0.0131)	(0.0123)
log(Population density)	0.0879***	-0.0886*	-0.0896**
	(0.0180)	(0.0406)	(0.0307)
log(Transition to sec. school rate)	–0.0518***	0.0083*	0.0034
	(0.0154)	(0.0038)	(0.0031)
lag.log(Equitable share per capita)	–0.1065*	-0.00345	-0.00951
	(0.0527)	(0.00431)	(0.01052)
lag.log(Total conditional grants per capita)	–0.0426	0.00342	0.00302
	(0.0405)	(0.00321)	(0.00640)
lag.log(Own Source Revenue Per capita)	–0.0591•	0.01684**	0.03555*
	(0.0334)	(0.00792)	(0.01990)
lag.log(Capital expenditure per capita)	–0.0214	-0.00770*	-0.02748**
	(0.0413)	(0.00449)	(0.01130)
lag.log(Operations expenditure per capita)	0.1935·	0.12147***	0.23320***
	(0.1002)	(0.02578)	(0.06898)
lag.log(Population density)	0.0533*	-0.08587**	-0.22727**
	(0.0212)	(0.04142)	(0.10140)

Variable / Parameter	GMM - SLX (Panel FE)	ML SDM (Panel FE)	ML SARAR-SDM (Panel FE)
lag.log(Transition to sec. school rate)	–0.0178	0.00806**	0.00863
	(0.0284)	(0.00422)	(0.00928)
λ (lambda)	–	0.5099***	0.7326***
		(0.0448)	(0.0444)
ρ (rho)	–	–	-0.5839***
			(0.1051)
T	10	10	10
N	47	47	47
N	470	470	470

Notes: Standard errors are shown in parentheses. Significance: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, • $p < 0.1$,

5.3.3 Impacts: Direct, Indirect, and Total Effects from the SARAR–SDM (FE) Model (R = 1000)

Table 5-4 presents the estimated direct, indirect (spillover), and total impacts for the key fiscal, demographic, and educational variables over the FY 2013/14–2022/23 period. The SARAR–SDM (FE) impact decomposition reveals heterogeneous spatial transmission mechanisms across fiscal and demographic covariates. Own Source Revenue per capita exerts a positive and statistically significant direct effect (0.0168, $p < 0.05$) and an even larger indirect spillover (0.0356, $p < 0.05$), yielding a sizeable regional multiplier effects of 0.0524, corroborating Martinez-Vazquez and McNab (2003) findings. This implies that locally mobilised revenues not only improve outcomes within the jurisdiction but also propagate benefits through spatial interdependence, consistent with positive fiscal spillovers in neighbouring counties. Generally, as local governments (counties) better understand community needs, they allocate resources more effectively, increasing accountability and efficiency and driving economic performance (Ebel and Yilmaz 2002; Bahl and Martinez-Vazquez 2013). This suggests that complex factors, such as regional tax mimicking and

yardstick competition, may create a more nuanced or diminished role for OSR in counties with strong spatial dependencies (Trojanek et al. 2021; Allers and Elhorst 2005). Regional tax mimicking manifests when counties mimic tax bases and rates, fees, and levies introduced by neighbouring counties, aiming to align with regional trends or avoid being undercut in attracting businesses and investments. The mimicry often leads to a convergence of tax policies and strategies, sometimes at the expense of developing unique, locally optimised revenue measures. This distorts the expected impact on own-source revenue since regional competition drives the behaviour more than each county's fiscal needs or revenue potential. These regional dependencies can dilute the potential impact of OSR, leading to inefficiencies or suboptimal revenue collection across counties and tax litigations in some cases. For example, clauses in Finance Acts that allowed for the collection of Cess were copied across counties but later repealed after successful litigation deemed them unconstitutional and, therefore, illegal[10]. The basis of Cess is regionally interconnected based on resource advantages such as minerals and agricultural production. Regarding yardstick competition, residents, investors, and policymakers have frequently compared counties based on service delivery, development projects, and revenue generation since county governments were established. Counties that perform poorly in raising OSR or delivering services face pressure from constituents and risk losing investor confidence. This can compel them to adopt revenue measures that align with neighbouring counties, even if these measures are not suited to their unique economic contexts. These scenarios highlight the importance of accounting for spatial effects to assess fiscal decentralisation policies' impacts more accurately. The Kenyan devolution experience offers valuable insights from the spatiotemporal results on own-source revenue (OSR) and its influence on economic performance. First, spatial spillover effects can enhance economic performance. The positive spatial lag results imply that a focal county's economic growth benefits neighbouring counties; thus, OSR efforts in one county can have a regional impact. Counties that successfully increase OSR through effective tax policies or improved administration can boost economic activity locally and across neighbouring regions. Second, efficiency in revenue utilisation affects economic outcomes. Counties that strategically invest OSR in local priorities such as healthcare, agriculture, Small and Medium Enterprises (SME) development) can maximise their economic impact. This calls for capacity-building in budget planning and fiscal management to ensure that increased OSR translates into improved public services and economic growth. Third, the impact of OSR on local economic performance

[10] See a sample of Cess Litigation on https://kenyalaw.org/caselaw/cases/view/187931/

highlights the need for simultaneous balanced fiscal autonomy and accountability in Kenya's devolved counties. Implementing transparent reporting systems and promoting public participation in fiscal decisions enhances governance, improves resource allocation, and supports sustainable economic development. Fourth is the need to tailor revenue strategies to local economies. The spatial variations in OSR effects imply that counties with different economic bases may need customised revenue strategies. For instance, urban counties like Nairobi or Mombasa may benefit from focusing on commercial revenue sources and property taxes. In contrast, rural counties like Kericho and Narok could capitalise on agricultural levies or natural resource management. Kenya's devolution framework could support this by allowing counties to tailor OSR strategies according to their unique economic contexts. Fifth, the spatiotemporal results also indicate the need for inter-county coordination, as counties' economic activities and fiscal decisions are interlinked by spatial dependence. Mechanisms to facilitate collaboration among counties, such as joint infrastructure investment, resource-sharing agreements, or regional economic blocs, could help address cross-county economic dependencies, making OSR strategies more effective and equitable across Kenya.

Equitable Share is statistically insignificant. Within Kenya's devolution framework, this insignificance is attributable to the exogenous nature of the division of revenue determined through a political process in Parliament and the equitable allocation of revenue amongst the counties underpinned by the formula developed by the Commission on Revenue Allocation (CRA). This can dilute the impact of funds or misdirect them to areas where they have little effect on economic growth (Shah 2007). Additionally, the equitable share can incentivise a "soft budget constraint" for local governments, allowing them to rely on these transfers regardless of economic performance or efficiency (Maskin 1996; Kornai* 1986). Political factors can further influence fund distribution, as seen in Kenya's parliamentary stalemates over the sharing, where political interests sometimes take precedence over economic efficiency. For example, some funds may be allocated based on political patronage to maintain political support, undermining their potential to stimulate economic growth. To optimise equitable share and generate localised economic impacts, the intergovernmental transfers thus need stronger targeting mechanisms and performance-based indicators.

Like the equitable share, conditional grants also show no significant impact on economic performance, suggesting these transfers may not be effectively targeted. However, spatial lag approaches significance, implying spillover benefits of transfers to neighbouring counties. Previous studies in other jurisdictions, just like Kenya's case, attribute this to misalignment

with local needs, inefficient use, dependency, political bias, inadequate monitoring, and the small size of the grants (Faguet 2004; Smoke 2015; Besley and Ghatak 2003). This challenge is compounded by bureaucratic inefficiencies, recurrent delays in enacting critical legislation such as the County Government Additional Allocations Bills, and persistently low absorption rates of allocated funds in Kenya's devolved governance framework. Conditional grants are tied to specific sectors like health, education, or infrastructure, as determined by the central government. While this ensures alignment with national priorities, the rigid conditions may not match local economic needs. For instance, matching grants may require counties to invest in areas that do not directly promote economic growth or are not top priorities for their context. Additionally, County governments may lack the capacity to effectively utilise grants if the grants are large or come with complex administrative requirements. This can lead to underutilisation, misallocation, or investment in low-impact projects, limiting the potential of these funds to foster economic development.

Operational Expenditure per capita results display the largest positive and significant multipliers directly and indirectly, implying strong contemporaneous operational spending linkages and regional complementarities. This result aligns with the previous research findings on the effect of recurrent expenditure on GCP per capita growth (Mose et al. 2019; Bahl and Martinez-Vazquez 2013). Higher recurrent spending boosts economic growth by supporting essential services like health, agriculture, water, and public administration, directly influencing economic activity and human capital development (Barro 1991; Baldacci et al. 2003). However, the significant negative spatial spillovers suggest inter-jurisdictional resource competition. Empirical evidence from China supports these findings, where recurrent spending, particularly in health and education, plays a significant role in economic growth (Luintel et al. 2020).

Capital expenditure per capita shows negative and highly significant effects at both the direct (–0.0130, $p < 0.01$) and indirect (–0.0275, $p < 0.05$) margins, indicating that higher local capital outlays may be associated with short-run displacement or resource reallocation effects that depress performance regionally. This is likely due to long gestation periods, inefficiencies, or misallocation of resources. Capital projects often take years to deliver economic benefits, creating a lag between spending and their impact on growth. Additionally, inefficiencies like time and cost overruns can reduce the effectiveness of capital investments. This insignificant finding corroborates the results of previous studies of the effects of county expenditure on real GCP in Kenya (Mose et al. 2019). Moreover, as noted in other jurisdictions, misallocating funds to low-priority or non-productive projects, often due to political influence, further

undermines their growth potential (Keefer and Knack 2007). These findings underscore the need to improve capital expenditure efficiency through better project management, transparency, and alignment with long-term development goals.

Table 5-4: Direct, Indirect, and Total Effects (R=1000)

Variable	Direct	Indirect	Total
log(Equitable share pc)	–0.0045	–0.0095	–0.0140
	(0.0042)	(0.0100)	(0.0141)
log(Total conditional grants pc)	0.0014	0.0030	0.0045
	(0.0028)	(0.0064)	(0.0091)
log(Own Source Revenue pc)	0.0168**	0.0356**	0.0524**
	(0.0075)	(0.0186)	(0.0255)
log(Capital expenditure pc)	–0.0130***	–0.0275**	–0.0405**
	(0.0037)	(0.0112)	(0.0145)
log(Operations expenditure pc)	0.1105***	0.2332***	0.3437***
	(0.0154)	(0.0692)	(0.0808)
log(Population density)	–0.1076***	–0.2273**	–0.3349**
	(0.0365)	(0.1026)	(0.1353)
log(Transition to sec. school rate)	0.0041	0.0086	0.0127
	(0.0038)	(0.0088)	(0.0125)

5.4. Economic performance convergence test results

Table 5-5 presents the results of both non-spatial and spatial convergence models, with county GCP per capita growth as the dependent variable. Across all specifications, the negative and highly significant coefficient on initial GCP per capita confirms robust β-convergence, consistent with neoclassical growth theory: poorer counties consistently grow faster than wealthier ones, narrowing inter-county income gaps.

The non-spatial absolute convergence models suggest unconditional convergence, although the one-way FE model exhibits limited explanatory power ($\beta = –0.203$, $p<0.001$, $R^2 = 0.10$), indicating unobserved heterogeneity. Incorporating both county- and time-specific effects (two-way FE) enhances convergence ($\beta = –0.502$, $p<0.001$, $R^2 = 0.258$), emphasising the influence of national-level movements such as macroeconomic shifts and fiscal transfers. Conditional convergence further indicates that growth

outcomes depend on fiscal-demographic heterogeneity ($\beta = -0.496$, $P<0.001$, $R^2 = 0.335$), with operational expenditure per capita consistently driving convergence, while capital spending and intergovernmental transfers remain insignificant. This highlights the growth importance of recurrent expenditure in maintaining service delivery and institutional capacity, as well as the limitations of formula-based transfers without endogenous, county-specific development strategies.

The spatial models show that convergence dynamics are spatially interconnected. The SDM reports a modest positive spatial lag ($\rho = 0.152$, $p=0.1$), aligned with growth spillovers through trade, infrastructure, and labour mobility. In contrast, the SARAR–SDM indicates a strongly negative spatial lag ($\rho = -0.704$, $p<0.001$), suggesting competitive or substitution effects, along with a large positive spatial error ($\lambda = 0.755$, $p<0.001$), reflecting highly correlated unobserved shocks, such as national reforms, climatic variability, or cross-county investments, which cause regional co-movement. This dual process implies that counties function within a system of simultaneous spillovers, competition, and shared shocks, requiring spatially explicit frameworks to understand the effects of devolution.

Overall, the consistent evidence of β-convergence supports the long-term viability of fiscal devolution in reducing regional disparities. However, the insignificance of capital expenditure indicates inefficiencies in development pipelines, while the negative relationship with population density reflects congestion pressures in urbanised counties. These findings emphasise the need to improve capital project efficiency, decongest urban centres, and promote balanced growth through spatial planning and rural transformation.

Table 5-5: Non-Spatial and Spatial Convergence Hypothesis Test Results (FY 2013/14-2022/23)

Variable	**Non-Spatial Absolute (plm, 1-way) (1)**	**Non-Spatial Absolute (plm, 2-way) (2)**	**Non-Spatial Conditional (plm,) (3)**	**Spatial SDM -FE (SPLM) (4)**	**Spatial SARAR-SDM – FE(SPLM) (5)**
Spatial lag (ρ)				0.1520*	-0.7035***
				(0.0606)	(0.0977)
Spatial error (λ)					0.7553***
					(0.0479)
Initial gross county product	-0.203***	-0.502***	-0.496***	-0.4845***	-0.4775***
	(0.031)	(0.044)	(0.038)	(0.0359)	(0.0378)
log(Equitable share per capita)			-0.002	-0.0018	-0.0031
			(0.004)	(0.0039)	(0.0032)
log(Total grants per capita)			-0.0004	-0.0008	0.0011
			(0.003)	(0.0028)	(0.0029)
log(OSR per capita)			0.0062	0.0051	-0.0009
			(0.0075)	(0.0069)	(0.0059)

log(Capital expenditure per capita)			0.0075 (0.0061)	0.0072 (0.0057)	0.0018 (0.0052)
log(Operational expenditure per capita)			0.137*** (0.0158)	0.1348*** (0.0146)	0.0873*** (0.0143)
log(Population density)			0.027 (0.042)	0.0264 (0.0389)	-0.1234** (0.0475)
log(transition to secondary rate)			0.0063 (0.0039)	0.0061. (0.0036)	0.0044 (0.0032)
n	47	47	47	47	47
N	423	423	423	423	423
T	9	9	9	9	9
R-squared	0.104	0.258	0.335		

Note: Significance levels: *** p < 0.001, ** p < 0.01, * p < 0.05.

Table 5-6 results show that initial economic disparities and complex spatial spillovers influence Kenya's county growth convergence, whose direction and magnitude depend on fiscal structure and inter-county linkages. Operational expenditure consistently emerges as the primary growth and convergence driver, yet competitive displacement can diminish its advantages without coordinated service delivery frameworks. Conversely, equitable share transfers and grants remain spatially neutral, highlighting the need for performance-based, collaboration-focused fiscal strategies. Harnessing these dynamics requires moving from isolated county efforts to a networked regional development approach that explicitly taps into positive spillovers while reducing negative externalities.

Table 5.6. Kenya's spatial convergence drivers and spillovers

Variable	SDM – Direct	SARAR–SDM – Direct	SDM – Indirect	SARAR–SDM – Indirect	SDM – Total	SARAR–SDM – Total
Initial gross county product	-0.487*** (0.036)	-0.506*** (0.040)	-0.085* (0.041)	0.226*** (0.030)	-0.571*** (0.061)	-0.280*** (0.029)
log(Equitable share per capita)	-0.0018 (0.004)	-0.00327 (0.003)	-0.00031 (0.001)	0.00146 (0.002)	-0.0021 (0.005)	-0.00181 (0.002)
log(Total grants per capita)	-0.00076 (0.003)	0.00115 (0.003)	-0.00013 (0.001)	-0.00051 (0.001)	-0.00089 (0.003)	0.00064 (0.002)
log(OSR per capita)	0.0051 (0.007)	-0.00095 (0.006)	0.00088 (0.001)	0.00042 (0.003)	0.00596 (0.008)	-0.00052 (0.004)
log(Capital expenditure per capita)	0.00725 (0.006)	0.00189 (0.006)	0.00126 (0.001)	-0.00085 (0.002)	0.00852 (0.007)	0.00105 (0.003)
log(Operational expenditure per capita)	0.135*** (0.014)	0.0926*** (0.015)	0.0236* (0.011)	-0.0413*** (0.008)	0.159*** (0.020)	0.0513*** (0.009)
log(Population density)	0.0265 (0.037)	-0.130** (0.050)	0.00462 (0.008)	0.0584** (0.023)	0.0311 (0.044)	-0.0724** (0.028)

Variable	SDM – Direct	SARAR–SDM – Direct	SDM – Indirect	SARAR–SDM – Indirect	SDM – Total	SARAR–SDM – Total
log(transition to secondary rate)	0.00611 (0.004)	0.00464 (0.003)	0.00106 (0.001)	-0.00207 (0.002)	0.00717 (0.004)	0.00257 (0.002)

5.5. Conclusion

This study employs a non-spatial and fixed effects spatiotemporal econometric model (SARAR-SDM) to evaluate the economic performance of Kenyan counties in the context of fiscal decentralisation and regional economic performance. The findings indicate that spatial dependencies significantly affect economic outcomes, where a county's performance impacts neighbouring regions, underscoring the interconnectedness of regional economies. Adopting spatial frameworks can improve Kenya's assessment of fiscal decentralisation, enabling targeted, equitable growth policies. Policies should encourage inter-county collaboration to leverage shared infrastructure, trade, and resources while addressing inefficiencies from tax mimicking and yardstick competition by developing revenue measures suited to each county's unique economic conditions. With spatial interdependence shaping economic outcomes, counties should collaborate on shared infrastructure and resource management. Mechanisms for regional coordination, such as joint economic blocs or resource-sharing agreements, can optimise the impact of fiscal decentralisation.

Regarding fiscal decentralisation, the positive impact of OSR on economic performance indicates that policies should focus on strengthening counties' revenue-generation capabilities. This includes competitive learning to improve revenue forecasting, tax administration, broadening the local revenue base, and tailoring OSR strategies to fit each county's economic profile. Moreover, for OSR to drive growth effectively, counties should prioritise investments in high-impact areas like healthcare, agriculture, and SME development. Capacity-building programs in public finance management can help counties use OSR more strategically to tailor revenue strategies to local economic contexts. Also, the positive effect of operational expenditure on growth further emphasises the need for efficient spending, with counties prioritising resource allocation and transparency to drive economic performance.

There were inherent challenges to fiscal decentralisation policies to foster economic growth and convergence. Specifically, equitable share and conditional grants were largely ineffective in promoting growth. This ineffectiveness likely stems from misalignment with local needs,

inefficient management, and political influences. The limited effectiveness of equitable shares and conditional grants indicates a need for targeted reforms. Transfers should be designed to address specific county needs. This calls for revising the resource allocation formula and criteria. Transparent, performance-based transfers could better support economic growth. Capital expenditures also negatively impacted growth, possibly due to inefficiencies and the long-term nature of such projects. The negative impact of capital expenditure highlights the need to address inefficiencies. Counties should focus on transparent project management, curbing delays and cost overruns, and aligning investments with long-term development goals.

The study also finds evidence of absolute and conditional convergence, where poorer counties grew faster than wealthier ones, supporting the catch-up effect. Since poorer counties are catching up with wealthier ones, policy interventions should emphasise strategic investment in underdeveloped regions to maintain and strengthen this convergence. The policy interventions include enhancing targeted operational expenditures to improve service delivery in low-income counties, foster faster growth, and reduce regional disparities. Though the convergence test indicates that targeted spending is effective, it has been revealed that capital expenditure is inefficient. Kenya's devolution framework should emphasise improved efficiency and accountability in capital expenditure, transparent project management, and monitoring to ensure capital investments drive growth without delays or inefficiencies. Moreover, supporting convergence through fiscal decentralisation allows counties to align their spending with local needs. Kenya should continue enhancing the autonomy of counties to manage their resources effectively, ensuring that recurrent expenditures align with development priorities in each county.

This study demonstrates that fiscal decentralisation’s growth impact depends on revenue generation, management, and allocation practices. To optimise its benefits, Kenya should implement spatially informed, regionally coordinated policies that account for local contexts and incentivise efficient spending. By focusing on effective OSR collection, targeted operational expenditures, and coordinated regional investments, Kenya can harness spatial dependencies to promote sustainable, equitable growth. Aligning fiscal policies with local economic conditions and improving capital spending efficiency will allow Kenya to leverage fiscal decentralisation to catalyse balanced regional development. These findings have global relevance and are vital lessons for countries leveraging fiscal decentralisation for balanced economic growth and convergence.

5.5.1 Hypotheses outcomes

H5a: Fiscal decentralisation positively influences county-level economic performance, with significant spatial spillover impacting neighbouring counties.

This hypothesis is partially supported. The results provide strong evidence that own-source revenue and operational expenditure positively influence county-level economic performance, showing significant spatial spillover effects on neighbouring counties. Conditional grants offer only weak support, while equitable share shows no effect and capital expenditure negatively affects performance. The significant spatial parameters (λ and ρ) further confirm the presence of inter-county spillovers and feedback mechanisms. Therefore, fiscal decentralisation contributes positively to local economic performance primarily through OSR and operational spending, with evident spatial interdependence across counties.

H5b: Kenyan counties exhibit absolute β-convergence under devolution.

The results support the hypotheses. The consistently negative and significant β-coefficients for initial gross county product indicate that Kenyan counties have undergone absolute convergence under devolution.

H5c: Conditional convergence provides a better fit than absolute convergence when controlling for structural and fiscal heterogeneity.

The hypothesis is supported. Conditional convergence models provide a substantially better fit (R^2 = 0.335 vs. 0.104–0.258) and reveal the role of fiscal and structural heterogeneity, particularly operational expenditure and population density, in shaping convergence dynamics. The results demonstrate that while convergence is evident, its pace and pattern are conditioned by inter-county differences in fiscal capacity and demographic structure.

CHAPTER SIX: EMPIRICAL RESULTS (STUDY 3)

Spatial Interdependence and Fiscal-Economic Dynamics in Regional Health: A Spatiotemporal Analysis of Kenya's Devolution

6.1. Introduction

This study seeks to contribute to the existing body of knowledge by examining the impacts of regional fiscal and economic structures on health outcomes, particularly in Kenya's recent devolutionary framework. Through exploratory spatial data analysis (ESDA), spatial econometric techniques and a comprehensive analysis of spatial interdependencies, this study aims to provide actionable insights to inform policy formulation, improve governance practices, and ultimately contribute to sustainable development goals. Specifically, the study establishes the nexus between fiscal decentralisation and spatial dependence of health outcomes and other socioeconomic indicators. The study documents the spatial effects of fiscal decentralisation and health outcomes and accounts for the impacts of decentralisation policies and other regional characteristics in achieving and tracking health outcomes.

The study **hypothesis** includes:

H6a: Fiscal decentralisation reduces disparities in health outcomes (mortality, morbidity, composite health), conditional on county capacity and sectoral structure.

H6b: Equitable share and conditional grants are more effective than OSR in improving population-level health indicators.

H6c: Health outcomes are subject to spatial externalities, mediated by population density and sectoral composition.

6.2. Descriptive Statistics

This study employs spatiotemporal analysis (2015 - 2021). Data includes health indicators from the World Health Organisation's Global Burden of Disease database.[11] Fiscal data was compiled from reports from the Office of the Controller of Budget.[12] Economic indicators (Gross Value Added) were sourced from the Kenya National Bureau of Statistics. Data management and analysis were conducted using packages such as plm, splm, tmap, ggplot2, tidyverse, sp, and spdep, among others, available in the R and R Studio software ecosystem.

[11] Global Burden of Disease Collaborative Network, Global Burden of Disease Study 2019 (GBD 2019) Results (2020, Institute for Health Metrics and Evaluation – IHME) https://vizhub.healthdata.org/gbd-results/

[12] See reports at https://cob.go.ke/reports/consolidated-county-budget-implementation-review-reports/

The descriptive statistics are shown in Table 6-1. The table displays the four Health Outcome Indices on a bounded scale (0–100), suitable for comparing across counties and over time. Despite being bounded, the distributions show considerable internal variation: the Composite Health Outcome Index has a mean of 69.0 and a median of 72.2, indicating slight left skewness, which suggests most counties perform above average. Conversely, the Mortality Index and Morbidity Index have means and medians in the 28–29 range, with maximum values reaching 100, indicating some counties face significantly higher disease burdens. The Health Development Index has a mean of 64.8, lower than the general health index, implying that development-related health factors (e.g., infrastructure or services) lag health outcomes. The fiscal variables, including conditional grants per capita, equitable share per capita, and OSR per capita, are all highly right-skewed, as shown by their notable mean–median gaps. For example, conditional grants per capita range from Kshs. 1.35 to Kshs. 4,770.70, with a mean of 954.54 and a median of 781.54. The equitable share per capita reaches a maximum of Kshs. 22,869, suggesting that a few counties receive disproportionately large equitable shares, probably due to need or political factors. Own Source Revenue is also skewed per capita, with some counties collecting over Kshs. 2,800, indicating strong local revenue-generating capacities in some regions. These statistics highlight the diversity among counties and support the log transformation of certain variables.

Table 6-1. Summary Statistics for Health, Fiscal, and Socioeconomic Variables (2015–2021)

Variable	Mean	SD	Min	25th Pctl	Median	75th Pctl	Max
Health Outcome Index	69.0	19.8	0.0	58.0	72.2	84.7	100.0
Mortality Index	29.9	25.2	0.0	11.7	28.3	40.1	100.0
Morbidity Index	28.9	22.5	0.0	15.0	24.0	40.1	100.0
Health Development Index	64.8	23.9	0.0	55.0	68.2	79.8	100.0
Conditional Grants per capita	954.5	769.3	1.35	496.67	781.54	1173.27	4770.70
Equitable Share per capita	7202.25	2694.56	5.17	5212.27	6246.53	7700.74	22869.33
Own Source Revenue per capita	522.85	421.89	58.11	218.15	362.72	627.73	2826.89

Variable	Mean	SD	Min	25th Pctl	Median	75th Pctl	Max
GVA – Agriculture	34233.1	18864.0	615.3	20561.2	28265.7	43475.4	104316.0
GVA – Manufacturing	9010.6	8612.6	782.4	2591.1	5017.0	7953.5	60415.5
GVA – Education	7350.0	3725.2	1935	5403	7157	8489	39095
Population Density (per km²)	553.25	952.71	6.05	56.11	242.56	456.08	7431.88
Crime Index	158.97	65.83	28.02	115.82	154.57	202.28	359.62

Notes: All currency figures are in Kenyan Shillings (Kshs); Health indices are normalised to a 0–100 scale. SD = Standard Deviation

6.3. Exploratory Spatial Data Analysis

6.3.1. Tests for Spatial Dependence

We applied the global Moran's I test to the baseline model composite health outcome residuals using a row-standardised spatial weights matrix based on first-order contiguity. The observed Moran's I statistic ($I = 0.1815$, $p < 0.0001$) is significantly higher than its expected value under the null hypothesis of spatial randomness ($E[I] = -0.0030$). The associated standard deviation ($Z = 5.16$) exceeds conventional critical thresholds, indicating strong statistical significance at the 0.1% level. These results provide robust evidence of positive spatial autocorrelation in the residuals, suggesting the existence of unobserved spatial spillovers or latent spatial processes. Consequently, the residuals violate the spatial independence assumption, necessitating spatial econometric models to ensure unbiased and consistent estimates.

Subsequently, we estimated and visualised the Local Indicators of Spatial Association (LISA). The LISA clusters in Figure 1 illustrate spatial clustering patterns in county-level health outcomes. The High-High (hotspots) cluster, which includes Narok and Baringo, demonstrates high composite health outcomes, surrounded by equally high-performing counties that showcase significant local spatial clustering. The positive regional health clusters suggest a

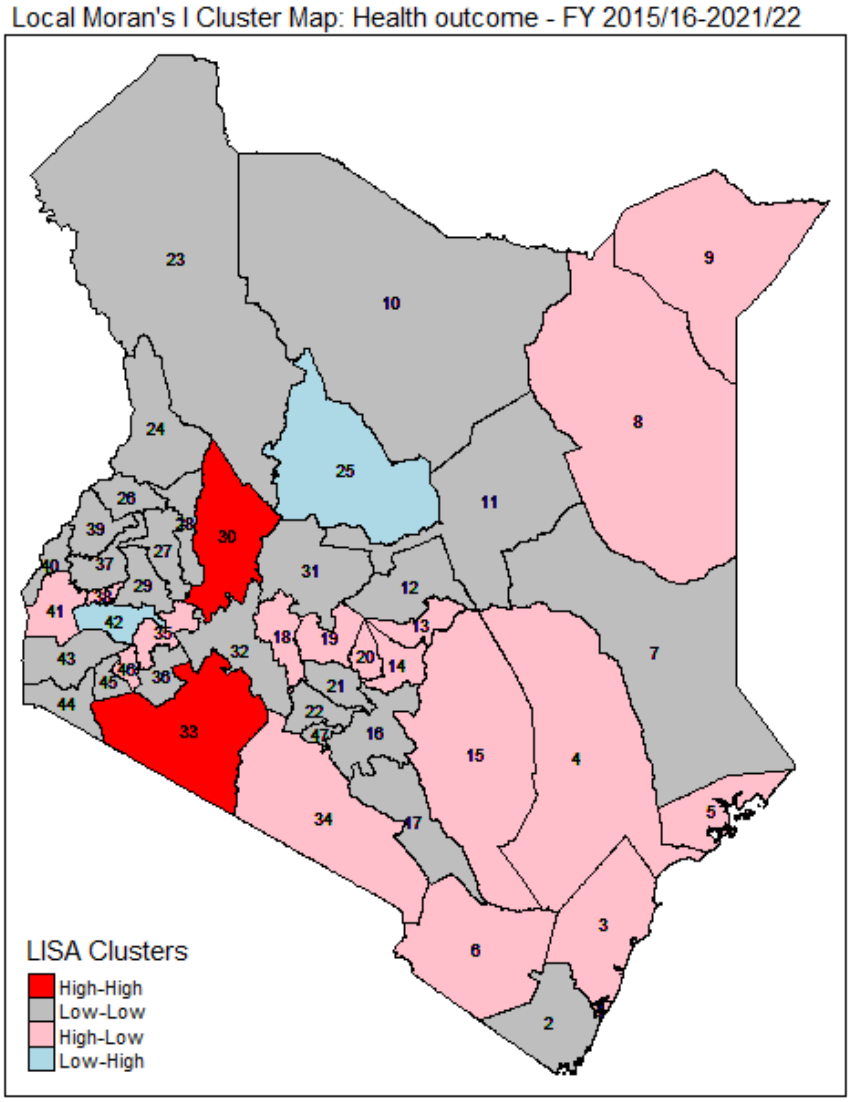
spatial diffusion of favourable health outcomes across neighbouring counties. Contrary to traditional assumptions that these areas are underserved or pastoralist, their composite performance indicates effective health interventions that have improved morbidity control, reduced mortality, or increased life expectancy. This also implies a likely resilience within the health system or a targeted focus from donors or the government in these regions.

The Low-High composite health outcomes cluster, which includes Samburu and Kisumu counties, indicates negative outliers in healthier regions. Despite the proximity to improving counties, this may stem from localised breakdowns in the health system, urban poverty, and inequality in Kisumu, which can obscure overall county performance, or from access barriers in Samburu, respectively.

The High-Low composite health cluster (Mombasa, Kilifi, Tana River, Lamu, Taita Taveta, Wajir, Mandera, Tharaka-Nithi, Embu, Kitui, Nyandarua, Nyeri, Kirinyaga, Kajiado, Kericho, Vihiga, Siaya, and Nyamira) highlights positive outliers in otherwise underperforming regional settings. This may be attributed to robust local governance or effective health management teams, including peer-to-peer county mentoring and fiscal strategy linkages (e.g. Health Facility Improvement Fund allocations and conditional grants), as well as urban and peri-urban infrastructure (e.g., Mombasa, Nyeri, Kitui), county investments, external partner support, or favourable social determinants.

The Low-Low health outcomes form a cluster of counties (Kwale, Garissa, Marsabit, Isiolo, Meru, Machakos, Makueni, Murang'a, Kiambu, Turkana, West Pokot, Trans Nzoia, Uasin Gishu, Elgeyo-Marakwet, Nandi, Laikipia, Nakuru, Bomet, Kakamega, Bungoma, Busia, Homa Bay, Migori, Kisii and Nairobi City) exhibiting persistently poor health outcomes, surrounded by similarly low-performing neighbours, which demonstrates significant spatial clustering. The inadequate health outcomes may stem from health system strain in urban counties (e.g., Nairobi), where slum conditions adversely affect overall performance, alongside underinvestment in health in rural or northern counties that face long-standing health access constraints.

Fig. 5-1 Local Moran's I Cluster Choropleth



Source: Authors' Visualisation

Note: 1=Mombasa, 2=Kwale, 3=Kilifi, 4=Tana River, 5= Lamu, 6=Taita Taveta, 7 = Garissa, 8=Wajir, 9 = Mandera, 10= Marsabit, 11 = Isiolo, 12 = Meru, 13 = Tharaka -Nithi, 14 = Embu, 15 = Kitui, 16 = Machakos, 17 = Makueni, 18 = Nyandarua, 19 = Nyeri, 20 = Kirinyaga, 21 = Murang'a, 22 = Kiambu, 23 = Turkana, 24 = West Pokot, 25 = Samburu, 26 = Trans Nzoia, 27 = Uasin Gishu, 28 = Elgeyo-Marakwet, 29 = Nandi, 30 = Baringo, 31 = Laikipia, 32= Nakuru, 33 = Narok, 34 = Kajiado, 35 = Kericho, 36 = Bomet, 37 = Kakamega, 38 = Vihiga, 39 = Bungoma, 40 = Busia, 41 = Siaya, 42 = Kisumu, 43 = Homa Bay, 44 = Migori, 45 = Kisii, 46 = Nyamira, 47 = Nairobi City

Consequently, to assist in selecting the appropriate model for estimation, we performed a panel Lagrange Multiplier (LM) test using a fixed effects specification to assess the presence and nature of spatial dependence in the residuals of the baseline model. The results showed highly significant LM-lag and robust LM-lag tests, along with a non-significant robust LM-error test, providing strong evidence that the spatial dependence in the model is best described

by a spatial lag process rather than a spatial error process, as shown in Table 5-3. This indicates that the composite health outcome in a particular county is significantly affected by the outcomes in surrounding counties, consistent with endogenous spatial spillovers. Consequently, we estimated the spatial lag model using Maximum Likelihood via the SPML package in R software.

Table 6-3: Lagrange Multiplier (LM) and Robust LM Test for Spatial Dependence (FY 2015/16 – 2021/22)

Test	LM Statistic	p-value	Interpretation
LM Test for Spatial Error Dependence (LM error)	320.165	1.3334e-71	Strong evidence of spatial autocorrelation in the error terms under the null hypothesis of spatial independence.
LM Test for Spatial Lag Dependence (LM lag)	423.68	3.8589e-94	Strong spatial dependence in the dependent variable itself, consistent with endogenous spatial interaction effects
Robust LM Test for Spatial Error Dependence (Robust LM error)	0.0182	0.8928	Once spatial lag dependence is controlled for, there is no remaining significant spatial error autocorrelation.
Robust LM Test for Spatial Lag Dependence (Robust LM lag)	103.5332	2.5607e-24	Spatial lag dependence remained strongly significant, even after accounting for possible spatial error dependence.

6.3.2. Spatial clustering (choropleth maps)

This sub-section leverages choropleth maps to draw inferences from the spatial distribution of health, fiscal, and economic indicators.

6.3.2.1. Geospatial clustering of health outcome indicators

Geospatial analysis from Figure 6-2 (a-d) shows the distribution of Kenya's health outcomes. The highest composite health outcomes are in Embu, Machakos, Nairobi, Murang'a, Laikipia, Nakuru, Uasin Gishu, and Nandi counties. These counties form a cluster of high-performing neighbours, allowing positive spillovers through trade, mobility, and shared health innovations. Additionally, counties such as Nairobi, Nakuru, and Uasin Gishu are urbanised with better health infrastructure, human resources, and access to services.

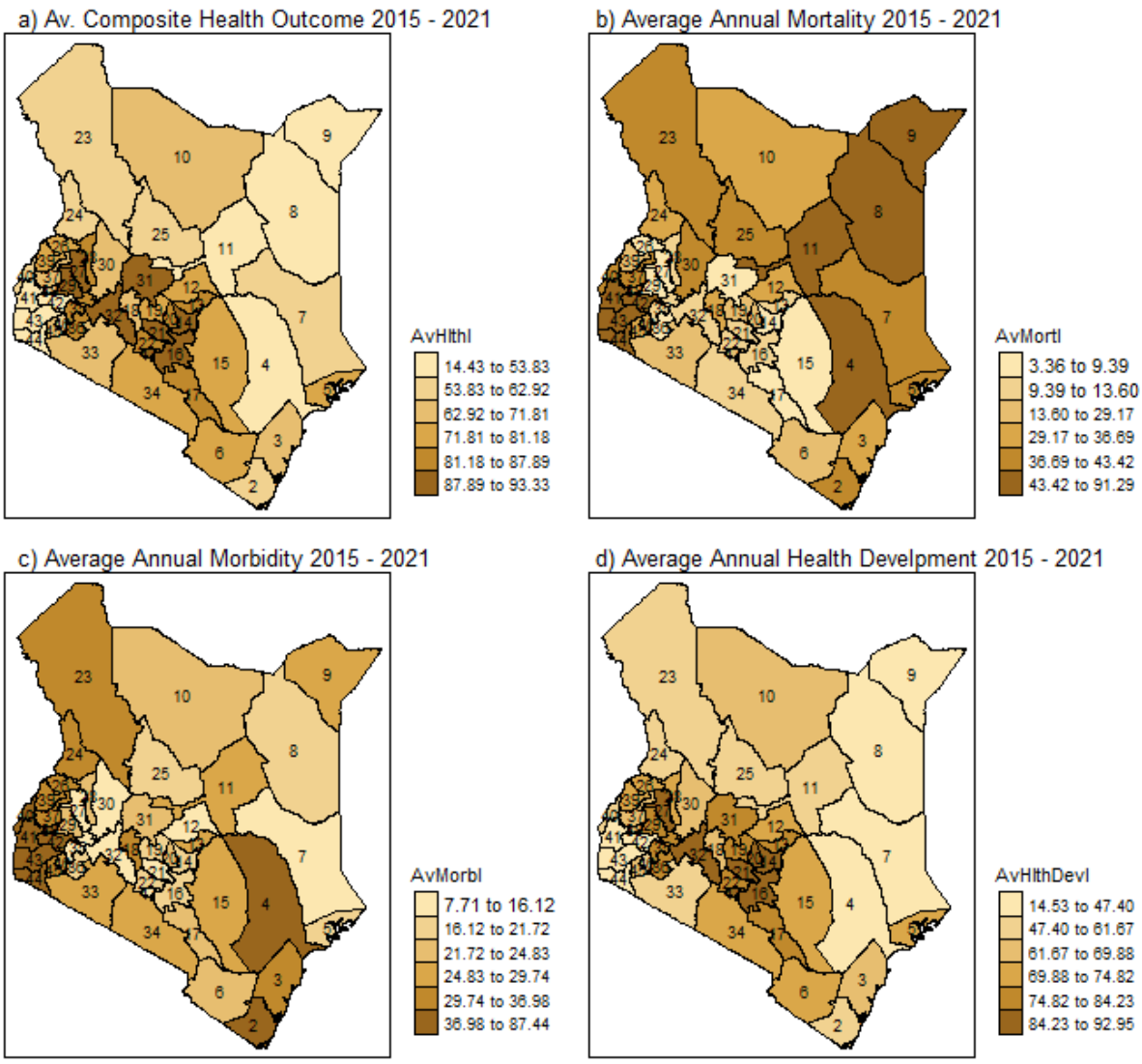
Figure 6- 2-b suggests that mortality outcomes are spatially dependent, with clusters of poor outcomes (Northern Kenya and Lake Region) reinforcing each other due to shared

environmental, socioeconomic, and institutional factors. This mortality pattern shows that the counties of Tana River, Wajir, Isiolo, and Mandera in Northern Kenya, as well as Migori, Homa Bay, Siaya, and Kisumu in the Lake Region, experience the highest mortality rates. Tana River, Mandera, Wajir, and Isiolo face peripheral disadvantages because they are geographically distant and have limited transport and health infrastructure, which increases the cost and difficulty of accessing healthcare. Furthermore, counties in the Lake Region (Migori, Homa Bay, Siaya, Kisumu) also face high levels of communicable diseases such as HIV/AIDS and malaria, contributing to higher mortality.

The high morbidity health outcome scores (Figure 6-c) in Kwale and Tana River (Coast Region) and Vihiga, Busia, Siaya, Kisumu, Homa Bay, and Migori (Western Kenya) reflect a complex interplay of epidemiological burden, socioeconomic factors, and spatial dynamics. The Western Kenya counties (Siaya, Kisumu, Homa Bay, Migori, Busia, and Vihiga) are situated within Kenya's Lake Region, exhibiting entrenched, spatially clustered disease ecologies and epidemiological hotspots for Malaria, HIV/AIDS, and waterborne diseases. Additionally, these counties are contiguous, enabling the transmission of health burdens across borders, particularly via shared waterways, markets, and transport routes. Kwale and Tana River, although coastal, share similar disease profiles owing to poor sanitation, limited access to clean water, and periodic flooding, all of which promote disease transmission.

The high Health Development Outcome Index scores in counties like Embu, Machakos, Kirinyaga, Murang'a, Nairobi, Uasin Gishu, and Nakuru (Figure 6-2-d) reflect several interconnected structural and spatial advantages. These counties have well-developed healthcare infrastructure, including high numbers of health facilities per capita, availability of specialised care services, and a greater presence of referral hospitals and training institutions. Additionally, counties like Nairobi, Machakos, and Kirinyaga benefit from urban spillovers, such as access to health markets, personnel, and innovations.

Figure 6-2: Geospatial distribution of mortality indicators in Kenya.



Source: Authors visualisation

6.3.2.2 Geospatial distribution of regional economic indicators

The spatial clustering of high Agricultural GVA in counties such as Nyandarua, Nyeri, Meru, Murang'a, Bomet, Nyamira, Nandi, and Vihiga (Figure 6-3-e) reflects agro-ecological endowments and historical path dependence. These highland zones exhibit favourable conditions, including fertile soils, reliable rainfall, moderate climate, and colonial-era infrastructure and land-use legacies that established them as agricultural cores. The densely populated counties like Vihiga and Nyamira intensify productivity through smallholder systems. As agricultural growth poles, these counties generate positive spatial spillovers via technology, input markets, and value chains, benefiting adjacent regions.

The choropleth maps (6-3-f) show that manufacturing activity is spatially concentrated in Machakos, Nairobi, Kiambu, Nyeri, Laikipia, Nakuru, and Narok, forming a distinct

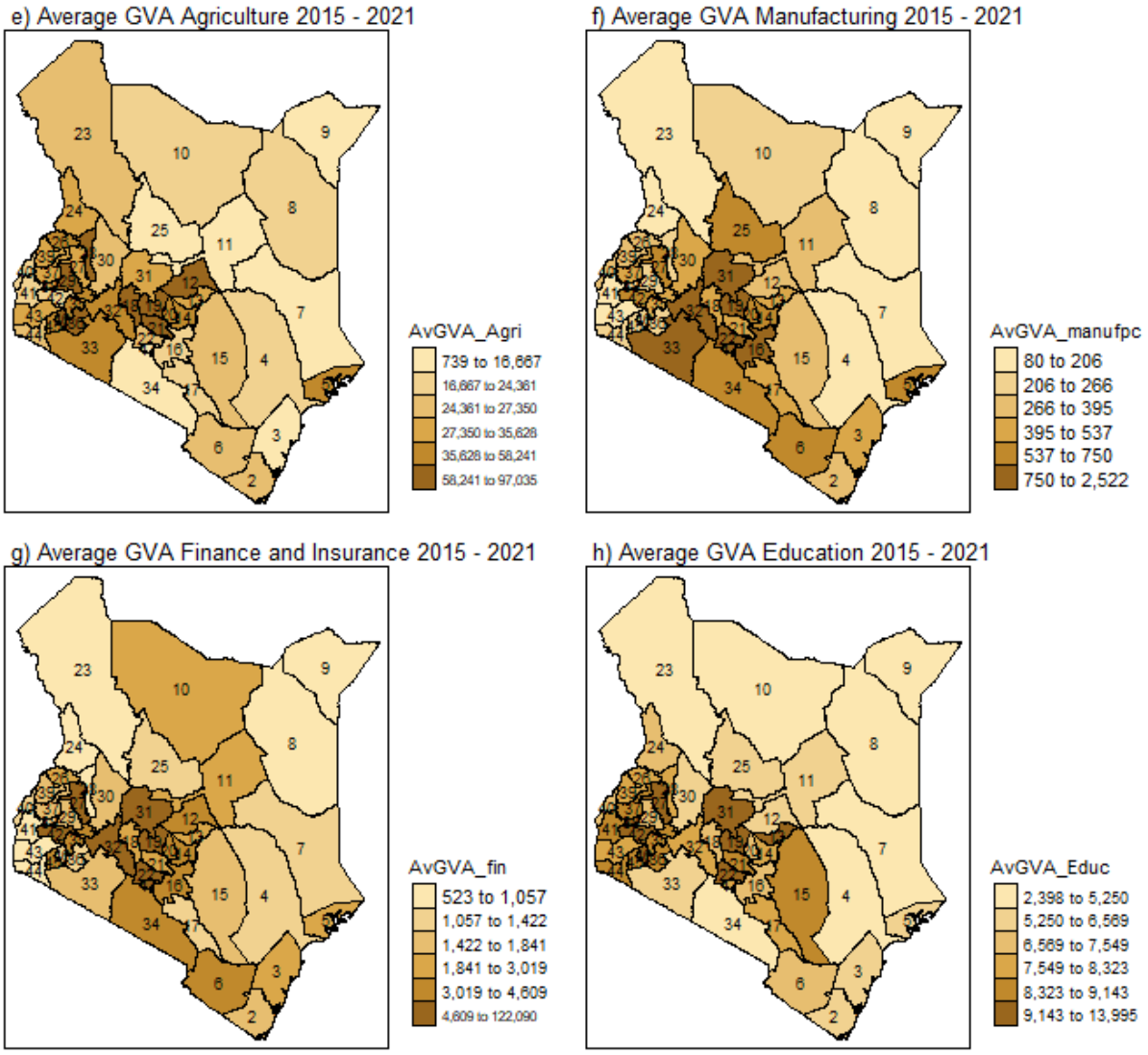
industrial corridor. This pattern aligns with proximity to urban areas, market access, and transport infrastructure. These counties benefit from agglomeration economies, including access to skilled labour, logistics, and energy. Conversely, Nyandarua and Murang'a, despite being geographically adjacent, display relatively lower manufacturing intensity. This spatial discontinuity may reflect institutional and infrastructural constraints, limited industrial zoning, or land-use rigidity rooted in agricultural path dependence. The divergence highlights diverse spatial spillover effects.

The choropleth map (Figure 6-3-g) shows a clear spatial clustering of financial and insurance services in Kiambu, Nairobi, Nakuru, Laikipia, Nyeri, Kisumu, and Uasin Gishu. This pattern reflects the influence of urbanisation economies, where focal counties benefit from high population densities, institutional presence, and digital infrastructure that support financial intermediation. These counties act as regional financial hubs, leveraging their roles as administrative, commercial, or transport centres. The observed clustering aligns with central place theory, which suggests that higher-order services tend to concentrate in counties with strong urban centrality and functional connectivity. The pattern also reveals a core-periphery structure in financial services distribution, with notable spatial spillovers into neighbouring counties through credit access, insurance penetration, and mobile banking networks.

The choropleth maps (Fig 6-3-h) show that Kiambu, Tharaka Nithi, Nyeri, Laikipia, Nyamira, Kisumu, Vihiga, and Uasin Gishu exhibit the highest levels of education sector activity, forming spatially coherent education clusters. These counties host major universities, teacher training colleges, and technical institutions, enhancing human capital capacity. Their spatial contiguity to moderate-performing neighbours suggests positive spatial spillovers, in line with knowledge diffusion theory. Education activity appears to follow a hierarchical spatial structure, where counties with established institutions stimulate growth in neighbouring areas through labour mobility, educational commuting, and institutional networks. This emphasises the role of education-driven growth poles in regional development and spatial equity.

The exploratory spatial analysis on the sectors discussed indicates that Kenya's economic landscape exhibits strong spatial heterogeneity shaped by agglomeration forces, functional specialisation, and path dependence. Each sector's spatial footprint reflects regional comparative advantages and reveals uneven development patterns with important implications for spatial equity and planning.

Figure 6-3: Spatial distribution of economic activities (2015-2021)



Source: Authors visualisation

6.3.2.1. Geospatial distribution of fiscal and population indicators

Regarding the fiscal indicators, the choropleth map reveals Own Source Revenue (OSR) per capita is highest in predominantly peripheral and arid counties such as Kwale, Lamu, Taita Taveta, Tana River, Isiolo, Mandera, Wajir, Turkana, Samburu, and Marsabit. This signals that some peripheral counties possess latent fiscal capacity rooted in spatial endowments or positional advantages.

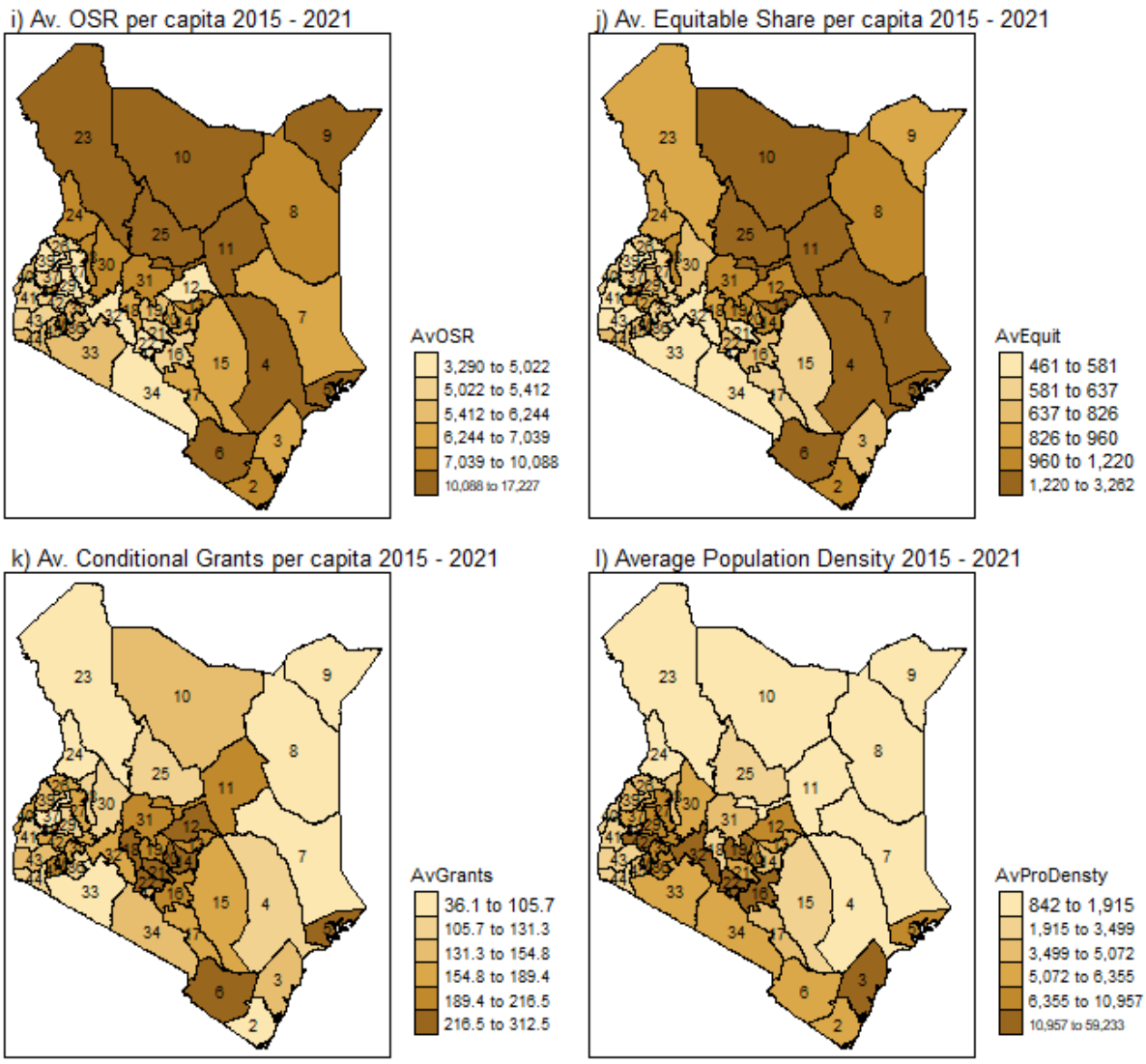
The choropleth map (Fig. 6-4-j) displaying the geospatial distribution of the equitable share per capita revealed the highest allocation clusters in counties such as Tana River, Lamu, Taita Taveta, Garissa, Marsabit, Isiolo, Tharaka-Nithi, and Samburu. These counties are mainly arid, semi-arid, sparsely populated, or historically underserved. The spatial clustering of these counties demonstrates Kenya's deliberate strategy of spatial equalisation. It underscores how

intergovernmental fiscal transfers serve as tools for spatial justice, aiming to balance historically uneven development paths. For the impact to be meaningful, such transfers must be supported by spatially targeted planning, capacity building, and infrastructure development to turn allocative flows into sustainable territorial growth.

The geospatial map (Fig. 6-4 - k) shows that conditional grants per capita are highest in counties such as Meru, Embu, Nyandarua, Kirinyaga, Murang'a, and Kiambu, reflecting a spatial concentration of targeted sectoral investment flows aligned with development potential and absorptive capacity. This cluster is located within Kenya's Central Highlands corridor, a subnational growth pole characterised by dense settlements, productive smallholder agriculture, and well-established service economies, making it a prime target for performance-based grants. The spatial pattern demonstrates how conditional funding mechanisms often reinforce core-periphery disparities by flowing to counties with higher technical readiness and absorptive capacity. Additionally, conditional grants may be driven by potential for inter-county spillovers, where investments yield regional public goods benefiting neighbouring jurisdictions (e.g., shared health referral facilities, agricultural value chains).

The choropleth map (Fig. 6-4-l) displays a high-density core centred on Machakos, Nairobi, Kiambu, Nakuru, Nyeri, and Kirinyaga, forming the demographic heart of Kenya's settlement system. Anchored by Nairobi's metropolitan influence, this cluster reflects agglomeration economies driven by employment, services, and connectivity. The contiguous peri-urban belt, including Murang'a and Nyandarua, shows spillover effects from urban centres through commuter zones and satellite towns, illustrating the dynamics of a polycentric urban region. Conversely, Kenya's northern peripheral zones, including Turkana, Marsabit, Mandera, Wajir, Isiolo, Samburu, and Tana River counties, are primarily arid and semi-arid lands (ASALs) characterised by low population densities. These regions experience limited rainfall, sparse settlements, and nomadic pastoralist systems, leading to a dispersed demographic pattern with minimal urbanisation and infrastructural concentration. Their peripheral location and ecological constraints contribute to marginalisation from core spatial development zones, reinforcing spatial inequality across the national territory.

Figure 6-4: Spatial distribution of fiscal indicators



Source: Authors visualisation

The geospatial distributions illustrate the systematic clustering and heterogeneities across health, fiscal, economic, and demographic variables. This indicates that a few counties dominate in terms of fiscal capacity, economic output, and population concentration. Such heterogeneity justifies using spatiotemporal econometric models to account for non-independence across space and time and highlights the necessity for equity-oriented health and fiscal policies.

6.4. Confirmatory Spatial Data Analysis (CSDA)

6.4.1 Non-Spatial Model

We estimated non-spatial Fixed Effects (FE) and Random Effects (RE) panel models as a baseline. Subsequently, we conducted the Hausman tests to provide a clear and statistically robust conclusion regarding model selection between FE and RE. As presented in Table 6-2,

the results consistently support using FE specifications in the panel health outcome models. This highlights the non-random structure of county-level heterogeneity, suggesting that spatial units (counties) possess unique, time-invariant characteristics that influence the relationship between fiscal capacity, sectoral GVA, regional demographics, and health outcomes. These four fixed effects models account for time-invariant heterogeneity across counties by estimating within-unit (county-specific) variations over time.

Table 6-2: Hausman Tests

	Model	Chi-sq	p-value	Interpretation
1	Composite Health Outcome	91.181	9.43e-16	FE is preferred
2	Mortality Outcome	49.671	1.24e-07	FE is preferred
3	Morbidity Outcome	262.05	2.2e-16	FE is best
4	Health Development	77.53	4.99e-13	FE is preferred

6.4.1.1. Non-Spatial Fixed Effects Models

The results of the non-spatial models are presented in Table 6-4. The fiscal variables demonstrate that conditional grants consistently emerge as the most robust fiscal determinant, significantly improving the health index, reducing mortality and morbidity, and fostering health development. This supports the hypothesis that intergovernmental fiscal transfers effectively enhance subnational health capacity, aligning with regional equity goals. The Own-Source Revenue (OSR) significantly affects mortality negatively, suggesting that local fiscal autonomy aids in life-saving services. However, its effects on other outcomes are insignificant, hinting at limited local discretion or inefficiencies in applying OSR in the health sector. The equitable share (unconditional transfers) is insignificant, implying that discretionary, targeted transfers (conditional grants) may be more effective than rule-based transfers in improving regional health outcomes.

The findings highlight the significance of economic structure in shaping regional health outcomes. Gross value added (GVA) from the financial and insurance sectors consistently positively influences the composite health index and health development, while significantly reducing morbidity. This suggests that the expansion of the financial sector facilitates health improvements through risk pooling (insurance), access to credit for health infrastructure, and broader investment in health-related services, supporting Kenya's strategic focus on universal health coverage through sustainable health financing. In contrast, manufacturing GVA is linked

to adverse health outcomes, considerably worsening morbidity and the composite health index. This aligns with regional science perspectives on industrial externalities, including environmental degradation, occupational hazards, and effects of urban crowding. However, these results should be interpreted cautiously given Kenya's policy orientation towards manufacturing-driven growth, particularly through agro-processing and value chain integration. Additionally, the positive association between agricultural GVA and morbidity may reflect occupational health risks, limited healthcare access, or service deficits in rural, agrarian counties, highlighting persistent spatial inequalities in health service delivery. Educational GVA, meanwhile, demonstrates limited statistical significance, suggesting that its health effects may operate through longer-term or more indirect spatial channels that are not captured within the model's temporal scope.

The demographic and social indicators reveal a nuanced health trade-off associated with population density. While higher density correlates with deteriorating outcomes in the composite health and mortality models, it is positively associated with morbidity, reflecting increased transmission potential in densely populated settings. This duality supports the regional science perspective that agglomeration economies may generate diseconomies, particularly in health externalities, thereby underscoring the need for spatially differentiated urban health interventions. The reinforcing effect of manufacturing GVA on adverse health outcomes further supports this interpretation, as industrial regions often attract large labour inflows without corresponding investment in basic amenities such as housing, Water, Sanitation, and Health (WASH) infrastructure, education, and healthcare. Although the crime index exhibits weak and largely insignificant effects, its modest association with higher mortality may indicate indirect pathways through social stress or data quality issues, particularly in densely industrialised regions.

Table 6-4. Fixed Effects Health Outcome Models

Variable	FE – Composite Health Index	FE – Mortality Index	FE – Morbidity Index	FE – Health Dev. Index
log(OSR per capita)	1.020	−2.874 ***	2.520	1.791
	(1.204)	(0.863)	(1.694)	(1.189)
log(Equitable share per capita)	0.896	−0.618	−0.951	0.803
	(0.829)	(0.594)	(1.167)	(0.819)
log(Conditional Grants per capita)	2.793 ***	−1.501 ***	−3.526 ***	2.451 ***
	(0.558)	(0.400)	(0.785)	(0.551)

Variable	FE – Composite Health Index	FE – Mortality Index	FE – Morbidity Index	FE – Health Dev. Index
log(GVA- Agriculture per capita)	−3.248 (4.132)	−5.099• (2.962)	12.514 * (5.815)	−2.424 (4.080)
log(GVA- Finance and Insurance per capita)	6.404 *** (1.341)	−1.218 (0.961)	−11.798 *** (1.887)	4.706 *** (1.324)
log(GVA – Education per capita)	−1.853 (1.517)	−0.166 (1.087)	3.842• (2.134)	−1.494 (1.497)
log(GVA Manufacturing per capita)	−19.510 *** (5.239)	−2.461 (3.755)	39.051 *** (7.372)	−17.494 *** (5.172)
log(Population density)	−61.343 *** (7.028)	−36.969 *** (5.037)	160.826 *** (9.890)	−51.517 *** (6.938)
Crime Index	0.023 (0.015)	−0.019• (0.011)	−0.026 (0.021)	0.017 (0.015)
R-Squared	0.344	0.352	0.592	0.278
Adj. R-Squared	0.212	0.222	0.509	0.133
F-statistic (9,273)	15.922 *** (p < 2.2e-16)	16.501 *** (p < 2.2e-16)	43.953 *** (p < 2.2e-16)	11.694 *** (p= 1.54e-15)
N	47	47	47	47
N×T	329	329	329	329

Significance codes: *p < 0.001, p < 0.01,* p < 0.05**, •p < 0.1

6.4.2 Spatiotemporal Models

6.4.2.1 Spatial Durbin Models for Regional Health Outcomes

While the FE panel models control unobserved heterogeneity across counties and time, they assume independence among spatial units. Given the significant spatial spillovers in the data, evident in the global Moran's I, LISA, and Lagrange Multiplier tests for spatial dependence, the spatial panel models were estimated to capture the interdependence of health outcomes across regions. By explicitly modelling spatial lags, the spatial lag model corrects for spatial autocorrelation and provides more reliable estimates of direct and indirect effects, thereby offering a more robust and policy-relevant understanding of regional health determinants.

Table 6-5 presents the results of the maximum likelihood (ML) estimation for each of the four health outcome models, comprising the composite health outcome and its decomposed components, including the mortality, morbidity, and health development models. These are

presented side by side for comparison. All four Maximum Likelihood spatial autoregressive (SAR) models yielded strong, significant spatial lag coefficients (λ) between 0.73 and 0.92, pointing to strong endogenous spatial interactions. This underscores the role of policy diffusion, regional benchmarking and shared service delivery structures.

Specifically, the composite health outcome exhibits a highly significant SAR coefficient ($\lambda = 0.886$, $p < 0.001$), confirming strong spatial dependence in health outcomes across counties. This implies that health performance in one county significantly influences neighbouring counties through spatial spillovers in health service delivery. The direct effects indicate that OSR per capita has a marginally significant positive association with the composite health index ($p \approx 0.077$), suggesting that locally raised revenues might enhance health infrastructure and service delivery, albeit with moderate certainty. Regarding regional demographic characteristics, population density demonstrates a significant negative direct impact (-12.42, $p < 0.001$), indicating that more densely populated areas may experience greater strain on health services or poorer composite health outcomes. Moreover, the indirect effects (spatial lags) reveal that the externalities of population density are highly significant and negative (mean = -92.99, $p < 0.001$), confirming that high density in neighbouring regions has adverse spillover effects, likely due to regional congestion, urban pollution, and bottlenecks (strain on infrastructure) in health service diffusion.

In granular form, the Mortality Model reveals a significant spatial autoregressive parameter ($\lambda = 0.731$, $p < 0.001$), confirming that outcomes strongly influence mortality in a focal county on neighbouring counties. The direct effect of OSR is significantly negative (-1.19, $p < 0.05$), indicating that enhancing OSR reduces mortality rates, possibly through adaptation and improvements in access to preventive or curative healthcare. The negative and significant indirect impact of OSR (-3.01, $p < 0.05$) signals that investments in local fiscal capacity yield regional public health dividends, confirming the positive spatial externalities of decentralisation. Additionally, regional population density has a significantly negative direct effect (-8.08, $p < 0.05$) and exerts a strong spatial spillover effect (-20.56, $p < 0.05$), suggesting the spatial diffusion of mortality risks in populous corridors.

The Morbidity Model has the highest spatial autoregressive parameter ($\lambda = 0.919$, $p < 0.001$) among all the models, indicating exceptionally high spatial dependence in disease burden and management. This implies a strong spatial transmission mechanism of morbidity patterns, possibly due to the spread of communicable diseases or shared environmental and social determinants. The direct effects demonstrate that equitable share per capita significantly

reduces morbidity (-0.91, $p < 0.01$), suggesting that redistributive intergovernmental transfers help offset health disparities. The indirect effect of equitable share per capita is also significantly negative (-10.05, $p < 0.05$), indicating considerable inter-jurisdictional spillovers of redistributive finance on health outcomes. The regional demographic dynamics reveal that population density has a notably large and significant positive direct (17.09, $p < 0.001$) and indirect impact (191.19, $p < 0.001$), underscoring how urban concentration exacerbates disease burden both locally and in spatially connected areas.

The health development model demonstrates a strong spatial autocorrelation ($\lambda = 0.864$, $p < 0.001$), confirming that health development progresses in clusters of spatial dependence. The direct effect of OSR per capita is significantly positive (1.37, $p < 0.01$), while its indirect effect is also notably positive (8.44, $p < 0.01$). This dual significance indicates that spatial fiscal federalism encourages local and regional health development. The population density consistently exerts significant negative spillovers (-87.78, $p < 0.001$), suggesting that crowding effects in one region can undermine health development in neighbouring jurisdictions through resource dilution, policy competition, and health infrastructure overload.

Table 6-5: Spatial Lag Panel Model Estimates

Variable	ML Composite Health Index	ML Mortality Index	ML Morbidity Index	ML Health Dev. Index
Spatial Lag **(λ)**	0.886 ***	0.731 ***	0.919 ***	0.864 ***
	(0.021)	(0.039)	(0.015)	(0.024)
log(OSR per capita)	0.784 .	-1.187 *	0.245	1.369 **
	(0.444)	(0.543)	(0.470)	(0.484)
log(Equitable Share per capita)	0.101	0.161	-0.910 **	-0.161
	(0.306)	(0.372)	(0.321)	(0.333)
log(Conditional Grants per capita)	0.300	-0.353	-0.324	0.315
	(0.207)	(0.251)	(0.217)	(0.225)
log(GVA – Agriculture per capita)	0.886	-2.270	-0.518	0.465
	(1.524)	(1.856)	(1.604)	(1.662)
log(GVA – Financial and Insurance per capita)	0.665	-0.496	-0.509	0.636
	(0.494)	(0.601)	(0.519)	(0.539)
log(GVA- Education per capita)	0.488	-0.664	0.411	0.820
	(0.559)	(0.679)	(0.589)	(0.610)
log(GVA – Manufacturing per capita)	1.879	-3.795	-1.246	0.454
	(1.941)	(2.355)	(2.059)	(2.123)
log(Population Density)	-12.418 ***	-8.076 *	17.086 ***	-14.442 ***

Variable	ML Composite Health Index	ML Mortality Index	ML Morbidity Index	ML Health Dev. Index
	(2.840)	(3.440)	(3.399)	(3.123)
Crime index	0.0089	-0.0127 .	-0.0049	0.0064
	(0.006)	(0.007)	(0.006)	(0.006)
lag. log(OSR per capita)	5.956	-3.015*	2.861	8.445**
	(3.692).	(1.572)	(5.447)	(3.522)
lag. log(Equitable share per capita)	0.807	0.441	-10.045*	-0.932
	(2.325)	(0.964)	(4.357)	(2.063)
lag. log(Grants per capita)	2.243	-0.913	-3.675	1.906
	(1.719)	(0.705)	(2.662)	(1.498)
lag. log(GVA Agriculture per capita)	6.406	-5.800	-5.603	2.927
	(11.595)	(4.871)	(17.917)	(10.248)
lag. log(GVA Finance & Insuance per capita)	5.168	-1.218	-5.441	4.010
	(4.100)	(1.620)	(6.133)	(3.619)
lag. log(GVA Education per capita)	3.576	-1.727	4.558	4.978
	(4.476)	(1.805)	(6.967)	(4.061)
lag. log(GVA Manufacturing per capita)	14.784	-10.013	-14.764	2.253
	(15.737)	(6.501)	(23.677)	(13.287)
lag. log(Population density)	-92.996***	-20.555*	191.188***	-87.778***
	(30.310)	(9.892)	(59.756)	(27.361)
lag. Crime index	0.068	-0.032	-0.052	0.040
	(0.045).	(0.019).	(0.067)	(0.039)
N	47	47	47	47
N × T	329	329	329	329

Significance codes: *p < 0.001, p < 0.01,* p < 0.05**, .p < 0.1
ML = Maximum Likelihood using `spml`; All models use within estimator and include spatial lag (λ), no spatial error

6.5. Conclusion

We employed spatiotemporal econometric analysis of composite health, mortality, morbidity, and health development indices to elucidate that health outcomes are spatially interconnected with strong fiscal-health linkages. This has significant implications for public health policy, fiscal federalism, and spatial planning. The policy implication is that health outcomes in a focal county are spatially dependent on conditions in neighbouring counties. This

justifies national government interventions and inter-county collaboration in health system planning and investment.

The revenue and expenditure autonomy provided by Own-Source Revenue (OSR) and the equitable share transfers exemplify the influence of regional fiscal dynamics on health outcomes. Concerning the direct effects, OSR is positively associated with improved composite health and health development outcomes and notably reduces mortality directly. Moreover, spillover effects reveal that OSR further benefits neighbouring counties' outcomes, particularly in health development, and decreases mortality. This indicates that strengthening local fiscal capacity improves local health outcomes and creates positive spatial externalities. Thus, policies promoting fiscal decentralisation and enhancing counties' revenue mobilisation are vital for regional health equity. Conversely, equitable share transfers tend to lower morbidity burdens, as evidenced by a significant negative direct effect on morbidity and additional negative impacts. Equitable intergovernmental transfers assist in redistributing resources to underserved areas, thereby reducing regional health disparities, especially regarding chronic disease burdens. This supports the continuation and strategic use of equity-based transfers. Direct and indirect spatial effects imply that policy interventions targeting local health determinants have spatially diffuse consequences, emphasising the need for coordinated regional planning.

Regarding regional demographic dynamics, population density is a crucial spatial factor. Population density consistently significantly negatively impacts health development and overall health outcomes, both directly and indirectly. Furthermore, higher population density increases morbidity, possibly due to urban disease transmission or system overload. This suggests that urban areas need substantial health infrastructure investment and reduced congestion. Urban planning and decentralisation of services could reduce health pressures in high-density areas.

The varying signs and significance levels across models demonstrate the outcome-specific nature of spatial dependencies, reinforcing that mortality, morbidity, and health development respond differently to the spatial structure of socio-economic determinants.

Overall, these findings substantiate key tenets of New Economic Geography and Fiscal Federalism within regional science, highlighting how place-based economic structures, fiscal autonomy, and intergovernmental transfers interact to shape the efficiency of public health delivery. By integrating spatial dependence and spillover effects, the study underscores the importance of regional coordination and localised policy responses in advancing social welfare and accelerating progress toward the Sustainable Development Goals.

6.5.1. Hypothesis outcomes

H6a: Fiscal decentralisation reduces disparities in health outcomes (mortality, morbidity, composite health), conditional on county capacity and sectoral structure.

The findings support the hypothesis. Fiscal decentralisation (mainly through own-source revenue and operational expenditure) enhances health outcomes, subject to county capacity and structural factors.

H6b: Equitable share and conditional grants are more effective than OSR in improving population-level health indicators.

The hypothesis is rejected. OSR is more effective than equitable share or conditional grants in improving population-level health indicators.

H6c: Health outcomes are subject to spatial externalities, mediated by population density and sectoral composition.

The hypothesis is supported. The highly significant spatial dependence parameters and strong direct and spillover effects of population density demonstrate that health outcomes are heavily affected by spatial externalities.

CHAPTER SEVEN

Dissertation Conclusion

7.1. Introduction

This dissertation has examined the intricate spatial interdependence relationships between fiscal decentralisation, regional economic growth, poverty alleviation, and financial health within Kenya's devolution framework. Through a theoretical and systematic review of literature and four empirical studies employing spatial econometric analyses, we provide significant insights into how spatial interdependence and spillover effects influence the effectiveness of fiscal decentralisation policies. Additionally, we explore methodological insights from spatiotemporal econometric models in understanding regional disparities under devolution. Ultimately, we highlight how Kenya's experience informs fiscal federalism and decentralisation frameworks in other developing countries. Table 7-1 presents the hypothesis outcome summary of the dissertation.

The findings have theoretical and practical implications for Regional Development Theory, including new economic geography, Fiscal Federalism, and Convergence theory. We empirically examined how fiscal decentralisation interacts with space and time to impact multidimensional development outcomes within Kenya's devolved context. The dissertation offers actionable recommendations for policymakers aiming to optimise the effectiveness of governance structures devolved in developing countries.

TABLE 7-1: DISSERTATION HYPOTHESIS SUMMARY

Hypothesis	Outcome	Evidence / Rationale
H4a: Own-source revenue (OSR), equitable share, and conditional grants have heterogeneous effects on poverty reduction across counties.	Partially Supported	Equitable share shows strong heterogeneous effects, conditional grants moderate and selective, while OSR is insignificant.
H4b: These effects exhibit spatial spillovers and inter-county feedback mechanisms.	Supported	Significant λ across most groups confirms inter-county spillovers and spatial feedback, except for retirees.
H5a: Fiscal decentralisation positively influences county-level economic performance, with significant spatial spillover impacting neighbouring counties.	Partially Supported	OSR and Operational expenditure are positive with spatial spillovers; grants are weak, the equitable share is insignificant, and capex is negative; λ and ρ confirm inter-county dependence.
H5b: Kenyan counties exhibit absolute β-convergence under devolution.	Supported	Consistently negative and significant β-coefficients for initial GCP confirm absolute convergence.

H5c: Conditional convergence provides a better fit than absolute convergence when controlling for structural and fiscal heterogeneity.	Supported	Conditional models fit better (R^2 = 0.335 vs. 0.104–0.258) and capture heterogeneity via operational expenditure and population density.
H6a: Fiscal decentralisation reduces disparities in health outcomes (mortality, morbidity, composite health), conditional on county capacity and sectoral structure.	Supported	OSR and operational expenditure improve health outcomes, especially mortality and health development, conditional on capacity/structure.
H6b: Equitable share and conditional grants are more effective than OSR in improving population-level health indicators.	Rejected	OSR is more consistently effective than equitable share or grants.
H6c: Health outcomes are subject to spatial externalities, mediated by population density and sectoral composition.	Supported	Strong λ and lagged population density effects confirm spatial externalities in health outcomes.

7.2. Outcomes and Theses

The theoretical and systematic literature review uncovered significant fragmentation and regional imbalance in research on fiscal decentralisation, especially within developing economies. The review highlighted notable empirical and theoretical gaps, particularly the lack of studies from the Global South and Sub-Saharan Africa in the' spatial and fiscal analysis of decentralisation dynamics. Most empirical work remains concentrated in Asia, with scarce comparative insights from Africa, Latin America, or Eastern Europe. Furthermore, much of the existing research focuses on national aggregates, overlooking the diversity and institutional differences at the subnational level. Therefore, this dissertation uses Kenya, a key case in Sub-Saharan Africa known for establishing an ambitious, constitutionally embedded devolution framework since 2013, as an empirical case to examine the spatial and temporal aspects of fiscal decentralisation. The Kenyan example offers a valuable opportunity to investigate subnational fiscal autonomy's territorial and economic effects within a developing country, adding to the broader discussion on regionally varied development paths under fiscal federalism.

The structured synthesis of the existing literature categorised it across six critical thematic domains within regional science and fiscal decentralisation scholarship. This dissertation systematically addresses empirical and theoretical gaps in four interrelated areas: a) fiscal decentralisation, economic growth, regional disparities, and convergence; b) intergovernmental fiscal relations (fiscal capacity) and local governance; c) fiscal decentralisation and spatial dependence; and d) fiscal decentralisation, poverty and inequalities, service delivery, and welfare (regional health outcomes). The two thematic areas, namely e) fiscal decentralisation, environment and natural resources, and f) fiscal decentralisation and foreign aid effectiveness (official

development assistance), remain outside the scope of this dissertation. However, these domains are relevant research frontiers and are proposed as avenues for future scholarly inquiry. The systematic literature review thus provides a strong foundation for subsequent empirical investigations by framing the research within established theoretical frameworks of fiscal federalism.

The core theme across the empirical essays is the significance of spatial interdependence in Kenya's fiscal decentralisation. The choropleth maps indicated spatial clusters, while spatial autocorrelations were confirmed by the Moran I and Lagrange Multiplier tests. Using spatiotemporal econometric techniques and drawing from New Economic Geography and fiscal federalism theories, the study demonstrates that spatial dependence is a vital yet underexplored mechanism that shapes how effective fiscal decentralisation is in reducing poverty, promoting regional economic convergence, improving health outcomes, and strengthening household financial health. Therefore, realising the full potential of decentralisation requires regionally coordinated, spatially informed, and context-sensitive fiscal policies that leverage inter-county cumulative causation while addressing spatial inequalities.

> **THESIS 1:** Spatial interdependence mediates the outcomes of fiscal decentralisation policies in Kenya's devolution framework. Thus, intra-county dynamics, spatial spillovers, and feedback effects across counties shape fiscal decentralisation's economic, social, and developmental impacts.

7.2.1 Role of Fiscal Decentralisation and Spatial Effects on Poverty Reduction

The second essay examines the spatially embedded effects of fiscal decentralisation on poverty reduction across demographic groups of Kenyan counties. It also asserts that decentralised fiscal governance, rooted in fiscal federalism and regional development theories, can alleviate poverty when spatial interdependencies are accounted. Using spatial panel econometric models, the study finds that revenue-based decentralisation measures, especially own-source revenue (OSR) and equitable share allocations, have stronger and more consistent poverty-reducing impacts than expenditure-based indicators. These impacts are not limited to administrative borders but spread across space through spillovers and inter-county feedback mechanisms, emphasising the vital role of spatial externalities in shaping local development results. Furthermore, the analysis uncovers age-specific effects, with equitable transfers particularly effective for the working-age population,

and OSR benefiting all age groups. These findings underline the importance of spatially coordinated and demographically tailored fiscal policy design under Kenya's devolved governance system. This highlights the necessity of incorporating spatial interaction effects into intergovernmental fiscal planning and national poverty reduction strategies.

> **THESIS 2:** While all fiscal decentralisation indicators (own-source revenue, intergovernmental fiscal transfers, and grants) contribute to poverty alleviation, their effects are uneven, with revenue-generating capacities (OSR) and equitable share transfers demonstrating stronger and more consistent links to poverty reduction outcomes. These findings highlight the crucial role of locally generated revenues and equitable transfers in promoting pro-poor development within decentralised governance.

> **THESIS 3:** Fiscal decentralisation influences poverty alleviation in Kenya unevenly, depending on the fiscal tools used and the demographic structure of county populations. Using age-disaggregated poverty data and spatial panel models, the analysis shows that Own-Source Revenue (OSR), equitable share transfers, and grants vary in magnitude and impact direction, both within and across counties. Equitable shares are most effective for adult and retiree populations, while OSR demonstrates strong local and regional poverty-reducing effects across all age groups. These different impacts emphasise the need for nuanced fiscal design, tailored to local capacities and demographic needs, to ensure equitable outcomes under Kenya's devolution framework.

7.2.2. Regional Economic Performance and Convergence

The third essay provided a detailed examination of the impact of fiscal decentralisation on regional economic performance and convergence across Kenyan counties. The findings demonstrated significant spatial dependencies and spillover effects, confirming that fiscal decentralisation positively influences economic growth through revenue-based measures and recurrent expenditure. Additionally, the absolute and conditional convergence evidence in Kenya's counties suggests that fiscal decentralisation contributes to narrowing regional disparities. However, local economic conditions and policy interventions influence the pace of convergence.

THESIS 4: The relationship between fiscal decentralisation and county-level economic growth in Kenya within a spatially interconnected regional economy shows that Own-Source Revenue (OSR) significantly improves economic performance when counties adopt context-specific revenue strategies and efficient spending. In contrast, general-purpose intergovernmental transfers (such as equitable share and conditional grants) exhibit limited growth-promoting effects due to inefficiencies and misalignment with local needs. Furthermore, spatial dependencies and spillover effects between counties play a crucial role in mediating the relationship between fiscal decentralisation and regional economic performance. This emphasises the importance of subnational fiscal autonomy, effective expenditure practices, and the implementation of fiscal decentralisation within a spatially coordinated policy framework. Enhancing inter-county cooperation, shared infrastructure investment, and spatially targeted fiscal strategies are vital for promoting geographically balanced economic growth.

THESIS 5: Empirical evidence indicates absolute and conditional income convergence among Kenyan counties under devolution. Poorer counties show higher growth rates than their wealthier counterparts, supporting the neoclassical convergence hypothesis within a spatially diverse fiscal environment. Nonetheless, the success of convergence relies on the quality and composition of fiscal instruments, especially the strategic deployment of operational expenditure and effective OSR mobilisation. Capital expenditure inefficiencies and poorly aligned transfers hinder convergence. These findings imply that fiscal decentralisation should be paired with reforms to improve subnational fiscal capacity, efficiency, and policy coherence with local development priorities to maintain convergence.

7.2.3. Regional Health Outcomes

This essay examines how fiscal decentralisation and regional economic structures impact spatial disparities in health outcomes across Kenyan counties. Using spatiotemporal econometric models, the analysis concentrates on four key health indicators: composite health, mortality, morbidity, and health development. The study uncovers strong spatial interdependencies in health outcomes, where conditions in one county significantly influence neighbouring counties. Fiscal tools such as

Own-Source Revenue (OSR) and equitable share transfers show different effects: OSR is positively linked to better health and produces positive spillovers, while equitable transfers mainly decrease morbidity through redistributive mechanisms. Spatial externalities, including population density, also shape health patterns, with high-density areas experiencing higher morbidity and poorer health development, emphasising the need for targeted infrastructure investment and urban decongestion. The findings highlight the importance of place-sensitive health financing, inter-county coordination, and the strategic use of fiscal decentralisation to advance regional health equity. The analysis supports insights from regional science, fiscal federalism, and new economic geography, illustrating how spatially structured fiscal capacity and economic context influence the efficiency and fairness of health service delivery.

THESIS 7: Regarding fiscal instruments and health outcome efficiency, OSR is the most effective in improving mortality and composite health indicators, directly and through spatial diffusion effects. Meanwhile, equitable share transfers reduce morbidity by reallocating health resources to underserved areas. This variation in effectiveness across health dimensions confirms that decentralised fiscal instruments, when tailored to local needs and spatial configurations, can improve the efficiency of health investments and promote inclusive health development.

THESIS 8: Health outcomes are embedded within a spatial system of inter-county dependencies, where spatial externalities, both positive and negative, amplify or attenuate local health gains. Population density exerts a significant spatial multiplier effect, worsening health development and morbidity in densely populated counties, thus necessitating regional coordination, targeted decongestion strategies, and spatially differentiated public health interventions within a new economic geography framework.

7.3. Policy implications

The dissertation's findings have significant implications for policymakers in Kenya and other developing countries with similar governance structures.

7.3.1 Optimising Fiscal Decentralisation

Policymakers should reinforce revenue-based fiscal decentralisation measures, such as OSR and equitable shares, to reduce poverty and boost economic performance. The significance of spatial interactions must be acknowledged, and policies should be crafted to maximise positive spillover effects across regions.

7.3.2. Targeted Poverty Alleviation Strategies

Given the varying effectiveness of fiscal decentralisation across different regions, targeted poverty alleviation strategies considering regional characteristics and spatial dependencies are vital. This approach ensures resources are allocated efficiently and that the benefits of decentralisation are distributed following subsidiarity and responsive service delivery.

7.3.3. Strengthen Decentralised Fiscal Capacities and Promote Coordinated Regional Health Planning to Address Spatial Health Inequities

Implement a spatially informed fiscal decentralisation strategy to promote regional health equity in Kenya. Improving counties' own-source revenue (OSR) is vital, as increased local fiscal capacity enhances health outcomes and generates positive spillovers. Equitable share transfers should be carefully allocated to reduce morbidity and address regional disparities. Given the strong spatial dependence of health outcomes, inter-county collaboration and spatially tailored fiscal policies are essential. Public health planning must account for demographic pressures, urban density, and regional economic structures. A place-based, fiscally empowered, and spatially coordinated approach is crucial for achieving health-related Sustainable Development Goals.

7.4. **Limitations and suggested future research.**

While this dissertation contributes significantly to understanding fiscal decentralisation's impacts on regional development outcomes in Kenya, several limitations remain, offering opportunities for further research. These limitations are grouped into two main categories: (1) general and cross-cutting limitations, including areas identified in the systematic literature review that were beyond the scope of this dissertation, and (2) essay-specific methodological and data limitations that can guide future empirical work.

7.4.1. General limitations and cross-cutting research gaps

On a broader level, the dissertation faces limitations due to the availability of detailed subnational data. The analysis was restricted to county-level observations, yet Kenya's devolution framework envisions decentralisation extending to sub-county, city, and urban levels. Future research could utilise ward or sub-county level data to better assess spatial heterogeneity and intra-county inequalities, especially in urban, peri-urban, and marginalised areas. Additionally, while this study mainly concentrated on fiscal decentralisation, other aspects such as political decentralisation, administrative decentralisation, and governance quality influence regional development outcomes. These areas deserve further investigation to understand how institutional arrangements and decision-making autonomy interact with fiscal reforms to impact development. Comparative studies involving countries with similar devolution frameworks in Sub-Saharan Africa or other parts of the Global South could also improve the generalisability of these findings and provide cross-national insights into the institutional conditions that promote successful decentralisation.

7.4.2. Empirical Studies Limitations and Suggested Future Research

7.4.2.1. Systematic Literature Review: Gaps Not Addressed in This Dissertation

The systematic literature review highlighted several underexplored areas in fiscal decentralisation that had not been empirically examined in this dissertation.

a) Fiscal Decentralisation, Environment, and Natural Resources

- The nexus between fiscal decentralisation and environmental sustainability remains under-theorised. Empirical research is needed on how decentralised fiscal systems influence environmental management, natural resource allocation, and community-based sustainability initiatives.
- Future research should also explore the connection between natural resource endowments, fiscal transfers, and growth outcomes, especially in decentralised systems of the Global South.
- The importance of technological innovation in reducing the environmental trade-offs of decentralised governance also warrants consideration.

b) Fiscal Decentralisation and Foreign Aid Effectiveness

The literature displays inconsistent findings regarding how fiscal decentralisation affects the effectiveness of foreign aid. Some studies suggest that robust institutions enhance aid impact,

while others highlight the disconnect between donor objectives and local capacities. Future research should empirically investigate the relationship between official development assistance, fiscal autonomy, and institutional quality, particularly in contexts where upward accountability and citizen participation are developing and complex.

7.4.2.2. Empirical study-Specific Limitations and Directions for Further Research

Study 2: The Nexus Between Fiscal Decentralisation and Regional Economic Dynamics

The lack of detailed sectoral economic data at the county and sub-county levels limited the analysis. Including such data would enable a more nuanced understanding of how fiscal decentralisation influences structural transformation and sector-specific convergence. Due to data constraints, public spending efficiency and governance quality measures, both vital for evaluating the success of fiscal transfers, were not sufficiently captured. Future research should also investigate dynamic spatial models, such as Bayesian model comparisons and log marginal likelihood methods, to enhance the robustness of spatial spillover analysis.

Study 3: Spatial Interdependence and Regional Health Outcomes

The county is a relatively broad spatial unit that conceals disparities within the county. Future studies should utilise sub-county or ward-level health data to understand intra-county spatial health inequalities better. The study did not explicitly account for urban–rural differences, despite their importance to healthcare access and disease burden. Future research should employ spatial regimes or interaction models to capture urban–rural heterogeneity systematically. Lastly, measures of spatial accessibility, such as proximity to health facilities and transport infrastructure, were not included, yet these are essential for understanding regional health disparities

CHAPTER EIGHT: DISSERTATION NOVELTY

This dissertation has elucidated four strands of novelties: theoretical, contextual, thematic and methodological.

8.1 Theoretical novelty

The dissertation advances the theoretical discussion on fiscal decentralisation by reconceptualising it in the broader framework of regional development theory, moving beyond the narrow scope of traditional fiscal federalism. It incorporates classical concepts such as growth pole theory, cumulative causation, and core–periphery models with more contemporary approaches, including New Economic Geography, Convergence, cumulative causation, Lengyel's pyramid model, and spatial econometric techniques. Through this integration, the study develops an inclusive spatial–fiscal conceptual framework that emphasises the dual role of decentralisation: firstly, generating direct impacts through resource allocation, service provision, and local accountability; and secondly, influencing indirect effects through spatial spillovers, intergovernmental fiscal feedback, and regional interdependencies. This theoretical advancement positions fiscal decentralisation as a fiscal policy arrangement and a structural catalyst for spatially distributed development outcomes.

8.2. Contextual novelty

The dissertation provides contextual insight by analysing Kenya's post-2010 devolution reforms, one of Sub-Saharan Africa's most ambitious decentralisation efforts. While most empirical studies on fiscal decentralisation focus on advanced economies, federal systems, or earlier reform phases, this research examines a new institutional and political economy context where decentralisation is more formalised, empirical data are more comprehensive, and counties have considerable autonomy. Kenya offers a unique opportunity to study intergovernmental fiscal relations within a setting characterised by structural inequality, spatial heterogeneity, and institutional fragility. The study offers context-specific insights reflecting Kenya's political and economic transition, whilst providing generalisable lessons for other developing countries implementing similar devolution reforms. The dissertation thus positions Kenya as a representative and distinctive case for understanding decentralisation dynamics in Africa and other developing regions.

8.3 Development Outcomes Thematic Novelty

This dissertation comprehensively analyses regional development outcomes by linking fiscal decentralisation to four development themes seldom explored in sub-Saharan Africa: poverty and inequality, economic performance, economic convergence, and regional health outcomes. It diverges from aggregated analyses on poverty and inequality by disaggregating fiscal instruments, such as own-source revenue, equitable share, and conditional grants, and examining their varied demographic effects. It demonstrates how decentralisation influences growth through local fiscal capacity and inter-county spillovers. The study offers one of the few sub-Saharan applications distinguishing between absolute and conditional convergence, illustrating how fiscal decentralisation and spatial dependence shape the pace and pattern of catch-up. Finally, in the health field, the research incorporates fiscal and economic structures into models of disparities in mortality, morbidity, health development and composite health indicators. This approach demonstrates the multi-dimensional role of fiscal decentralisation, extending its importance from fiscal efficiency debates to broader concerns of welfare, growth, and human development.

8.4. Methodological novelty

The dissertation advances methodological innovation by employing exploratory spatial data analysis (ESDA) and spatiotemporal econometric models (including SAR, SEM, SDM, and SARAR-Durbin) that explicitly account for spatial dependence, spillover effects, and inter-county feedback mechanisms. This marks a significant departure from the traditional reliance on cross-sectional or purely temporal models, which often neglect spatial interactions vital to understanding regional development dynamics. By embedding disaggregated fiscal instruments (own-source revenue, equitable share, conditional grants) into spatially explicit frameworks, the study offers more precise and differentiated estimates of their effects on poverty, growth, convergence, and health outcomes. Furthermore, integrating convergence testing within spatial panel frameworks bridges fiscal policy analysis with advanced spatial econometrics, pushing the methodological frontier in development economics. These innovations strengthen the findings' explanatory power and policy relevance, establishing a robust platform for future empirical research on decentralisation and regional development.

Appendices

Appendix A-T1: Kenya county codes and geographical information (2021)

County	CODES	Area_Sq_Km	Population (2021)
Mombasa	1	219.9	1256006
Kwale	2	8253.66	900872
Kilifi	3	12553.27	1518160
Tana River	4	37903.62	334765
Lamu	5	6283.02	158960
Taita Taveta	6	17152.01	355073
Garissa	7	44753.2	883144
Wajir	8	56773.81	826133
Mandera	9	25942.15	911265
Marsabit	10	70944.27	491483
Isiolo	11	25349.19	301382
Meru	12	7013.95	1585608
Tharaka-Nithi	13	2564.36	407529
Embu	14	2820.67	635160
Kitui	15	30429.61	1200627
Machakos	16	6037.27	1457065
Makueni	17	8176.67	1019118
Nyandarua	18	3285.76	669950
Nyeri	19	3324.98	818202
Kirinyaga	20	1478.31	642463
Murunga	21	2522.77	1088456
Kiambu	22	2538.7	2551620
Turkana	23	68233.08	971900
West Pokot	24	9123.28	646190
Samburu	25	21089.69	329638
Trans Nzoia	26	2495.17	1029856
Uasin Gishu	27	3398.61	1207797
Elgeyo-Marakwet	28	3032.06	481359
Nandi	29	2849.4	920906
Baringo	30	10984.62	702256
Laikipia	31	9507.64	539414
Nakuru	32	7504.91	2250502
Narok	33	17931.68	1213213
Kajiado	34	21871.18	1208593
Kericho	35	2436.09	929777
Bomet	36	2507.08	914280
Kakamega	37	3016.62	1932305

Vihiga	38	563.76	615206
Bungoma	39	3023.94	1729265
Busia	40	1699.78	931984
Siaya	41	2529.74	1021774
Kisumu	42	2085.43	1206931
Homa Bay	43	3152.53	1185135
Migori	44	2613.48	1176159
Kisii	45	1323.28	1319443
Nyamira	46	897.32	649528
Nairobi City	47	703.87	4593757

Appendix C-T1: Non-Spatial Random Effects Model

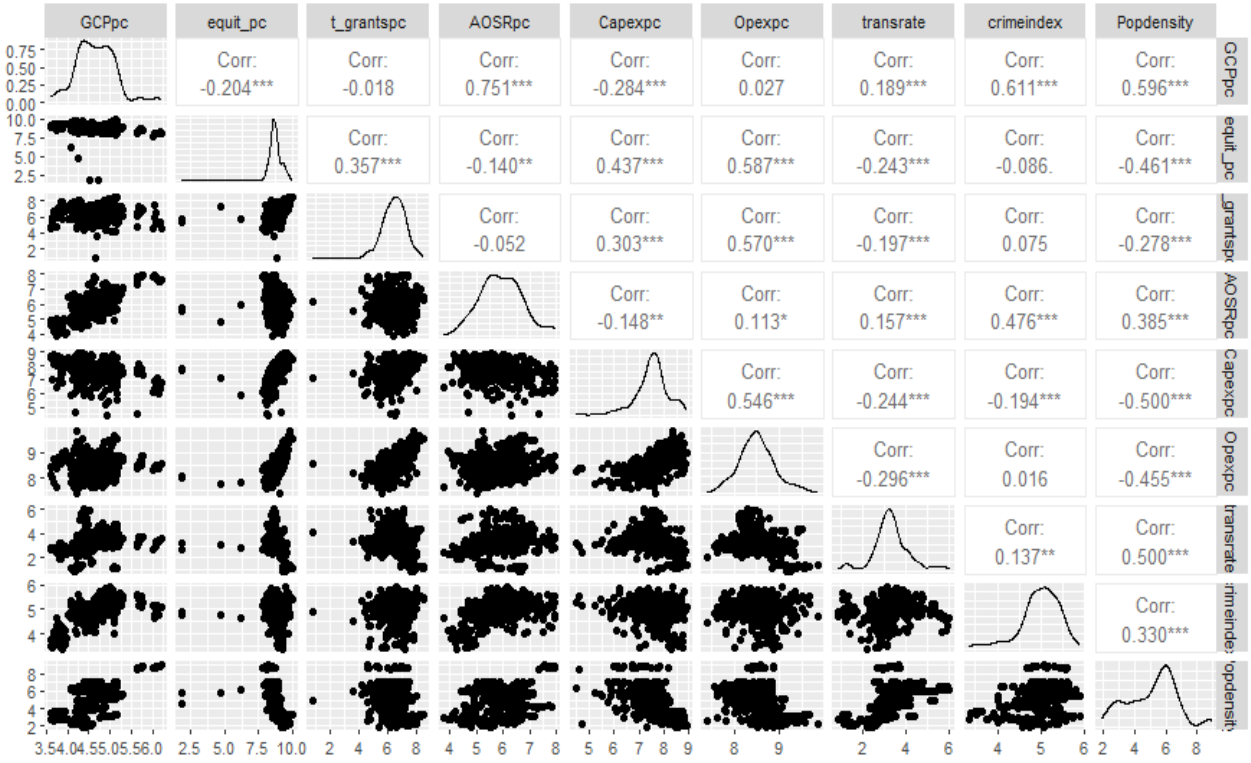
Variable	Total	Child	Youth	Adult	Retiree	Senior
(Intercept)	149.8026 (55.94)**	184.0179 (55.72)***	168.2736 (58.56)**	123.5259 (57.07)*	202.6496 (65.66)**	202.6496 (65.66)**
log(OSR_pc)	-3.5260 (1.91)	-3.5155 (1.90).	-4.6305 (2.09)*	-3.3931 (1.97).	-5.0393 (2.41)*	-5.0393 (2.41)*
log(equit_pc)	-8.0439 (6.03)	-13.6158 (5.97)*	-10.6441 (6.84)	-5.4279 (6.28)	-11.1605 (8.25)	-11.1605 (8.25)
log(grants_pc)	-3.8381 (1.6422)*	-2.3145 (1.6253)	-3.8881 (1.8860)*	-4.7550 (1.7185)**	-2.3185 (2.2898)	-2.3185 (2.2898)
log(Capex_pc)	4.1715 (2.0713)*	6.2578 (2.0497)**	4.2703 (2.3796).	3.5835 (2.1681).	5.8654 (2.8861)*	5.8654 (2.8861)*
log(Opex_pc)	9.3934 (5.6587).	8.8651 (5.6035)	9.9587 (6.4326)	10.5473 (5.9076).	4.9588 (7.7155)	4.9588 (7.7155)
log(GCPpc)	-18.5846 (4.57)***	-19.0624 (4.56)***	-17.7300 (4.71)***	-18.3385 (4.64)***	-17.7264 (5.24)***	-17.7264 (5.24)***
log(transrate)	-3.8247 (1.65)*	-4.5611 (1.64)**	-3.9378 (1.66)*	-3.6740 (1.66)*	-6.3283 (1.82)***	-6.3283 (1.82)***

Note: 1) * p < 0.10, **p < 0. 05, and *** p< 0.01.

2) The standard errors are in parenthesis

The random effects model emphasises that regional economic conditions and demographic characteristics are the main drivers of poverty reduction. Grants also play a significant role but with lesser effect compared to the regional characteristics

Appendix D-F1: The ggpairs scatter plot (Growth and Convergence)



Comprehensive ggplot plot of the dependent and independent variables. It shows the distribution and skewness, the scatter plots of the variables, the magnitude of correlation and the statistical significance of the correlations.

Appendix D-T1: Data Sources and Variables Description

Variable	Description	Source
GCP	Gross County Product (GCP) in constant 2016 prices (Kshs)	Kenya National Bureau of Statistics (KNBS[13]) https://www.knbs.or.ke/

[13] See https://www.knbs.or.ke/reports/gross-county-product-2023/

Equitable share	Share of revenue raised nationally between the national government (Art 217)[14] and county governments and shared equitably between county governments (Art 218).	Office of Controller of Budget – County Reports[15] (https://cob.go.ke/)
Grants	Conditional and unconditional grants	Office of Controller of Budget https://cob.go.ke/
Own-Source Revenue (OSR)	Local revenue raised by the counties from local taxes (property and entertainment), charges (	Office of Controller of Budget https://cob.go.ke/
Capital (development) expenditure (Capex)	Actual development expenditure 2013/14 – 2022/23	Office of the Controller of Budget https://cob.go.ke/
Operations (recurrent) expenditure (Opex)	Actual recurrent expenditure 2013/14 – 2022/23	Office of the Controller of Budget https://cob.go.ke/

[14] See the Constitution of Kenya (2010) https://kenyalaw.org/kl/index.php?id=398
[15] See https://cob.go.ke/reports/consolidated-county-budget-implementation-review-reports/

Population	Population projections in the counties 2013/14 – 2022/23	KNBS population projections
Transition rate	Secondary School Transition Rate 2013/14 – 2022/23	KNBS – Economic Surveys
Crime Index	Number of crimes reported per 100,000 population	National Police Service[16]

Appendix D- T2 : Summary Statistics (Growth and Convergence)

Variable	Min	1st Quartile	Median	Mean	3rd Quartile	Max
County Area (Sq Km)	220	2,523	3,325	12,360	17,152	70,944
Total Budget (Millions)	1,648	4,265	7,156	14,336	17,226	41,382
Total Revenue (Millions)	1,662	3,527	6,205	11,533	14,211	32,060
Actual Receipts (Millions)	998.6	3,510.60	5,900.90	18,500.10	20,890.40	61,200.00
Operational expenditure (Millions)	609.2	2,599.80	4,200.80	9,409.70	11,010.80	28,627.90
Capital Expenditure (Millions)	32.2	863.4	1,561.70	2,389.60	3,087.90	6,402.90
Total Expenditure (Millions)	729	3,138	5,530	11,257	13,649	33,238
Target OSR (Millions)	30	873.3	1,833.40	5,826.90	6,787.00	19,610.70
Actual OSR (Millions)	27.42	570.23	1,159.28	3,513.99	4,103.04	11,710.01
PE (Millions)	305.5	1,577.80	2,574.50	5,073.00	6,069.60	14,837.20
Disbursements (Millions)	1,510	2,523	4,830	8,076	10,383	21,135

[16] See https://www.nationalpolice.go.ke/crime-statistics.html

Equitable Share (Millions)	4.47	2,010.59	4,464.46	7,045.77	9,499.63	19,249.68
National Government grants from its Share (Millions)	0.11	191.41	301.41	551.93	661.93	1,604.79
Grants from proceeds of Loans (Millions)	0	281.2	435.7	1,774.80	1,929.20	6,227.80
Total Grants (Millions)	2.31	452.64	662.69	2,048.02	2,258.06	6,864.38
Capital Budget Ratio	0.0096	0.1672	0.215	0.2225	0.2726	0.5358
PE to Total Revenue Ratio	0.0679	0.3196	0.3703	0.3756	0.4434	0.6187
OSR to Total Revenue Ratio	6.77	51.64	68.1	71.34	86.33	320.39
GCP (constant KES, 2016)	15,357	54,511	93,476	157,875	145,254	2,659,197
Population	129,731	663,706	990,159	1,090,032	1,272,722	5,400,707
Crime index	208	795.8	1,336.50	1,709.10	2,077.20	8,520
Primary Enrollment	26,820	121,200	204,809	217,125	291,161	589,883
Secondary Enrollment	4,038	29,633	56,861	63,432	91,890	209,834
Births	1,815	10,413	16,702	22,409	29,031	145,000
Deaths	273	1,603	3,378	4,251	6,078	25,097

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List of Publications

1) Apostol, Stefan and Muthama, Wencelaus Musyoka (2024). *Complexity and FDI in market-dependent economies: The hidden effect of industrial offshoring*. ACTA OECONOMICA, 74 (2). pp. 187-212. ISSN 0001-6373
2) Muthama, Wencelaus Musyoka and Gál, Zoltán. (2025). *Role of fiscal decentralisation in poverty reduction: spatio-temporal evidence from Kenya's devolution framework*. Regional Statistics 15(2):292-320 DOI: 10.15196/RS150205