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Managing Global Transitions (MGT) is a quarterly, scholarly journal that covers diverse aspects of transitions and welcomes research on change and innovation in increasingly digitalized and networked economic environments, from a societal, organizational, and technological perspective. MGT fosters the exchange of ideas, experience, and knowledge among developed and developing countries with different cultural, organizational, and technological traditions. MGT invites original scientific, research, and review papers advancing the field of transitions in societies, organizations, and technologies.

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Does Current Popular Leadership Literature Show a Preference for Transformational Leadership?

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Over the past few years, numerous Leadership models, theories, and methodologies have emerged so that the question arises as to which of the models is most effective, or even which has prevailed. One approach to this question is to compare different models in terms of their overlaps or similarities. This study researches the topic with a reverse approach: can one derive a preference for a particular leadership style or even a leadership direction or leadership 'school' from the popular leadership literature? The guiding question is which leadership books sell the most and which leadership style or elements of leadership they represent. For this purpose, Amazon's bestseller lists in leadership and management in a specific period and local market are examined in a quantitative-qualitative study both to elicit the distribution of a model and to find common styles and elements of leadership among different authors. The result shows that current popular leadership literature primarily reflects transformational leadership models with elements of transactional management. A particular leadership mindset and special leadership activities such as goal orientation or inspirational motivation can be found in almost all of the most widespread models.

Key Words: transformational leadership, transactional model, leadership theory
JEL Classification: M0, M19
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Introduction

The fact that leadership is critical to the success of organizations and plays a crucial role in the management of companies, in terms of customer relations, in the design of employee motivation, in the management of change, in the skill and competence development of employees and ultimately in the achievement of goals is undisputed (Miloloza 2018). With more than 1500 definitions of leadership (Kellerman 2012) and over 66 leadership theories (Mango 2018), the question arises whether, among

all definitions, there is one or some that are 'correct,' that is, most effective. Hence, the fundamental problem and question is whether and how leadership can be understood 'correctly' and whether or how a verifiable and, above all, demonstrably successful leadership model can be derived from the multitude of approaches from a scientific perspective. One could approach this problem – finding common principles and elements of the most effective leadership methods – purely deductively, by superimposing and comparing all models but still the question would remain, whether such a leadership model would find a significant widespread acceptance.

In this study, a different approach has been chosen: an empirical examination of mostly accepted or widespread leadership models in popular leadership books would provide the material to identify common leadership principles. These could be examined in terms of their commonalities and overarching models to finally form a universal model. Therefore, the basic assumption for this inductive study is that those models or principles of leadership that are most popular and eagerly imitated are also found in popular literature on leadership. Therefore, from the best-selling relevant books, one could infer the acceptance of a model or a particular leadership direction principle. This, in turn, can provide a valid input for further (theoretical) investigation of a (universal) leadership model.

Therefore, in a snapshot of bestseller lists of popular leadership literature, an overview can be created of which leadership topics, theories, and models are most popular – limited in time and locality limited: what are the best-selling and best-ranked leadership books on Amazon as one of the largest providers of the online book trade, which leadership models and theories do they reflect, are there common principles or even standard models and what conclusions, if any, can be drawn from them?

There is a multiple heuristic challenge with this question:

- With the rise of non-print media, such as on social platforms, via blogs, podcasts, and videos, it can be asked quite fundamentally whether other forms are not overtaking print media's information strength and penetration. That is a valid question worthy of investigation. Nevertheless, print media still play an essential role in the dissemination of models. Also, the question whether e-books have not long replaced print books can be answered in the negative, c.f. the comprehensive and fascinating study on bestsellers (Yucesoy et al. 2018). Therefore, this paper works with the basic assumption that

an influencing factor, or at least an indication of topics that were or are of interest in the respective time, can still be derived from the distribution of print media. Nevertheless, e-books are also taken into account, as they are partly counted in the bestseller lists.

- Leadership models are not necessarily disseminated via distinct leadership books. There may be books that are not declared as leadership books but strongly influence managers' leadership behaviour. An example is Martin Goleman, whose EQ concept is very influential (Goleman 2004), although it is not explicitly a leadership book. On the other hand, large corporations, for example, may promote a particular leadership model that can be traced back to a particular book so that the reach of this model is extensive without affecting the sales figures of the book. Corporations are highly cautious in publishing their leadership models and sources, so the data is not transparent.
- It is also questionable whether it is possible in principle and at all to determine which books on leadership are sold the most.
- In the last 15 years, about 500,000 new books have been produced annually in Europe alone, and more than 3 million books worldwide (Statista n.d.). The total number of leadership books in all local markets is impossible to determine, and it is also challenging to define the leadership books that have sold the most (bestsellers), as sales figures are not necessarily made public by publishers. Moreover, the few existing bestseller lists are more meaningful for regional markets and not globally. In the German-speaking market, for example, the Spiegel bestseller list is well known. Interestingly, however, there is not a single book on leadership in the Spiegel bestseller list in the non-fiction category that has made it to the top of the list (Wikipedia 2022).
- From the sales figures, it is not necessarily possible to assume the distribution of the model. In other words, a high sales figure does not necessarily mean that the book has been read, understood, and, above all, implemented. With 3,000 publishers in Germany alone, for example, it is not easy to find out from these publishers, let alone all the publishers in the world, whether and which leadership books they publish, especially since the sales figures are usually not publicly known.
- The period under consideration can lead to very different results.

Some books may currently top the bestseller list but not make an impact in the long run.

Taking these limitations into account, it is nevertheless possible to find out within a clearly defined research framework which leadership books top the bestseller lists, to reflect on the content of whether they follow a particular theory, and if so, which theory. Ultimately, the decisive factor for any leadership theory is whether it is received and accepted. Therefore, from its dissemination, the recognition, acceptance, and ultimately the validity of the theory can be inferred.

Methodology

An approach that considers the heuristic limitations mentioned above will be attempted utilizing the following methodology: using various bestseller lists from Amazon, all of which revolve around the topic of leadership, the best-selling or highest-rated business books in a local market (Germany), and in a specific period (May 10–20, 2021) are examined. There is initially a restriction to the top 20 to make the amount of data manageable. The books are surveyed for explicit or underlying leadership models to uncover clues as to which aspects of leadership generate a great deal of resonance.

Amazon Inc. already had over 50% of the German online book trade in 2017 (EHI Retail Insitute n.d.). Since Amazon has been measuring and publishing bestseller lists for several years, even if the criteria change from time to time and the logarithms are not publicly visible, there is at least investigable data available here. These data are usable with the following limitations: they do not represent a 'world bestseller list,' but reflect the national (German) sales figures of Amazon – not those of all retailers. Although Amazon's market share is substantial, the largest distribution channel for books in 2019 was brick-and-mortar bookstores (EHI Retail Insitute n.d.). Nevertheless, and primarily because of Amazon's significant influence on sales behaviour, bestseller lists from Amazon can indicate the influence of popular leadership books. Further limiting, it must be added that the bestseller list of Amazon is adjusted daily. Thus, the research results give insight into a particular point in time and are instead understood as a selective snapshot. On amazon.com, different categories, each with their lists, can be found under the umbrella term Leadership and Management, all of which have been examined. The categories are 'Leadership and Motivation,' 'Management and Leadership,' 'Leadership

and Human Resource Management,' 'Business Administration and Management,' 'Strategic Management,' and 'Management Science.' This survey reflects the date range of May 10–20, 2021. Subsequent sampling has shown that the ranking is constantly adjusting, new categories are being found, and new entrants, in particular, are quickly making it onto the bestseller list.

In order to keep the amount of data organizable, the top 20 books in each category are filtered out. Amazon creates different lists for different topics or categories that overlap, especially in leadership and management. Since they nevertheless show different results, all lists relating to leadership and management have been included in the study. Amazon distinguishes between books (bound and unbound) and e-books, and both genres are found indiscriminately in the bestseller lists and were integrated equally. The books are then examined for theories of Full Leadership or Elements of Leadership and Transactional or Transformational and multiple rankings. In order to make the amount of data more manageable, we have limited ourselves to the top 10.

The Criteriology of Evaluation

Each book was evaluated according to the following criteria:

- *Full Leadership Theory or Elements of Leadership.* This criteriology examines whether the book attempts to build a full leadership theory, or whether it contains only elements of a theory, or even has no elements of a leadership theory at all. Books with a full leadership theory will be discussed separately.
- *Transactional/Transformational.* With a confusing number of leadership theories and methodologies, the category Transactional/Transformational can be applied to almost any theory. Even if Bernhard Bass in the Full Range Leadership Model describes transactional and transformational rather as poles of a continuum (Bass and Riggio 2005), the following elements of a criteriology can be selected for this study:
    1. Transactional leadership consists of management-by-exception, and contingent reward in external motivational control: (external) goals are set, and the achievement of the goals is rewarded for controlling desired behaviour. External goal setting and reward through goal achievement are the main qualities of this leadership style.

2. Transformational leadership, with the four areas of Idealized Influence, Inspirational Motivation, Intellectual Stimulation, and Individualized Consideration, emphasizes the role-modelling of the leader and the visionary development of the employee, aiming at intrinsic motivation control. Visionary goal setting supported by role-modelling and intrinsic motivation is used in this study as the main qualities to describe this leadership style.
3. Since there is also a continuum in the Bass model, 'Transformational and Transactional' is set as a criterion here in addition to 'Transformational,' 'Transactional,' and a 'None' for non-existent models.

- *The number of Transactional/Transformational books.* First, how many books can be assigned to the transactional or transformational style is examined.
- *Average rating.* Then, an average rating of the categories ranking places 1 to 10 are taken.
- *Multiple rating.* Finally, the multiple ratings of places 1 to 10 are evaluated. *Qualitative deep-dive.* Since the multiple ranking, i.e. the frequency of placement in places 1–10, indicates widespread distribution, the books that make it to a place between 1 and 10 more than once are also examined more deeply in qualitative terms for the prevailing leadership model.

Discussion

In the six different Amazon categories (leadership and motivation; management and leadership; leadership and human resource management; business administration and management, strategic management, management science), a total of 57 books were examined that ranked between 1 and 20 in the respective category at least once.

In the perspective of the research question, which leadership topics, theories, and models are most prevalent in the best-selling books, the books containing only theory *elements* are first distinguished from those containing a *full* leadership theory. There are only three of these: Peter Drucker with *The Effective Executive* (1967), Jocko Willink with *Leadership Strategy and Tactics* (2020), which in turn goes back to the best-seller *Extreme Ownership* (Willink and Babin 2015), and Gino Wickman, who also presents a complete leadership model with *Traction* (2007).

Since only three books contain a complete leadership theory, these will be briefly presented below.

In summary, according to Drucker (1967), effective self-management is the foundation of all management and consists of precise steps and actions to follow – always to meet the best outcome for the organization: using time effectively, making the best contribution (why am I being paid?), using strengths productively and making effective decisions. Elements of transactional leadership (such as setting and achieving extrinsically imposed goals) and transformational leadership (such as a more robust 'we' emphasis or role-modelling) can be found in his work.

Willink (2020) also talks about self-management and self-organization, transactional and transformational leadership. In summary, according to Willink, leadership requires the development of a humility and responsibility mindset and the elements of spacing out, communicating effectively, decentralization, and empowerment.

Gino Wickman lands with his book *Traction,* again in transactional and transformational leadership realms (Wickman 2007). On the one hand, the book contains clear frameworks on how to set up and implement a business and, on the other hand, shows many elements regarding leadership that have to do with measurement, execution and empowerment, and delegation. He presents the EOS Model (Entrepreneurial Operating System), which consists of the six areas of Vision, Data, Process, Traction, Issues, and People, and describes how a business can be managed and made successful.

Concerning the Full Leadership Theory, it can be stated that all three books have a vigorous implementation orientation as well as a strong people focus on self-management (knowing oneself and being able to lead; taking responsibility; humility), implementation orientation (focusing and prioritizing; implementing through clear goals and actions; gaining clarity from a distance); people orientation (decentralization and empowerment; effective communication; strength-based leadership). Even though they tend to be assigned to transformational leadership, they all contain transactional or implementation-oriented leadership elements motivated by external goals.

In a further step, we will examine how many books represent transactional, transformational, or both leadership approaches to refer to the respective elements and examine whether similarities appear in the elements.

Two of the 57 books examined listed in the top 20 in the various cate-

TABLE 1 Overview Transactional/Transformational Books

Transactional	2
Transformational	24
Transactional/Transformational	17
None	15

gories on Amazon can be assigned to transactional, twenty-four to transformational, and seventeen to both leadership styles. Sixteen books are not assigned to any leadership style, as they do not discuss the topic of leadership in the true sense.

The numerical analysis alone shows a strong tendency towards transformational or a combination of transformational/transactional leadership. Since some of the same books appear several times in the different categories, in a further research step, the average rating in the ranking is formed from the different Amazon management and leadership bestseller categories in which the respective book is ranked. In order to form a stronger concentration here, the average is calculated exclusively from places 1 to 10.

Of these 29 books, one can be classified as transactional leadership, eleven as transformational leadership, nine as a mixture of transactional and transformational leadership, and a further eight as having no leadership framework. Among the latter are works that deal with mindset topics in the broadest sense (Grant 2021; Hill and Bandini 1999; Morin 2017; Cardone 2011; Cialdini 2021; Silva and Miele 1991) or focus on individual business topics (Voss and Raz 2017; Osterwalder and Pigneur 2013) without really talking about leadership. That these books are listed on Amazon in one of the categories belonging to leadership or management indicates that business-relevant topics and everything that has to do with mindset and psychological background in the broadest sense are essential for management or leadership.

Some of these 21 books dealing with leadership have a high ranking and have thus received a high place; however, they have not been ranked as often in the different categories. For example, *22 Talk Shifts* (Ungerböck 2020) is ranked once, in first place, but does not appear again in any of the other categories and is not ranked again. Therefore, in the next step, the ranking frequency of places 1–10 is evaluated. Since some books were published in different print and e-versions and ranked highly in several categories, they have a higher multiple rating. A wider distribution can

TABLE 2 Average Rating in Ranking Places 1–10

Author	*Title*	Ranking
Ungerböck (2020)	*22 Talk Shifts: Tools to Transform Leadership*	1
Greene (2013)	*The 48 Laws of Power*	1.3
Grant (2021)	*Think Again*	3
Rath (2017)	*StrengthsFinder 2.0*	3
Willink and Babin (2015)	*Extreme Ownership: How US Navy Seals Lead and Win*	3.3
Doerr (2018)	*Measure What Matters: How Google, Bono, and the Gates Foundation Rock the World with OKRs*	3.6
Voss and Raz (2017)	*Never Split the Difference: Negotiating as if Your Life Depended on It*	4
Covey (2013)	*7 Habits of Highly Effective People*	4
Collins (2001)	*Good to Great*	4
Cialdini (2021)	*Influence, New and Expanded: The Psychology of Persuasion*	4
Scott (2017)	*Radical Candor*	4
McChesney, Covey, and Huling (2015)	*The 4 Disciplines of Execution: Achieving Your Wildly Important Goals*	4
Silva and Miele (1991)	*The Silva Mind Control Method*	4
Brown (2018)	*Dare to Lead*	5
Lencioni (2002)	*The Five Dysfunctions of a Team*	5
Tzu (2007)	*Art of War*	5
Stone, Patton, and Heen (2010)	*Difficult Conversations: How to Discuss What Matters Most*	5
Miller (2021)	*Business Made Simple: 60 Days to Master Leadership, Sales, Marketing Execution, Management, Personal Productivity, and More*	6

Continued on the next page

be concluded from the rating frequency so the qualitative study will be based on that.

Among the eight books ranked 1–10 more than once, all six belong to the transformational style or a mixture of both – except for the book with no particular leadership content (Hill and Bandini 1999) and the transactional leadership book (Greene 2013).

It can be deduced from the above that Transformational Leadership meets with a more significant response than Transactional Leadership, whereby Transactional Leadership is described in particular with the

TABLE 2 *Continued from the previous page*

Author	*Title*	Ranking
Osterwalder and Pigneur (2013)	*Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*	6
Hill and Bandini (1999)	*Think and Grow Rich*	6.3
McKeown (2014)	*Essentialism: The Disciplined Pursuit of Less*	7
Andrei (2020)	*How Highly Effective People Speak: How High Performers Use Psychology to Influence with Ease*	8
Sinek (2011)	*Start with Why: How Great Leaders Inspire Everyone to Take Action*	8.5
Morin (2017)	*13 Things Mentally Strong People Don't Do*	9
Gensler and Lindenmayer (2015)	*Art's Principles: 50 Years of Hard-Learned Lessons in Building a World-Class Professional Services Firm*	9
Sinek (2020)	*The Infinite Game*	9
Cardone (2011)	*The 10x Rule: The Only Difference between Success and Failure*	10
Harnish (2014)	*Scaling Up: How a Few Companies Make It . . . and Why the Rest Don't*	10

TABLE 3 Number of Transactional/Transformational with Average Ranking of 1–10

Transactional	1
Transformational	11
Transactional/Transformational	9
None	8

qualities of external goal setting and reward through goal achievement. In contrast, Transformational Leadership is described above all with the qualities of role-modelling, visionary goal setting, and intrinsic motivation.

In the following, the seven leadership books will be examined concerning these qualities. Brené Brown's *Dare to Lead* (2018) is a follow-up to *Daring Greatly* (2015) and aims to encourage leaders to show courage and to face their weaknesses and vulnerabilities. Along with the four main parts (vulnerability, values, trust, growth), she explains the primary skills of a (transformative) leader, how they can become successful, and how they can support and challenge their employees. In summary, Brown is primarily concerned with leaders learning to know and to show their weaknesses.

TABLE 4 Frequency of Rating in the Different Categories

Author	*Title*	# times placed on 1–10 in different categories
Covey (2013)	*7 Habits of Highly Effective People*	6
Willink and Babin (2015)	*Extreme Ownership: How US Navy Seals Lead and Win*	4
Scott (2017)	*Radical Candor*	4
Greene (2013)	*The 48 Laws of Power*	3
Brown (2018)	*Dare to Lead*	3
Hill and Bandini (1999)	*Think and Grow Rich*	3
Doerr (2018)	*Measure What Matters: How Google, Bono, and the Gates Foundation Rock the World with OKRs*	3
Sinek (2011)	*Start with Why: How Great Leaders Inspire Everyone to Take Action*	2
Ungerböck (2020)	*22 Talk Shifts: Tools to Transform Leadership*	1
Grant (2021)	*Think Again*	1
Voss and Raz (2017)	*Never Split the Difference: Negotiating as if Your Life Depended on It*	1
Morin (2017)	*13 Things Mentally Strong People Don't Do*	1
Cardone (2011)	*The 10x Rule: The Only Difference between Success and Failure*	1
Rath (2017)	*StrengthsFinder 2.0*	1
Lencioni (2002)	*The Five Dysfunctions of a Team*	1
Wickman (2007)	*Traction: Get a Grip on Your Business*	1
Collins (2001)	*Good to Great*	1
Cialdini (2021)	*Influence, New and Expanded: The Psychology of Persuasion*	1
Miller (2021)	*Business Made Simple: 60 Days to Master Leadership, Sales, Marketing Execution, Management, Personal Productivity, and More*	1

Continued on the next page

Stephen Covey has created an absolute bestseller with *The Seven Habits* (Covey 2013). Unlike other books that talk more about behaviour and skills, Covey is more concerned with character and the inner core of a person. The seven core behaviours can be summarized as taking responsibility, creating a vision, time and implementation management, successful interpersonal relationships, empathetic listening, balancing differences, and comprehensive recovery strategies (Covey 2013). In Covey's work, it is striking that, on the one hand, a strong people-orientation

TABLE 4 *Continued from the previous page*

Author	*Title*	# times placed on 1–10 in different categories
McChesney, Covey, and Huling (2015)	*The 4 Disciplines of Execution: Achieving Your Wildly Important Goals*	1
Tzu (2007)	*Art of War*	1
Osterwalder and Pigneur (2013)	*Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*	1
McKeown (2014)	*Essentialism: The Disciplined Pursuit of Less*	1
Gensler and Lindenmayer (2015)	*Art's Principles: 50 Years of Hard-Learned Lessons in Building a World-Class Professional Services Firm*	1
Harnish (2014)	*Scaling Up: How a Few Companies Make It . . . and Why the Rest Don't*	1
Silva and Miele (1991)	*The Silva Mind Control Method*	1
Stone, Patton, and Heen (2010)	*Difficult Conversations: How to Discuss What Matters Most*	1
Andrei (2020)	*How Highly Effective People Speak: How High Performers Use Psychology to Influence with Ease*	1
Sinek (2020)	*The Infinite Game*	1

TABLE 5 Classification Transactional/Transformational of Ratings >1 of Places 1–10

Transactional	1	Greene (2013)
Transformational	4	Brown (2018); Covey (2013); Sinek (2011); Scott (2017)
Transactional/Transformational	2	Willink and Babin (2015); Doerr (2018)
None	1	Hill and Bandini (1999)

with many elements from transformational leadership such as creating a vision, successful interpersonal relationships, empathy, and listening, to name but a few, can be observed. On the other hand, there is a vital fact/discipline/execution orientation with a firm decision orientation and discipline.

Sinek (2011) has not only become famous with his book *Start with Why*, but his Tedx talk about the so-called 'Golden Circle' is one of the most viewed with over 50 million clicks (Sinek 2014). The main message of his book is that the best and most successful leadership unfolds in inspiring people when starting with the 'why,' then talking about the 'how' and only then the 'what.' As can easily be seen, Sinek revolves around the 'inspirational motivation' theme of transformational leadership.

Scott (2017) describes her leadership model with a matrix of how much you directly challenge someone on the horizontal axis and how much you care about a person on the vertical axis. Both are important: caring for a person and achieving results. This results in the target quadrant 'Radical Candor,' which describes behaviour in which the supervisor empathically expresses their sympathy and understanding and acts in a highly challenging way to develop the employee. Results achievement, guidance, and teams are the main aspects of this type of successful leadership, which Scott developed and applied at Apple and Google.

The book *The 48 Laws of Power* by Robert Greene is assigned to transactional leadership and sometimes reads like a counter-draft to transformational leadership (Greene 2013). For example, the laws 'always say less than necessary' or 'let others work for you, but always take the credit' or even 'destroy your enemies completely' make Greene seem almost disturbing from a moral perspective. The book, which Greene calls the 'ultimate encyclopaedia of power' (Greene 2013), is influenced by many historical figures, including Niccolò Machiavelli. It would be interesting to reflect on why this book is so well received, even though its content fundamentally contradicts the transformational mainstream. At this point, it must suffice to say that the ranking on Amazon shows that the topic of 'power' has a particular resonance and plays a corresponding role in the leadership continuum.

Since Napoleon Hill's *Think and Grow Rich* (Hill and Bandini 1999) is one of the best-selling advice books of all time (Behling 2021), but not a book on leadership, it will not be discussed further.

Jocko Willink shares experiences from his time as a Navy Seal in *Extreme Ownership* (Willink 2020). As highlighted, the title of the book suggests that being a leader is about taking responsibility, especially for the mistakes and failures of a team, and then developing plans to overcome those mistakes. In addition to teamwork, simplicity, prioritization, and decision-making skills, this book's main keywords are decentralization and discipline, and is well worth reading.

In *Measure What Matters*, John Doerr (2018) describes the now widely known concept of Objective and Key Results (OKR). While the objectives rather describe the 'what,' the big goal to be achieved, the key results characterize the concrete and measurable 'how.' The aspect of 'inspirational motivation' from the transformational leadership model should be reflected in the inspirational objective. Other engaging moments, called superpowers, consist of priority setting, teamwork, transparent progress

measurement, and aspirational goals that are genuinely challenging and stretching to achieve.

Conclusion

Before discussing the individual findings, it can first be stated on a meta-level: there has not yet been a study that explores the relationship and connection between popular leadership literature and scholarly findings on leadership in general. The methodology of concluding leadership and its principles from a scientific perspective from the prevalence of leadership models in popular leadership literature bestseller lists is also new and generates new results. Furthermore, with more than 60 leadership theories, one can ask which one is the right one, respectively which one should be followed. As the result shows, certain leadership principles generate the most significant resonance; hence it is possible now to conclude the leadership principles that should flow into a universal model.

While few leadership books can be categorized as purely transactional, most are transformational or a mixture of both approaches. The main elements that can be found in almost all books are:

- *Effectiveness in implementation orientation:* vision, plan, prioritize, decide, implement.
- *Positive orientation:* opportunities instead of problems.
- *People orientation:* listening, we, strengths orientation; team-work (decentralization/empowerment); effective communication. *Self-management:* being able to lead oneself, taking responsibility, humility, emotional distancing.

That means it is possible to deduce from the available data which elements of leadership and how the construct of leadership, in general, can be understood to be both successful in the sense of business and accepted in the sense of organizations, institutions, and, ultimately, people. A comprehensive leadership model encompasses many aspects and will take a holistic approach rather than narrowing down to one model (which of the more than 60?). If one can infer its need and current acceptance from the prevalence of leadership concepts in popular print media, current leadership will be primarily transformational and contain transactional elements. Following this line of reasoning, there is a current need for leaders with personal qualities and outstanding self-management, but also with the ability to motivate in a visionary way, to communicate effectively, to empower employees in an opportunity-oriented manner, and at the same

time to set transactional (challenging) goals and reward their achievement. Converting these elements into a universal model is yet to be done.

Scientific Limitation and Further Research

As described earlier, this study of leadership books represents a limited sample: the slice of the market is limited, bestseller lists are hard to come by, and an assumption for the spread of the model cannot necessarily be made from sales figures. Put differently, a high sales figure does not necessarily mean that the book has been read, understood, and, above all, implemented. The period under consideration can lead to very different results. Some books may currently top the bestseller list but do not necessarily influence in the long run. Nevertheless, it became clear that the vast majority of books propagate a particular form of leadership. Further research should try to obtain similar bestseller lists from other markets. An Amazon long-term study could also provide essential insights into whether bestsellers persist over time. A new model could then be created from the core content of all leadership bestsellers, which would have the charm of combining the elements of leadership that seem to be most popular into a universal model.

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Foreign Development Assistance and Macroeconomic Policy Stance: The Underlying Levers of Growth in Emerging SSA Countries

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The economic growth of emerging Sub-Saharan African countries is investigated in this study, with the aim of determining the relative impacts of foreign development assistance (FDA) and macroeconomic policies. The GMM and VECM models are respectively employed in estimating the long-run and short-run impacts. The short-run results indicate that FDA strongly complemented fiscal policy only, in facilitating economic growth within the period 1980–2019. The long-run results, on the other hand, show that FDA complemented both monetary and fiscal policies in driving growth. The results further reveal that exchange rate played a non-complementary role, and economic growth did not respond significantly to its own lag. Generally, the estimated impacts conform to theoretical expectations of the models. The results are also considered reliable for policy making. The possible policy measures emanating from the estimation results include sustenance of FDA inflow, reinforcement of monetary policy framework, maintenance of fiscal policy framework, enhancing efficiency of the exchange rate system, and allowing market forces to drive the economy.

Key Words: development assistance, macroeconomic policies, economic growth, developing countries
JEL Classification: E51, F21, F43, O55

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Introduction

Economic growth in less developed economies of the world has remained slow for several decades, in spite of the contributions of various factors

such as foreign development aid and macroeconomic policies, among others. Over time, development assistance has been able to substantially increase the amount of resources available to facilitate economic growth in these economies, while the countries have also applied macroeconomic policies to facilitate growth (Chowdhury and McKinley 2007). In particular, monetary and fiscal policies have consistently been applied to drive economic growth. However, it is still unclear how foreign development assistance works with macroeconomic policies to facilitate economic growth in most developing countries. Since the early 1990s, the inflows of development assistance have been greatly encouraged by the political and economic reforms in most of the developing countries, which have created a conducive environment for advanced countries to supply more foreign aid (Tuman and Ayoub 2004). Today, the countries of East Europe, Africa, and Asia, where reforms have taken place, are the major recipients of foreign development assistance. The reforms have also enabled the countries to fine-tune macroeconomic policy framework for efficiency and better performance.

So far, previous research studies on economic growth in developing countries, such as Mahembe and Odhiambo (2019), Aghoutane and Karim (2017), etc., have not given adequate attention to how foreign development assistance (FDA) works with macroeconomic policies to facilitate growth in developing countries. Thus, more research work needs to be done, in order to shed more light on this issue. This study therefore attempts to address the issue, with the aim of producing new evidence that would be useful for policy making in Sub-Saharan Africa (SSA), as well as other developing regions of the world.

The study employs the general method of moments model (GMM) to evaluate the long-run impacts of FDA and macroeconomic policies on economic growth, while the vector error correction model (VECM) is used to determine the short-run impacts and adjustments. In terms of scope, the study covers the emerging economies in SSA, and the period 1980–2019. The emerging economies are the top five, in terms of their contributions to total GDP of the region (International Monetary Fund 2019). The economies and their respective contributions are Nigeria (18.1%), South Africa (15.1%), Kenya (4.0%), Angola (3.7%), and Ethiopia (3.7%). These countries are assumed to be large recipients of foreign development assistance. They are listed as eligible recipients of official development aid (ODA) by the Organization for Economic Co-Operation and Development (OECD). Furthermore, it is assumed that the coun-

tries have been consistent in using macroeconomic policies to facilitate growth. Finally, it is assumed that the countries have experienced highly unstable economic growth over time.

The study is structured into six sections comprising introduction, literature review, descriptive analysis, model specification, estimation/analysis of results, and conclusion.

Literature Review

THEORETICAL REVIEW

Development economists of the 1970s, represented by Lewis (1979), argued that development assistance is needed to improve infrastructure and facilitate economic growth in developing countries. Contemporary economists have also expressed the same view that development aid can play a significant positive role in economic growth when it is properly channelled into productive ventures. This view is championed by Sachs (2005), who contended that large scale aid can work to improve the welfare of countries when it is targeted and effectively utilized. He described aid as a big push required to overcome the specific economic problems confronting developing countries. Barder (2011) described human development as a major channel that foreign aid can pass through to impact positively on economic growth, while Easterly (2009) and Deaton (2013) argued that development aid not properly channelled may fail to impact positively on economic growth.

The theoretical framework for analysing the effect of macroeconomic variables on economic growth has over time evolved from the neoclassical growth theory propounded by Solow (1956) and Swan (1956). The theory focused on how supply factors (capital and labour) determine equilibrium economic growth, and ignored the demand factors that are also important in determining growth. As such, changes in demand-related factors like financial inflows, macroeconomic policies, and others have no effect on long-run growth.

However, the endogenous growth model, pioneered by Romer (1986), introduced financial conditions into the growth theory, through which macroeconomic policies can also influence growth. Otani and Villanueva (1989) further expanded the endogenous growth model by including external borrowing, through which macroeconomic policies can affect growth. In so doing, long-run economic growth was posited to be highly dependent on changes in macroeconomic policies, particularly monetary and fiscal policies. It was further posited that monetary policy impacts

positively on growth if it does not generate strong inflation. Similarly, fiscal policy is a potentially strong driver of economic growth if it does not conflict with monetary policy and create inflation. Min-Chang (2018) also posited a theoretical argument which states that fiscal policy has a strong positive impact on long-run growth, if it does not create a high debt burden with negative effects.

EMPIRICAL REVIEW

The role of foreign development assistance has been a topical issue in the growth process of developing countries, which several researchers have investigated. Some of the studies have found the role to be favourable on economic growth, while others found it unfavourable. Mallik (2008) investigated the role in the six poor African countries of Mali, Malawi, Niger, Sierra Leone, Togo, and the Central African Republic. The study found a negative long-run effect over a period of thirty-five years, which is contrary to the finding of Refaei and Sameti (2015) that indicated a positive relationship in Iran during the period 1980–2012. The positive effect of foreign development assistance on economic growth is corroborated in a study of eighty-two developing countries, covering the period 1981–2013, where Mahembe and Odhiambo (2019) discovered that foreign aid and growth converged in the long-run. In Ghana, Appiah-Konadu et al. (2016) tested the hypothesis which states that foreign aid promotes growth in developing countries, using the ARDL bounds test, and found long-run convergence between foreign aid and economic growth. The speed of adjustment towards convergence was found to be moderate. In the case of Morocco, Aghoutane and Karim (2017) used a VECM model to investigate the impact and discovered that foreign aid promoted growth in the short-run, but the impact became negative in the long-run. The finding on short-run impact tends to support Martinez (2015), who found a modest positive impact of foreign aid on growth in one hundred and four developing countries. On the other hand, the finding on long-run impact supports M'Amanja and Morrissey (2005), who revealed a significant negative impact in Kenya over the period 1964–2002.

The role of macroeconomic policy in the economic growth of developing countries has also been investigated in several studies. Monetary and fiscal policies are often deployed to maintain economic growth and stability. Over time, these policies have tended to exert considerable impact on economic growth in these countries, which has, however, remained highly contentious. In a study of Nigeria, covering the period 1980–

2011, Baghebo and Stephen (2014) found that monetary policy played an important role in encouraging investment and economic growth, which was further confirmed in a study by Ufoeze (2018) on the same country, where the effect of monetary policy on economic growth was also found to be significantly positive. In a study to ascertain the relationship between monetary policy and growth in Uganda, Twinoburyo and Odhiambo (2017) discovered that expansionary monetary policy had significant positive impact on growth within the period 1983–2014. This finding was replicated in Malaysia, where Akalpler and Duhok (2018) found that monetary policy affected growth positively, though the effect was considered to be moderate. In South Africa, Precious and Makhetha-Kosi (2014) carried out a study on the role of monetary policy in economic growth, which showed a positive impact during the period 2000–2010. The finding is in consonance with that of Nouri and Samimi (2011) that revealed a positive impact in Iran during the period 1974–2008, and is corroborated by Aliyev et al. (2020) in a study of Azerbaijan within the period 2005–2018. In contrast, Amarasekara (2008) revealed that monetary policy adversely affected economic growth in Sri Lanka over the period 1978–2005, because it was targeted more at containing inflation.

Some studies also examined the role of fiscal policy in the economic growth of developing countries, with mixed results. The strategic role of fiscal policy in economic growth was investigated in a study of the Tajikistan economy, where Brownbridge and Canagarajah (2008) revealed that higher levels of government spending translated into stronger economic growth and poverty reduction. In a more recent study, Tun (2019) investigated fiscal policy in Myanmar and found a significant positive long-run impact on growth within the period 1979–2016. This finding is comparable to that of Senekovič, Kavkler, and Bekő (2019) that also showed a positive role of fiscal policy in economic growth of the G7 countries, and of Ali, Ahmad, and Khalid (2010) that again revealed a significant positive impact of fiscal deficit on growth in Pakistan, within the period 1972–2008. In South Africa, Ocran (2011) discovered a moderate positive effect of fiscal expenditure on output growth in the period 1990–2008. This result is comparable to that of Ismal (2011) which showed a strong positive impact in Indonesia during the same period, as well as of Osuala and Jones (2014), that revealed a positive relationship between fiscal policy and growth in Nigeria, within the period 1986–2010. However, Eid (2020) found that government expenditure in Qatar had asymmetric ef-

fect on growth, with positive effect in some sectors and negative effect in others.

GAP IN LITERATURE

The literature survey in this section shows that economic growth is influenced positively or negatively by foreign development assistance (FDA) and macroeconomic policies. However, previous studies did not give adequate attention to how FDA works with macroeconomic policies in driving the economic growth of African countries. Therefore, this current study attempts to build on the existing knowledge by determining whether or not FDA complements macroeconomic policies in facilitating economic growth, with particular focus on emerging Sub-Saharan African countries. The investigation is intended to bridge the perceived gap in previous studies and add to the expanding knowledge on economic growth in developing countries.

Descriptive Analysis

FOREIGN DEVELOPMENT ASSISTANCE

Foreign development assistance has continued to flow from advanced economies to less developed economies, mostly in SSA, helping to ameliorate macroeconomic instability in the region. Inflows to the five emerging economies of SSA have increased significantly in the last two decades (figure 1).

Nigeria is currently the largest economy in SSA, with a significant part of fiscal revenue accruing from crude oil exports. The economy has experienced fluctuations in the level of development assistance, with an inflow of $0.17 billion in 2000, which rose to an all-time high of $11.4 billion in 2006, and subsequently dropped to $3.3 billion in 2018. The period 2000–2004 witnessed particularly poor inflows, with an average of $0.31 billion.

South Africa, on the other hand, is the most highly indebted country in SSA, depending largely on external borrowing to sustain its economy. In addition to borrowing, the economy receives development assistance, which has also fluctuated from $0.49 billion in 2000, to a peak of $1.42 billion in 2015, but declined to $0.91 billion in 2018. The initial period of 2000–2007 recorded unimpressive inflows, but significantly improved in the period 2008–2018.

Kenya also received development assistance, which is far larger than that of South Africa. The inflow rose steadily from $0.51 billion in 2000, to the highest level of $3.31 billion in 2013, but dropped slightly to $2.49

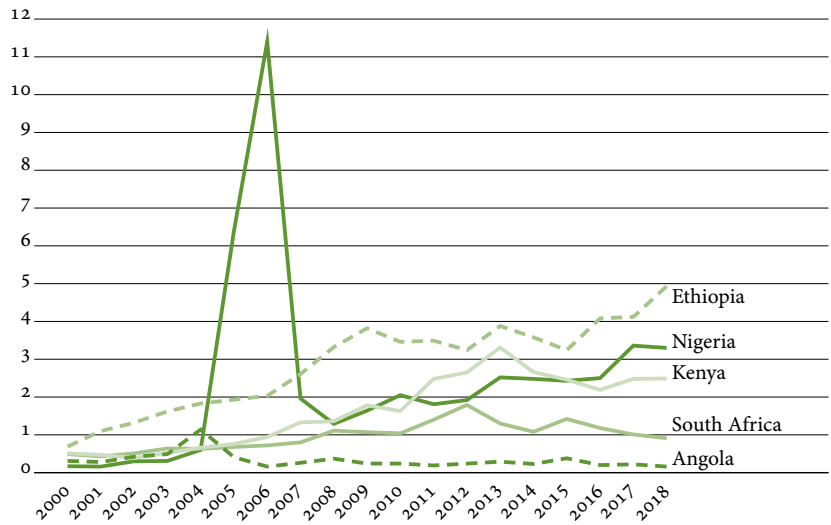

FIGURE 1 Official Development Aid and Assistance to Emerging Sub-Saharan African Economies (based on data from the World Bank, https://data.worldbank.org/indicator/DT.ODA.ALLD.CD)

billion in 2018. The trend was particularly impressive in the period 2001–2018.

Angola, like Nigeria, depends predominantly on oil export. The economy recorded abysmal performance in the inflows of development assistance, which was relatively low during the period. The inflows declined significantly from $0.31 billion in 2000, to the lowest level of $0.16 billion in 2018, which is also the overall lowest among the five economies. It follows that the economy has been a poor recipient of foreign development assistance.

Ethiopia experienced impressive inflow, as the economy is reported to be the highest recipient of development assistance among the top five economies. It recorded the lowest inflow of $0.69 billion in 2000, which rose astronomically to the highest level of $4.93 billion in 2018. This level is the overall highest among the five economies.

All the economies, together, recorded appreciable inflows of development assistance within the period 2000–2018. The aggregate inflows increased from $2.09 billion in 2000, to a peak of $15.52 billion in 2006, but dropped to $11.93 billion in 2018. The period 2005–2018 is quite remarkable, as the aggregate inflows stayed above $7.0 billion. This is a clear indication that SSA economies benefited largely from foreign development assistance during the period.

ECONOMIC GROWTH

Sub-Saharan Africa experienced significant economic growth within the period 2000–2019, driven largely by Ethiopia with an average growth rate above 10 percent (figure 2). Some of the countries, however, witnessed a decline in growth rate that necessitated the application of macroeconomic policies to defend the economy. The decline, in most cases, was caused largely by external shocks arising from the global financial crisis and oil price slump.

Nigeria is currently the leading economy in SSA, with an impressive GDP growth rate of 5.1 percent in 2000, which rose to a record high of 8.1 percent in 2009. The growth rate, however, dropped to a record low of –1.6 percent in 2016, and remained below the IMF/World Bank recommended minimum growth rate of 6 percent, as a result of the oil market crash. The country, being a major world exporter of crude oil, has tended to depend largely on oil revenue, thus making the economy highly vulnerable to oil market shocks. This suggests that the dependence on the oil sector needs to be reduced, by deploying macroeconomic policies to development of the non-oil sector.

South Africa was the most dominant economy in Africa up to 2007, and currently ranks as the second largest economy in SSA. The economy has been considerably unstable, as the growth rate rose from 4.2 percent in 2000, to 5.6 percent in 2006, and fell to its lowest level of –1.5 percent in 2009. It only improved marginally to 0.2 percent in 2019, indicating that the economy has been struggling to come out of depression. The economic growth predicament is attributed to several factors, such as the global financial crisis of 2008–2009, and the turbulent global oil market.

Kenya is ranked as the ninth largest economy in Africa, although it is the leading economy in the eastern part of SSA, as of 2019. The GDP growth rate rose from an abysmal rate of 0.6 percent in 2000, to the highest rate of 8.4 percent in 2010. Thereafter, it recorded a slight drop to 5.4 percent in 2019. Election crises in the country and the global financial crisis accounted for the growth rate of less than 1 percent in 2002 and 2008. The impressive growth performance of the economy within the period 2010–2019 may be attributed to significant political and economic reforms, which created a stable macroeconomic environment. The country has thus become one of the fastest growing economies in SSA.

Angola is highly dependent on oil export, which is the main driver of growth and development in the country. The growth performance, which

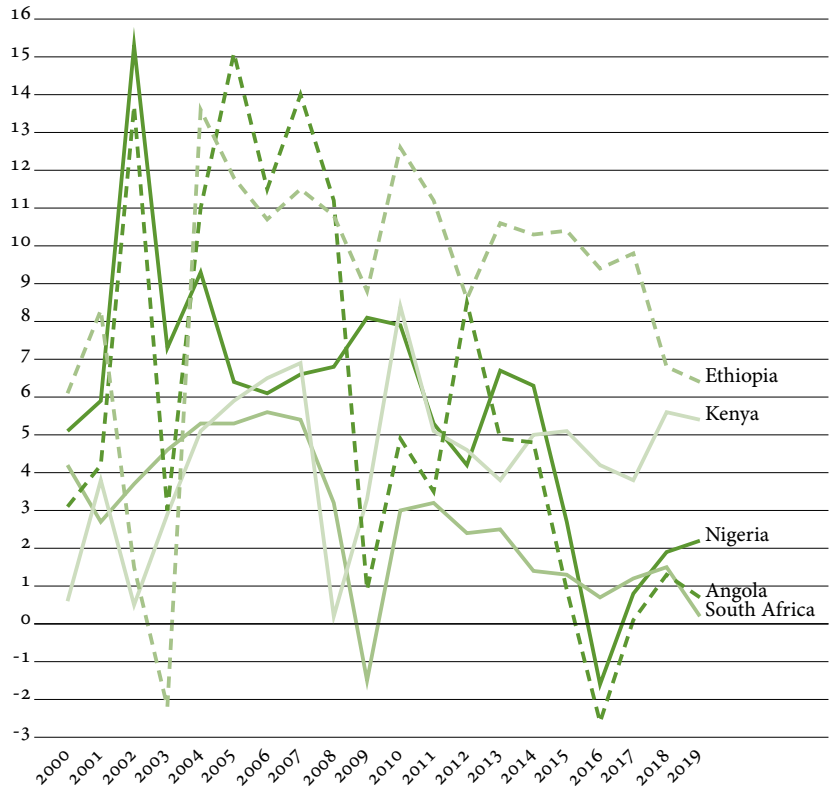

FIGURE 2 GDP Growth in Selected SSA Economies (based on data from the World Bank, https://databank.worldbank.org/source/world-development-indicators)

stood at 3.1 percent in 2000, rose astronomically to a peak of 15.1 percent in 2005, and dropped to a record low of –2.6 percent in 2016. The period 2002–2008 witnessed outstanding performance, with the average growth rate exceeding 10 percent. The economy was severely affected by the slump in global oil price, which led to the unprecedented decline in growth rates towards the end of the period.

Ethiopia dominated all other economies in growth performance during the period, with an outstanding average growth rate of over 10 percent. The economy is ranked among the fastest growing economies in the world. Although it experienced a slight hiccup in 2002–2003, the growth performance remained far above the IMF/World Bank recommended minimum growth rate of 6 percent for developing countries. The highest growth of 13.6 percent was recorded in 2004, while the lowest growth rate of –2.2 percent occurred in 2003. The impressive growth per-

formance of this economy can be attributed largely to inflows of capital through external borrowing and foreign aid. The inflows were effectively deployed into infrastructure development, which led to rapid economic growth.

Model Specification

THEORETICAL FOUNDATION

The Neoclassical model of economic growth (Solow 1956; Swan 1956) posited that growth (ECG) depends positively on capital-labour ratio (k), suggesting that only supply factors drive economic growth, as presented below.

$$\text{ECG} = f(k), f' > 0.$$

Subsequently, the endogenous growth model (Romer 1986) linked the supply factors with demand side factors, thus providing a basis for other relevant variables (Z) to influence economic growth, as shown below.

$$\text{ECG} = f(k), k = f(Z), \text{hence,}$$
$$\text{ECG} = f(Z), Z = 1, 2, \ldots, n \text{ variables.}$$

The growth model, therefore, accommodates other relevant exogenous variables, apart from the neoclassical postulated variables. The current study is built on this foundation, with the purpose of determining the effects of foreign development assistance and macroeconomic policies on economic growth.

GENERALIZED METHOD OF MOMENTS MODEL (GMM)

Based on the foregoing exposition, relating growth to other exogenous variables, the GMM model linking growth to foreign development assistance and macroeconomic policies can be constructed in two stages. The first stage shows the functional and stochastic relationships between the endogenous and exogenous variables, as follows.

$$\text{ECG}_{it} = f(\text{FDA}_{it}, \text{MOP}_{it}, \text{FIP}_{it}, \text{EXR}_{it}), \tag{1}$$

$$\text{ECG}_{it} = \alpha_0 + \sum_{j=1}^{4} \alpha_j X_{it} + \mu_{it}. \tag{2}$$

Equation (1) represents the functional relationship between the endogenous variable and exogenous variables, while equation (2) is the econometric specification of the relationship. The endogenous variable

in the model is ECG_{it} (economic growth), while the exogenous variables are FDA_{it} (foreign development assistance), MOP_{it} (monetary policy), FIP_{it} (fiscal policy), and EXR_{it} (exchange rate). The vector X_{it} contains all the exogenous variables, and μ_{it} is the error term. The parameters α_j ($j = 1, 2, 3, \ldots, 4$) are elasticity coefficients of the corresponding exogenous variables.

The second stage involves transformation of the model into the generalized method of moments model (GMM), proposed by Arellano and Bond (1991), and extended by Blundell and Bond (1998). The main feature of the GMM model is that it relates the endogenous variable to its own lag and the lags of exogenous variables, as presented below.

$$\text{ECG}_{it} = \beta_0 + \beta_1 \text{ECG}_{it-1} + \sum_{j=2}^{4} \beta_j X_{it-1} + \tau_{it} + \upsilon_{it}, \tag{3}$$

$$\Delta\text{ECG}_{it} = \lambda_0 + \lambda_1 \Delta\text{ECG}_{it-1} + \sum_{j=2}^{4} \lambda_j \Delta X_{it-1} + \omega_{it}. \tag{4}$$

The moment conditions are:

1. $\varepsilon(w_{it}) = \varepsilon[F(\text{ECG}_{it}, X_{it-1}, \lambda)] = 0$; zero expected residual of exogenous variables.
2. $\varepsilon(Y' w_{it}) = \varepsilon(Y' w_{it}, \lambda) = 0$; zero expected residual of instrumental variables (Y).
3. The unknown parameter λ determines whether expected residuals are significantly close to zero or not.
4. There is the optimum parameter λ^* that ensures expected residuals become zero.

Equation (3) is the GMM model with country fixed effect τ_{it}, which is eliminated by casting the variables in first difference form, denoted by the Δ operator, as indicated in equation (4). The correlation among the exogenous variables is minimized by including instrumental variables during estimation. Such instruments must be strong correlates of the endogenous variable. Higher lags of the endogenous variable are commonly used as instruments, e.g. ECG_{it-2} and ECG_{it-3}, which are usually not reported in the analysis of estimation results. The model is expected to be well behaved when the moment conditions are satisfied, that is, the expected value of the random error term becomes zero for exogenous variables and instrumental variables. All variables in the model, except exchange rate,

bear positive *a priori* relationship with economic growth. The relationship with exchange rate is uncertain.

VECTOR ERROR CORRECTION MODEL (VECM)

In order to determine the short-run effects and adjustment of variables, the VECM model is specified where all variables are endogenous. The model shows a simultaneous interrelationship among the variables, with each variable related to its own lag and lags of other variables. Following Engle and Granger (1987), the model is derived by transforming the conventional vector auto-regressive model (VAR) in equation (5) into the dynamic vector error correction model (VECM) in equation (6), by including the first difference operator Δ, and the error correction term ECT_{it-1}.

$$Z_{it} = \pi_0 + \sum_{j=2}^{4} \pi_j Z_{it-1} + \varepsilon_{it}, \tag{5}$$

$$\Delta Z_{it} = \eta_0 + \sum_{j=2}^{4} \eta_j \Delta Z_{it-1} + \text{ECT}_{it} + \upsilon_{it}, \tag{6}$$

The vector Z_{it} in the model is a composition of endogenous variables, while the matrix Z_{it-1} contains the lagged endogenous variables. Since all variables are endogenous, the problem of endogeneity is completely eliminated.

Model Estimation and Analysis of Results

ESTIMATION TECHNIQUES

The panel unit root test is employed to ascertain stationarity of variables, which is a condition that would enable the model to produce consistent and unbiased estimates. The test involves the three techniques of LLC, IPS, and HD, proposed respectively by Levin, Lin, and Chu (2002), Im, Pesaran, and Shin (2003), and Hadri (2000). The co-integration test is also employed to ascertain the long-run convergence of the variables, which would ensure that estimates are reliable for the purpose of forecasting and policy making. The co-integration test employed in this study was proposed by Pedroni (2004), which has four vital indices of variance ratio, rho statistic, PP statistic, and ADF statistic. The GMM estimator is used to determine the long-run impacts of variables on economic growth, while the VECM estimator is employed to evaluate the short-run impacts. Both estimators have been employed in previous studies to produce reli-

able estimation results for developing economies. The test for structural stability is conducted by employing the maximum likelihood estimator, following Yu, Jong, and Lee (2008).

The estimation is undertaken for the period 1980–2019, with data obtained from the World Bank Open Database, World Development Indicators, and OECD Statistics. The following measures of variables are used in the study: economic growth (GDP growth rate), foreign development assistance (foreign development aid from OECD), monetary policy (percentage change in money supply), fiscal policy (percentage change in fiscal expenditure), and exchange rate (exchange rate per dollar).

PANEL UNIT ROOT AND CO-INTEGRATION TESTS

These preliminary tests were conducted to confirm that variables in the model possess desirable empirical properties. The results are reported in table 1, where LLC and IPS produced significant FDA values of 2.94 and 3.04, respectively. Similarly, the LLC and HD produced significant FIP values of 2.87 and 0.88, respectively. It follows that only two variables are stationary in levels, and thus possess expected empirical properties. However, the three test indices show significant values for all variables in first differences, which indicate they are all stationary. Therefore, the null hypothesis of non-stationarity is rejected; hence, the variables are suitable for empirical estimation. In the case of the co-integration test, the Pe-

TABLE 1 Panel Unit Root and Co-Integration Test Results

Unit root test	Variable	Level			First difference		
		LLC	IPS	HD	LLC	IPS	HD
	ECG	0.68	0.77	1.99	6.06*	3.81*	0.78*
	FDA	2.94*	3.04*	2.01	4.12*	5.02*	1.04*
	MOP	1.05	0.98	1.98	6.33*	2.96*	0.99*
	FIP	2.87*	1.22	0.88*	7.05*	4.43*	1.17*
	EXR	0.93	1.03	2.55	5.17*	3.71*	1.06*
Pedroni co-integration test	Variance ratio (%) Critical range: $0 \leq r \leq 5$		Rho statistic Critical range: $0 \leq \sigma \leq 1$		PP statistic Critical range: $1.5 \leq p \leq 5$		ADF statistic Critical value = 1.95
		2.11*		0.86*	3.05*		2.96*

NOTES Sample size: 5 countries, estimation period: 1980–2019, observations: 200. In LLC and IPS tests, larger statistics indicate more stationary variables. In the HD test, smaller statistics indicate more stationary variables. * Variables are stationary (unit root test) and convergent (co-integration test).

droni variance ratio of 2.11 percent falls within the critical range. Similarly, the rho statistic of 0.86, PP statistic of 3.05 and ADF statistic of 2.96 fall within the critical level. These are indications that all the variables move toward convergence. Therefore, the null hypothesis is rejected, which further confirms that the variables are suitable for estimation.

GMM ESTIMATION

The GMM model was estimated to determine the long-run effect of exogenous variables on economic growth. The estimation results, reported in table 2, show how the exogenous variables interacted with one another to influence economic growth. The estimate of ΔFDA-1 is 0.19, which is positive and significant at 5 percent, indicating that foreign development assistance impacted favourably on economic growth. The estimate

TABLE 2 Estimation Results (GMM Model)

Dependent variable	Explanatory variable	Explanatory variable					
		Intercept	ΔECG-1	ΔFDA-1	ΔMOP-1	ΔFIP-1	ΔEXR-1
ΔECG	Intercept†	1.05*	0.02	0.19*	0.11*	0.14*	0.22
		(3.27)	(1.11)	(2.96)	(1.92)	(4.01)	(1.24)
	ΔECG-1	1.28*	_	0.49	0.69*	0.12	1.01
		(2.02)		(1.33)	(2.04)	(1.26)	(0.93)
	ΔFDA-1	0.41	0.66	_	1.11*	0.85	−0.37
		(1.18)	(1.08)		(3.19)	(1.31)	(−1.04)
	ΔMOP-1	2.11*	0.92	1.19*	_	0.95*	1.13*
		(4.05)	(1.14)	(2.88)		(9.12)	(3.32)
	ΔFIP-1	1.12*	0.51	−0.85	0.94*	_	0.55
		(1.99)	(1.27)	(−1.11)	(8.22)		(0.98)
	ΔEXR-1	0.84	0.71	−0.62*	1.15*	0.48	_
		(1.22)	(1.08)	(−1.98)	(2.22)	(1.03)	
Diagnostics	Sargan χ^2 statistic ($0.05 < p \leq 1$)	5.96	4.02	6.22	3.66	4.46	7.88
		(0.34)	(0.63)	(0.58)	(0.49)	(0.66)	(0.51)
	A-B(1)z-statistic ($0 < p < 0.1$)	1.09	0.99	1.11	1.06	0.95	1.01
		(0.18)	(0.13)	(0.15)	(0.16)	(0.19)	(0.14)
	A-B(2)z-statistic ($0.25 < p \leq 1$)	1.21	1.37	1.06	1.18	0.97	1.13
		(0.26)	(0.39)	(0.58)	(0.42)	(0.61)	(0.48)

NOTES † The main focus of empirical analysis; * significant at 5 percent; ** significant at 1 percent, *t*-statistics in parenthesis.

of ΔMOP-1 (0.11), representing the impact of monetary policy, is also significant at 5 percent. However, the impact is exceeded by that of foreign development assistance. The estimate of ΔFIP-1 (0.14) indicates positive and significant impact of fiscal policy at the 1 percent level, which is stronger than that of foreign development assistance and monetary policy. Exchange rate (ΔEXR-1) is the only variable that had unimpressive impact on economic growth, as shown by the estimate 0.22, which is insignificant at 5 percent. The adjustment of economic growth to its own lag (ΔECG-1) is positive, but insignificant. The other results in the table represent various effects of interaction among the variables.

Generally, foreign development assistance, over the period 1980–2019, can be considered to have significantly complemented monetary and fiscal policies in facilitating economic growth of the emerging Sub-Saharan African countries. All the variables in estimation results satisfy theoretical expectations. In the diagnostics, *p*-values of Sargan statistics fall within critical range, hence the null hypothesis of no auto-correlation in residuals of instrumental variables can be accepted. The *p*-values of A-B(1) statistics did not fall within the critical range of the null hypothesis, but they fall within the range in $A - B(2)$ statistics, indicating acceptance of the null hypothesis of no auto-correlation in residuals of exogenous variables. The GMM estimator is therefore valid, hence the estimates can be considered unbiased and reliable.

VECM ESTIMATION

The estimation of the VECM model is undertaken to further determine the short-run inter-dependence among the variables, since all the variables are endogenous. The estimation results, reported in table 3, show that the foreign development assistance (ΔFDA-1) estimate of 0.13 is positive and significant at the 5 percent level. It indicates that the effect on economic growth is appreciable. The monetary policy (ΔMOP-1) estimate of 0.04 is, however, not significant at 5 percent, while the fiscal policy (ΔFIP-1) estimate of 0.23 is highly significant at 1 percent. All the three variables conform to theoretical expectations. However, the significant effect of foreign development assistance is greater than that of monetary policy, but lesser than fiscal policy. The estimate of exchange rate (ΔEXR-1) is 0.07, which indicates insignificant impact on economic growth at the 5 percent level. The estimate of ΔECG-1 (0.09) is also insignificant, suggesting that growth did not significantly respond to its lag. Other estimates represent the several interactive effects of variables that eliminated

TABLE 3 Estimation Results (VECM)

Dependent variable	Explanatory variable						
	Intercept	ΔECG-1	ΔFDA-1	ΔMOP-1	ΔFIP-1	ΔEXR-1	ECT-1
ΔECG†	1.08*	0.09	0.13*	0.04	0.23*	0.07	−0.28
	(2.33)	(1.13)	(3.02)	(1.06)	(6.14)	(1.32)	(−1.33)
ΔFDA	0.91	0.02	0.16	−1.02*	0.22	−0.08	−0.31
	(1.07)	(0.96)	(1.13)	(−2.41)	(1.25)	(−1.06)	(−1.04)
ΔMOP	1.26	2.20	−0.44*	1.15	0.04	0.03	−0.77*
	(1.25)	(1.19)	(−2.21)	(1.33)	(0.88)	(1.10)	(−3.19)
ΔFIP	0.77	0.02	0.66*	0.12	0.09	0.21	−0.39
	(1.14)	(0.74)	(3.31)	(0.87)	(1.27)	(0.93)	(−1.18)
ΔEXR	0.05	0.03	0.07	−0.35*	−1.16	0.42	−0.27
	(1.11)	(1.06)	(1.21)	(−2.54)	(−0.95)	(1.31)	(−0.93)

NOTES Diagnostics: R^2 (adjusted) = 0.88, F-statistic = 29.06**, Sargan statistic 2.72 (>1.65), Arch statistic = 0.22, Durbin's h = 2.02. † The main focus of empirical analysis; * significant at 5 percent; ** significant at 1 percent, t-statistics in parenthesis.

the problem of endogeneity. It is also observed that the short-run adjustment of economic growth towards a steady state is slow, as indicated by the error correction term (ECT-1) estimate of –0.28, which represents a periodic adjustment speed of less than 30 percent.

The short-run estimation results are largely consistent with the long-run results. The impact of foreign development assistance on economic growth in the emerging Sub-Saharan African countries is quite significant, and also complementary to that of monetary and fiscal policies. The reliability of the results is confirmed by the various diagnostic statistics. The adjusted R-square of 0.88 is an indication that all the variables accounted for about 88 percent of systemic variation in the model. The F-statistic of 29.06 shows that the explanatory power of the model is significant at 1 percent. The Sargan statistic of 2.72, Arch statistic of 0.22, and Durbin's h-statistic of 2.02, all suggest that auto-correlation and spuriousness are considerably minimized. The VECM estimator is therefore valid, hence the estimates can be considered reliable.

LONG-RUN STRUCTURAL STABILITY

Long-run estimation results are considered useful for the purpose of policy making when structural stability exists in a model. The maximum likelihood estimator is commonly employed to test for structural stability. It involves splitting the entire period of study into two sub-periods, by choosing a suitable break point (Yu, Jong, and Lee 2008). The break

TABLE 4 Maximum Likelihood Structural Stability Estimates

Exogenous variable	All period (1980–2019)		Sub-period 1 (1980–2000)		Sub-period 2 (2001–2019)	
	(1)	(2)	(1)	(2)	(1)	(2)
Intercept	0.19	0.95	0.27	1.37	0.24	1.25
ECG-1	0.22	1.16	0.31	1.41	0.28	1.29
FDA-1	0.17	0.91	0.25	1.25	0.30	1.30
MOP-1	0.23	1.23	0.33	1.43	0.29	1.31
FIP-1	0.18	1.19	0.29	1.32	0.31	1.33
EXR-1	0.20	1.14	0.52*	2.20	0.27	1.36

NOTES Column headings are as follows: (1) coefficient, (2) asymptotic *t*-statistic. * Significant at 5 percent level.

TABLE 5 Maximum Likelihood Reliability Estimates

Alternative break point	Structural break parameter estimate		Normalized bias statistic	Standard deviation	Root mean square error
	Rho 1	Rho 2			
1997	0.03	0.06	0.36	0.17	0.21
1998	0.05	0.04	0.38	0.15	0.20
1999	0.07	0.05	0.42	0.13	0.22
2000	0.06	0.08	0.39	0.16	0.24
2001	0.05	0.07	0.41	0.14	0.27
2002	0.04	0.08	0.37	0.15	0.26
2003	0.06	0.06	0.40	0.16	0.24

NOTES Alternative break points are distributed evenly around the year 2000.

point in this study is the year 2000, which was characterized by extensive structural reforms in all countries under investigation. In table 4, the maximum likelihood estimates of the whole period and sub-periods are not significant at the 5 percent level. Again, the sub-period estimates of each variable are not significantly different. Therefore, the null hypothesis of no structural break is accepted, hence the long-run estimation results may be considered suitable for policy making. In table 5, the parameter estimates (Rho 1 and Rho 2), normalized bias statistic, standard deviation and root mean square error show insignificant variation in values, which validates the maximum likelihood estimator; hence, the structural stability estimates remain unbiased and reliable.

POLICY PERSPECTIVES OF ESTIMATION RESULTS

The analysis of short-run and long-run estimation results revealed that foreign development assistance exerted significant positive impact on

economic growth in the five emerging economies of Sub-Saharan Africa, and complemented the role of macroeconomic policies. The impact is observed to be more significant than that of monetary policy, but less significant than fiscal policy. On the other hand, exchange rate did not complement the role of macroeconomic policies, following its insignificant impact on growth. Furthermore, economic growth did not significantly respond to its own lag. These findings necessitate the following policy measures:

1. Foreign development assistance needs to be sustained in order to foster its complementary role in facilitating the economic growth of Sub-Saharan African countries. This can be achieved by maintaining a stable political environment.
2. Monetary policy framework should be reinforced to focus more on economic growth, without relegating other macroeconomic objectives.
3. Fiscal policy framework should be maintained and focused on economic growth, without conflict with monetary policy.
4. The exchange rate system can be made to operate more efficiently, by removing possible official constraints, to enable it to impact significantly on economic growth.
5. Economic growth can be encouraged to adjust faster by allowing market forces to operate and allocate resources efficiently.

Conclusion

Various studies have revealed several factors that accounted for economic growth in developing countries over the years. However, adequate study has yet to be undertaken on how foreign development assistance works with macroeconomic policies in facilitating the economic growth of Sub-Saharan African countries. The current study, therefore, employed the GMM and VECM models to investigate the issue, in the five emerging Sub-Saharan African economies, within the period 1980–2019. The short-run and long-run results revealed that foreign development assistance exerted positive and significant impact on economic growth, which is largely complementary to the impact of macroeconomic policies. The impact is greater than that of monetary policy, but lesser than fiscal policy. Exchange rate is the only variable that failed to make meaningful impact on economic growth. It was also observed that economic growth did not significantly respond to its lag. Therefore, the role of foreign development

assistance and macroeconomic policies, over the period 1980–2019, can be considered highly complementary and quite beneficial to economic growth of the emerging Sub-Saharan African countries. Furthermore, the structural stability of the model confirmed the usefulness and reliability of the empirical results to policy making.

The results produced by the two estimation methods conform largely to theoretical expectations, which state that foreign development assistance, monetary policy, and fiscal policy are positively related to economic growth, while exchange rate is uncertain. The possible policy measures emanating from the estimation results include sustenance of foreign development assistance, reinforcement of monetary policy framework, maintenance of fiscal policy framework, enhancing the efficiency of the exchange rate system, and allowing market forces to drive the economy.

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Infrastructure and Health System Performance in Africa

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Empirical findings for the effect of infrastructure on health system performance and across a range of infrastructure types in Africa are not common. This is important for ascertaining the infrastructure with more influence on health systems. Findings in this regard are vital in Africa where health systems perform poorly, with fiscal challenges for public provision of health care needs. This paper examined the effect of infrastructure types on health system performance in Africa using data for 54 countries in the region and over the period 2003–2018. Health system performance is captured by population health outcome. Findings are shown using the System GMM estimation technique. The results showed a significant effect of transport and ICT in improving the length of life and reducing under-five mortality. Improvement in ICT reduced maternal deaths. An increase in all infrastructure types (transport, electricity and ICT) significantly reduced infant mortality. From the results, only ICT is associated with improvement in all population health outcome variables used in the study. Findings suggest the key role of infrastructure on health system performance, with ICT shown to have more influence on health systems than other infrastructure types. The provision and use of ICT should therefore be given top priority in the pursuit of better health system performance in Africa.

Key Words: infrastructure, health system performance, population health
JEL Classification: I15, P46, H54

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Introduction

The African region is characterized by poorly performing health systems resulting in a relatively higher illness burden than other continents on the globe. The region carries about 25% of the world's disease burden with global health expenditures of less than 1%, and manufactures less than 2% of the medicines it consumes (United Nations 2017; World Health Organization 2015). There are clues that the poor state of health system performance in Africa extends beyond poor public sector financing to a

shortfall in the level of infrastructural development (UN 2017). This follows from the complementary role of infrastructure in ensuring low input cost, promoting advances in medical research and encouraging innovation and technological advancement (Calderón, Cantú, and Chuhan-Pole 2018).

One of the ways of preventing health workers from migrating, aside from an increase in salaries, is improved working conditions (Chen, Chindarkar, and Xiao 2019). The provision of infrastructure not only improves working conditions but also mitigates the migration of health workers (Chen, Chindarkar, and Xiao 2019). This role is essential given the growing shortage of doctors and nurses for tackling the heavy disease burden in the African region.

There are essentially two broad groupings of infrastructure, which are the soft and hard forms (Zeufack et al. 2020; United Nations n.d.). Examples of hard infrastructure include transport (road, rail, ports and airports) and electricity, as well as Information and Communication Technology (ICT) (Zeufack et al. 2020 2017). Soft forms of infrastructure include health, education, and national defence among others (Zeufack et al. 2020). They are mainly skills that are required to operate technologically and institutionally complex processes (Zeufack et al. 2020; United Nations n.d.). Studies that examined the effect of infrastructure on an outcome variable generally focus on the hard form of infrastructure and the results are often obtained with the use of one type of hard infrastructure (Cole, Watkins, and Kleine 2016; Lenz et al. 2017; Maboshe and Kabinga 2018; Köroglu, Irwin, and Grépin 2019; Chen, Chindarkar, and Xiao 2019; Majeed and Khan 2019; Shobande 2020; Kouton, Bétila, and Lawin 2021). This does not give room for comparison of findings for the effect of infrastructure types on the outcome variable.

In terms of health system performance, hard infrastructure, such as the provision of transport facilities, ensures access to health care by removing distance barriers and facilitating timely use of health services (Lungu et al. 2001; Fiagbe, Asamoah, and Oduro 2012; Syed, Gerber, and Sharp 2013; Broni et al. 2014; Brown et al. 2019; Varela et al. 2019). Poor provision of transport infrastructure and cost of transport are major causes of poor use of healthcare services, particularly where referral care is needed (Broni et al. 2014). Inadequate transport infrastructure is also identified as a major constraint to achieving child and maternal health targets in many developing countries (Babinard and Roberts 2006).

Other forms of hard infrastructure such as electricity also affect health

system performance in several ways. At the facility level, electricity provision impacts on the delivery of health care by aiding advanced diagnostics and treatment of poor health conditions (Chen, Chindarkar, and Xiao 2019). It also aids the availability and functioning of medical equipment, night time service provision by health workers, improved data collection at the health facility and proper records of patient information (Chen, Chindarkar, and Xiao 2019). Electricity infrastructure also aids information sharing, networking among medical professionals, increased education and training of medical personnel as well as the provision of safe water for drinking (Palei 2015).

The provision of electricity is also key in improving maternal and child health status (Maboshe and Kabinga 2018). This relates to the use of electricity in health facilities to provide lighting during child delivery, emergency night-time care and refrigeration of essential vaccines and medicines. In developing countries, most healthcare facilities lack access to a stable electricity supply and this is shown to have a negative effect on infant and maternal health (Maboshe and Kabinga 2018).

Using predictors of energy use in a panel study for African countries and with a Generalized Method of Moments (GMM) estimation, findings by Shobande (2020) showed a reduction in infant mortality rate with an increase in energy consumption. Similarly, Chen, Chindarkar, and Xiao (2019) observed increased probability of children receiving vaccinations following an electricity upgrade programme in rural India. Findings also showed an increase in the probability of mothers attending antenatal check-ups during the first trimester due to the electricity upgrade programme. Similar results were obtained by Köroglu, Irwin, and Grépin (2019), showing that frequent power outages induced a fall in the odds of expectant mothers delivering in a healthcare facility in Maharashtra State, India. The results also showed a reduction in the odds of skilled birth attendance due to an increase in power outage frequency and duration. In Rwanda, evidence provided by Lenz et al. (2017), using a mixed-method study, associated improved use of medical equipment, drug storage, sterilization, and administrative duties with electrification.

Adequate power supply is also associated with better dissemination of information regarding health safety measures using mobile phones. This function is vital, especially when there is an outbreak of illness that contributes to high mortality rates such as the Human Immunodeficiency Virus (HIV) and during periods of an epidemic such as the recent COVID-19 pandemic (Suhlrie et al. 2018; Ghosh, Bernstein, and Mersha 2020). Ev-

idence provided by Chen, Chindarkar, and Xiao (2019) in Gujarat, India, showed significant increase in the probability of receiving information about HIV via television and among women due to increased electricity duration and voltage stability. This, in turn, improved health seeking behaviour by educating individuals about the course of treatment of the ailment and the consequences of not seeking care.

Contrary to evidences of the strong impact of electricity supply on the provision of health services, an insignificant effect was observed by Maboshe and Kabinga (2018) in Zambia. Using the data envelope analysis and tobit regression framework, they found a negligible effect of access to electricity on the efficiency of maternal and child service provision at the basic healthcare level in Zambia. This finding is, however, linked to low use of energy dependent technologies or energy-intensive inputs for basic health service provision at the primary health care level.

Infrastructure provision such as ICT also serves as a booster to health system performance in terms of spreading health information to promote efficient disease management and prevention as well as improving communication between the patient and provider of health care (Cole, Watkins, and Kleine 2016; Kouton, Bétila, and Lawin 2021). Among health workers, ICT can be used to improve ordering of medical equipment, minimize stock shortage and facilitate long-distance medical consultations (McConnell 2006; Haluza and Jungwirth 2015; Lee, Liu, and Lio 2016). In Ghana, Abekah-Nkrumah, Guerriero, and Purohit (2014) showed a significant positive effect of ICT on health care use, specifically for maternal health services. Majeed and Khan (2019) examined the effect of ICT on health for a large data set comprising a panel of 184 countries and with use of the GMM, and the fixed and random effects techniques. The evidence showed improvement in population health, specifically life expectancy at birth and infant mortality rates, with development in ICT. Findings by Kouton, Bétila, and Lawin (2021) showed similar results for a panel study of 35 African countries and with use of the GMM estimation. The results showed a reduction in infant deaths with development in ICT.

The use of ICT can, however, be linked with poor health outcomes. In this case, high usage of ICT induces irregular food intake, mental distress and less physical activity (Booth et al. 2001; Rosell et al. 2007; Kim et al. 2010). Findings by Rana, Alam, and Gow (2018) showed negative effects of ICT use on public health measured using an index of health outcome in a panel study for 20 countries in the Organization for Eco-

nomic Cooperation and Development (OECD). Adverse effects of ICT on health outcome are also connected to misleading or misinterpreted information online that can cause unnecessary anxiety, unrequired visits to physicians and even mortality (Murray et al. 2003; Tanis, Hartmann, and Te Poel 2016).

By 2050, Africa's population is projected to reach one quarter of the world's total, increasing from 17% of the global population in 2018 to 26% in 2050 (OECD/ACET 2020). Interestingly, the recent COVID-19 pandemic that has slowed down population growth in most parts of the world had relatively minimal effect on mortality in the African region (Ghosh, Bernstein, and Mersha 2020). The projected rise in population in the African region will further strain existing poor health systems, leading to more adverse health conditions than are currently observed. Empirical findings for the determinants of health system performance in Africa are mainly in terms of the role of funding, environmental pollution and poor governance (Novignon and Lawanson 2017; Boachie, Ramu, and Põlajeva 2018; Osakede 2018; Osakede and Ajayi 2019; Osakede 2020). Not many studies have focused on the role of infrastructure. The few existing findings that associate health system performance with infrastructure examined the effect of a single form of infrastructure (Cole, Watkins, and Kleine 2016; Lenz et al. 2017; Maboshe and Kabinga 2018; Köroglu, Irwin, and Grépin 2019; Chen, Chindarkar, and Xiao 2019; Majeed and Khan 2019; Shobande 2020; Kouton, Bétila, and Lawin 2021). There is, therefore, a dearth of findings for the effect of several infrastructure types in terms of their relative effect on health system performance. This research is necessary to ascertain the infrastructure type that should be considered top priority in addressing improvement in health systems. In addition, findings for the effect of infrastructure on health system performance captured using population health outcome have mainly focused only on one or two indicators of population health (Maboshe and Kabinga 2018; Kouton, Bétila, and Lawin 2021; Shobande 2020). A focus on the effect of a range of infrastructure types on several indicators of population health will be more distinct and informative in the pursuit of better health system performance.

This paper provides findings for the effect of hard infrastructure on health system performance in Africa using data for 54 countries in the region, over the period 2003 to 2018. The effect of transport, electricity, ICT and an overall composite measure of infrastructure on health system performance are examined, captured using measures of population

health: life expectancy at birth, and infant, under-five and maternal mortality rates. The focus on hard infrastructure follows from data availability as there are challenges with data for soft forms of infrastructure.

The contribution of the study to the literature is as follows. First, this paper adds to literature findings on the determinants of health care system performance in Africa with a focus on the role of infrastructure. Second, unlike most existing research, it provides empirical findings for the effect of infrastructure on health system performance across a range of infrastructures to ascertain the type of infrastructure that exerts a stronger influence on health systems in the region and hence should attract more policy attention. Third, the study differs from existing findings in this regard with its focus on more indicators of population health outcome as a measure of health system performance than is observed in the extant literature. Findings in this regard are also not common in Africa and will be more informative in guiding policy initiatives in promoting health system performance in the region.

Methodology

MODEL SPECIFICATION AND ESTIMATION TECHNIQUE

The World Health Organisation has identified three broad goals of health systems (World Health Organization 2000). These are to improve the health of the population, respond to the reasonable expectations of the population and collect funds in a fair way (World Health Organization 2000). The performance of health systems is hence captured by the extent of achievement of these goals. The achievement of the goals of health systems is connected to its key dimensions, namely accessibility, quality, and efficiency of health care (Mackillop, Hanna, and Brundage 2016). Smith et al. (2010) provide several ways in which health system performance can be measured. This includes the use of population health indicators such as life expectancy, disability adjusted life years and years of life lost. Others are the use of clinical quality and appropriateness of care with outcome measures such as specific post-operative readmission and mortality rates. Additional proposed measures are the responsiveness of health systems in terms of patient experience and satisfaction, and equity in the access and use of health care. Some other measures are the productivity of health-care organizations and individual practitioners in terms of the use of cost-effective methods, and allocative and technical efficiency in the delivery of health care.

In examining health system performance, measures that capture population health are often preferred, particularly for macro-related studies, due to challenges with data availability for other measures (Olafsdottir et al. 2011). As noted by Rechel and Karanikolos (2014), a key challenge in the assessment of health systems is the lack of reliable and high-quality data. Population health indicators are a reflection of the dimensions of health care systems in terms of timely access to care when it is needed, the quality of care, the effectiveness and efficiency of health care (Smith et al. 2010). Based on data availability for a macro study of this type, health system performance is captured using measures of population health outcome, specifically life expectancy at birth, and infant, under-five and maternal mortality. These indicators are widely accepted to measure population health (Boachie, Ramu, and Põlajeva 2018). Moreover, infrastructure, which is the main predictor variable in this study, is identified to have strong association with infant, under-five and maternal health condition as well as length of life. The general assumption is that countries with healthy populations have good health systems and will have low mortality and higher life expectancy (Boachie, Ramu, and Põlajeva 2018).

In specifying the empirical relationship between the selected population health outcome variables and the predictor variables, this study adopts the theoretical foundation of the health production function in line with the Grossman (1972) modelling strategy for health care demand. According to Grossman (1972), individuals can produce health based on inputs that influence health condition such as their behaviour or lifestyle, medical care consumption or expenditure on health, literacy rate and income. In line with the supposition by Grossman, the individual's health production function can be represented as:

$$H_i = f(hinpts_i), \tag{1}$$

where H is the health output for individual i and *hinpt* represent inputs or factors that determine the individual's health.

This model presents the health production function at the individual level. At the macro level, the health production function captures population health and the inputs are reorganized into three categories: social, economic and environmental factors (Fayissa and Gutema 2005). For simplicity, this study categorizes health inputs at the macro level into social economic and environmental factors. So, equation (1) can be restated in the panel form as:

$$H_{it} = f(Se_{it}, Env_{it}), i = 1, 2, \ldots, n, \text{ and } t = 2003, \ldots, 2018, \tag{2}$$

where *H* represents population health outcome. Se captures social economic factors and Env represents the environmental condition. Based on available data, socioeconomic factors considered in this study include macroeconomic income measured using per capita Gross Domestic Product (GDP), government spending on health and education, and labour force participation (Majeed and Khan 2019; Osakede 2020). Environmental condition is measured using carbon dioxide emission (Majeed and Khan 2019; Osakede and Ajayi 2019). In this study, the role of governance quality is also considered as a determinant of population health (Novignon and Lawanson 2017; Boachie, Ramu, and Põlajeva 2018; Osakede 2020). Governance quality is measured using the control of corruption. This is because other forms of governance quality are often a reflection of the extent of corruption in a society. To capture the role of infrastructure, the index for transportation, electricity, ICT and a composite infrastructure index are included in the health production function.

Similar to the techniques used by macro studies of this type, the model for the effect of infrastructure on health systems is estimated using the GMM technique. This is the most appropriate methodology for panel data study of this type because it is mainly applied to models with large cross section and small time dimension. The approach makes it possible to predict the dynamic nature of the human condition (Shobande 2020). Choice of this technique is also based on its wide application in controlling potential endogeneity due to the omission of country-specific explanatory variables in panel data models (Majeed and Khan 2019; Shobande 2020; Kouton, Bétila, and Lawin 2021). In the GMM estimation, lagged values of the dependent variables are used as instruments to control for endogeneity (Roodman 2009). The GMM estimates can be derived using the one-step (first difference) or two-step (second difference) transformation. However, the two-step GMM is often preferred because it provides more efficient and consistent estimates, particularly if a variable's recent value is missing (Roodman 2009; Arellano and Bover 1995). The GMM estimate can be derived using the Arrelano and Bond (1991) Difference GMM (DGMM) or the Blundell and Bond (1998) system GMM (SGMM). Oftentimes the SGMM is preferred to the DGMM because it provides more efficient estimates than the DGMM and circumvents the finite sample bias with small time periods that is often observed with the DGMM (Alonso-Borrego and Arellano 1999; Heid, Langer, and Larch 2011).

The general model of the data-generating process for the GMM model specification in this study is stated as:

$$H_{it}^{j} = H_{i,t-1}^{j} + X_{i,t}'\beta + \varepsilon_{i,t}, \tag{3}$$

where $H_{i,t}^{j}$ is health outcome j for country i at time t. Four health outcome variables are considered in this study: life expectancy at birth (years), infant mortality per 1,000 live births, under-five mortality per 1,000 live births, and maternal mortality per 100,000 live births. $H_{i,t-1}^{j}$ is health outcome j for country i at time t-1. $X_{i,t}'$ is a vector of control variables. The control variables are the natural logarithmic value for per capita Gross Domestic Income at constant USD, labour force participation as a percentage of total population ages 15 and above, government spending on health in constant USD and government spending on education in constant USD. Others include carbon dioxide emission in metric tons per capita, the control of corruption and the natural logarithmic value for infrastructure variables.

The disturbance term $\varepsilon_{i,t}$ has two orthogonal components: the fixed effects, μ_i, and the idiosyncratic shocks $\upsilon_{i,t}$. That is,

$$\varepsilon_{i,t} = \mu_i + \upsilon_{i,t}, \tag{4}$$

where $E(\mu_i) = 0$ and $E(\upsilon_i) = 0$, so that $E(\mu_i \upsilon_{i,t} = 0)$.

It is expected that:

- The initial value of the dependent variable will be positively related to its current value.
- A rise in per capita income will translate to better health outcomes as higher income ensures financial access to health care when needed and is also an indication of increased welfare such as better nutrition and housing (Majeed and Gillani 2017).
- Similarly, increased labour force participation can lead to better health outcome, especially where the nature of employment is with minimal work hazards. Moreover, with improved economic empowerment, individuals are able to purchase more baskets of goods that raise welfare and health conditions. In addition, revenue generated from income taxes can serve as a booster to government spending on basic needs in the society that can improve health conditions.
- Increased government spending on health and education are also expected to have a positive impact on health. Higher public health spending is an indication of better provision of health care services for the populace and hence should raise health conditions. Similarly,

improved public spending on education should raise literacy rates that in turn improves the effectiveness and efficiency of the use of health care. This in turn raises health outcomes.

- Carbon dioxide is a form of environmental pollution and constitutes unhealthy changes in the atmosphere that harms the health of present and future generations. Increase in carbon dioxide emission is expected to have negative effects on population health and hence dampen efforts geared towards improving health systems. However, increased carbon emission can be due to higher industrial sector activities, suggesting a rise in income. In this case, negative effects may be dampened by a rise in wellbeing.
- Improvements in the index of governance are expected to induce positive effects on health outcome due to its influence on the effective use of public funds (Osakede 2020). The governance indicator is measured using the control of corruption based on suggestions of a strong effect on health system performance. Countries with high corruption are generally characterized by poor institutions and low governance quality. They are also associated with low investment in social welfare and poor population health (Gupta, Davoodi, and Tiongson 2000; Kaufmann, Kraay, and Mastruzzi 2004). Estimates for governance indicators range from approximately –2.5 (weak) to 2.5 (strong) governance performance.
- In terms of infrastructure provision, it is expected that improved infrastructure supply will enhance health system performance, reflected in improved health outcome. This follows from the role of infrastructure in promoting quality and effective delivery of health care services, better response to emergencies, improved data collection and databases for better implementation of health care intervention (van Schalkwyk and Mindell 2018; Brown et al. 2019; Chen, Chindarkar, and Xiao 2019; Varela et al. 2019; Shobande 2020; Kouton, Bétila, and Lawin 2021).

DATA SOURCES

The data for infrastructure used for the study were sourced from the Africa Infrastructure Development Index provided by the African Development Bank (2018). Data for the control of corruption was obtained from the World Governance Indicators provided by the World Bank (https://databank.worldbank.org). Data for the other variables used in

TABLE 1 Descriptive Statistics

Variables and Measurement	Mean	SD	Min	Max
Life expectancy (total in years)	59.65	7.71	42.42	76.69
Infant mortality (per 1000 live births)	55.42	24.11	10.20	134.30
Under-5 mortality (per 1000 live births)	83.69	41.29	12.00	216.80
Maternal mortality (per 100,000 live births)	504.40	330.10	37.00	1,960.00
Real GDP per capita (constant 2010 USD)	2,558.00	3,312.00	194.90	20,513.00
Labour force participation total (% of total population ages 15 years and above)	65.31	12.61	41.15	89.05
Domestic government health expenditure (% of total government expenditure)	7.01	3.47	0.65	18.29
Government spending on education (% of total government expenditure)	16.89	5.76	0.88	37.52
CO_2 emission (metric tons per capita)	1.19	2.07	0.02	1.00
Control of corruption	−0.66	0.60	−1.87	1.22
Transport infrastructure index	10.84	12.20	0.00	56.59
Electricity infrastructure index	9.18	16.85	0.00	100.00
Information and communication technology infrastructure index	6.15	10.01	0.00	67.39
Composite infrastructure index	20.88	18.44	0.01	94.97

NOTES Based on data from from World Bank (https://databank.worldbank.org) and African Development Bank (2018).

the study were obtained from the World Development Indicators provided by the World Bank (https://databank.worldbank.org). Data used covered 54 countries in the African region. Based on constraints for the availability of infrastructure data, the time frame for the study spans from 2003 to 2018.

Results and Discussion of Findings

The results for the descriptive statistics of the variables used in the study are shown in table 1. Average life expectancy in the African region and over the period of the study is approximately 60 years with a maximum value of about 77 years. The standard deviation of life expectancy of approximately 7 years shows that the figures are not very distant from its mean value. On average, infant deaths are approximately 55 per 1,000 live births. At maximum, the value is as high as 134 infant deaths per 1,000 live births. This is quite high when compared to global average figures

of 39 per 1,000 live births in 2017 and also far from the Sustainable Development Goal (SDG) of 25 deaths per 1,000 live births (UNICEF, WHO, World Bank Group and United Nations 2018). The mean value for under-5 mortality is approximately 84 per 1,000 live births. This is also high relative to global estimates of 39 deaths per 1,000 live births in 2017 and far from the SDG of 25 deaths per 1,000 live births (UNICEF, WHO, World Bank Group and United Nations 2018). On average, maternal mortality rates are about 504 per 100,000 live births. This, again, is far from the SDG of 70 per 100,000 live births (World Health Organization 2019). The statistics suggest the need for countries in the African region to accelerate progress to meet the SDG for infant, under-five and maternal mortality.

The average value of real GDP per capita is 2,558 USD. The standard deviation of real per capita GDP is 3,312 USD. This is quite high and may be due to the heterogeneous nature of country cross sections. Approximately 65% of individuals aged 15 years and above are actively engaged in the labour force, suggesting that less than half of the individuals aged 15 and above are unemployed. However, most employment types in African economies are in the informal sector and this creates a low tax base for the government (International Labour Organisation 2020). Domestic government health expenditure as a percentage of total government expenditure is approximately 7% with a maximum value of 18%. The indication is that for the time period of the study, governments in the African region allocated 7% of budgetary provision to health. This suggests low domestic health prioritization in terms of budgetary allocation to health and less financial protection, especially for persons who are poor (World Health Organization 2018). Government spending on education as a percentage of total government expenditure is approximately 17% on average with a maximum value of 38%. The indication is that governments in the region allocate more funds to education than health. The education and health sectors are important in achieving sustainable growth and development and each complements the other in achieving this objective. With higher budgetary allocation to education than health, individuals may not be able to harness the reward of education due to poor health following from low provision of health care needs.

CO_2 emission is approximately 1 metric ton per capita on average. Carbon emission is oftentimes associated with increase in economic output yet negative effects are noticeable on health condition as it generally promotes poor air quality (Farooq et al. 2019; Osakede and Ajayi 2019; Olubusoye and Musa 2020). On average, the index for the control of corrup-

tion is –0.664. The negative sign suggests the prevalence of poor control of corruption in the region.

The average value for infrastructure suggests better provision of transport infrastructure than other forms of infrastructure considered in the study. Transport infrastructure is shown to have an index value of 11 on average while electricity infrastructure has an average index value of 9. ICT is shown to have an average index value of 6. The figures clearly show that the African region is characterized by less ICT infrastructure than other forms of infrastructure. On average, the composite index of infrastructure is shown to have a value of 21. The minimum value of the composite infrastructure index is approximately zero, showing that some countries in the region do not have records of any form of infrastructure.

Table 2 presents the estimates of the SGMM regression results for the effect of infrastructure on life expectancy.

Findings show positive effect of past values of the dependent variable on its current value. Findings also show that macroeconomic income positively impacts the average length of life in the region. The result showed that a 1%-point increase in per capita income implies a rise in life expectancy by approximately 0.305 years. This is not surprising as higher income enables financial access to health care and better living conditions that should ordinarily increase the length of life. Similarly, findings showed that a rise in the labour force participation rate raises life expectancy. A 1%-point increase in the labour force participation rate implies a rise in life expectancy by approximately 0.018 years. As individuals get some form of economic empowerment, they are able to afford basic needs and better living conditions that should promote health status.

An increase in government spending on education is also found to raise life expectancy. A 1%-point increase in government spending on education as a percentage of total government spending would raise life expectancy by approximately 0.006 years. Increase in carbon emission is found to reduce life expectancy in the region. A 1-unit rise in CO_2 emission in metric tons per capita induces a fall in the length of life by approximately 0.112 years. This is in line with expected findings as carbon emission is associated with several chronic illnesses and hence detrimental to health and wellbeing (Ebenstein et al. 2017; Liu, Xu, and Yang 2018). As expected, the index for the control of corruption is shown to have negative effects on life expectancy. A 1-unit rise in the index for the control of corruption implies a fall in life expectancy by approximately 0.050 years.

Findings for the effect of infrastructure on life expectancy showed that

TABLE 2 SGMM Regression Results: Dependent Variable Life Expectancy

Variables		(1)	(2)
Initial life expectancy		0.9360***	0.0034
Log of per capita GDP		0.3050***	0.0191
Labour force participation		0.0176***	0.0017
Domestic general government health expenditure		0.0014	0.0017
Total government expenditure on education		0.0059***	0.0012
CO_2 emission		−0.1120***	0.0074
Control of corruption		−0.0503**	0.0219
Log of transport infrastructure index		0.1360***	0.0189
Log of electricity infrastructure index		−0.0096	0.0071
Log of ICT infrastructure index		0.0466***	0.0054
Log of Composite infrastructure index		0.3830***	0.0397
Observations			320
Number of ID			47
Hansen_test			39.5800
H0: over-identifying restrictions are valid	Hansen Prob		0.9690
	AR(1)_test		1.4000
H0: no first order autocorrelation	AR(1)_*P*-value		0.1620
	AR(2)_test		1.6780
H0: no second order autocorrelation	AR(2)_*P*-value		0.0933
	No. of instruments		66

NOTES Column headings are as follows: (1) coefficients, (2) standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.

transport, ICT and the composite infrastructure index induce a significant effect on life expectancy. The results suggest stronger influence of transport infrastructure in raising the length of life than other forms of infrastructure. Findings show that a 1-unit rise in the index of transport infrastructure would increase life expectancy by about 0.136 years. Similarly, a 1-unit increase in the index of ICT infrastructure would raise life expectancy by approximately 0.047 years while that for the composite index for infrastructure would raise life expectancy by approximately 0.383 years. The result for the composite index of infrastructure induced a larger effect on health outcome as it comprises more infrastructure components. As noted in most studies, the provision of transport facilities can improve population health as it removes distance barriers to the use

TABLE 3 SGMM Regression results: Dependent Variable Log of Infant Mortality

Variables		(1)	(2)
Initial infant mortality		0.9890***	0.0009
Log of per capita GDP		0.0090***	0.0009
Labour force participation		−0.0002***	0.0000
Domestic general government health expenditure		−0.0007***	0.0000
Total government expenditure on education		−0.00001	0.0000
CO_2 emission		−0.0002	0.0002
Control of corruption		−0.0030***	0.0009
Log of transport infrastructure index		−0.0057***	0.0009
Log of electricity infrastructure index		−0.0018***	0.0004
Log of ICT infrastructure index		−0.0007***	0.0000
Log of Composite infrastructure index		−0.0134***	0.0013
Observations			320
Number of ID			47
Hansen_test			40.1300
H0: over-identifying restrictions are valid	Hansen Prob		0.9920
	AR(1)_test		0.4780
H0: no first order autocorrelation	AR(1)_*P*-value		0.6330
	AR(2)_test		2.1990
H0: no second order autocorrelation	AR(2)_*P*-value		0.0279
	No. of instruments		76

NOTES Column headings are as follows: (1) coefficients, (2) standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.

of health care and facilitates timely use of health services (Lungu et al. 2001; Broni et al. 2014; Brown et al. 2019;). Similarly, the provision of ICT improves health system performance in several ways, one of which is promoting efficient disease management and prevention (McConnell 2006; Haluza and Jungwirth 2015; Cole, Watkins, and Kleine 2016; Lee, Liu, and Lio 2016; Kouton, Bétila, and Lawin 2021).

Findings for the effect of infrastructure on infant mortality are shown in table 3.

The results show that past values of infant mortality rate significantly explain the current value. Contrary to a priori expectation, findings suggest that an increase in per capita income does not translate to a reduction in infant deaths. With a 1%-point increase in per capita income, infant

deaths rise by approximately 0.009%. This can be associated with high income inequality in most African countries. Evidence from the literature shows that the region is characterized by unequal income distribution (UNDP Regional Bureau for Africa 2016). The high uneven spread in income implies that the majority of the populace in the region are still poor even with the statistics showing high per capita income. Recent estimates show that 85% of Africans are still categorized as poor (Castaneda Aguilar et al. 2019). In this case, there can be some possibility of experiencing an increase in infant mortality with a rise in per capita income as the rise in per capita income relates to few individuals in the region. Infants and children are more likely to experience negative impacts of inequality in income relative to the adult population due to low health capital stock as shown by Grossman (1972). In line with expected results, findings show that increase in the proportion of individuals participating in the labour force reduces the number of infant deaths, but by a very small magnitude.

The result also showed that an increase in government allocation to health induces better infant health. For every 1%-point increase in government allocation to health as a percentage of total government spending, infant deaths would fall by approximately 0.001%. The index for the control of corruption also showed an expected negative effect on infant health. With 1 unit increase in the index for the control of corruption, infant deaths fall by approximately 0.003%. This suggests that improvement in institutional quality promotes infant health.

Findings for the effect of infrastructure showed that all forms of infrastructure used in the study improve infant health, with slightly higher effect of transport over other forms of infrastructure. A 1%-point increase in the index of transport infrastructure induces a fall in infant mortality by approximately 0.006%. With a 1%-point increase in the index of electricity infrastructure, infant mortality would fall by approximately 0.002%. A 1%-point increase in ICT infrastructure index would reduce infant deaths by about 0.001%. Findings for the composite infrastructure index further strengthen evidence for the strong role of infrastructure on infant health. Findings show that a 1%-point increase in the composite infrastructure index induces a fall in infant deaths by approximately 0.013%. The results suggest the strong effect of not only electricity and ICT in promoting infant health as shown in the extant literature but also transport infrastructure (Lenz et al. 2017; Chen, Chindarkar, and Xiao 2019; Köroglu, Irwin, and Grépin 2019; Shobande 2020; Kouton, Bétila, and Lawin 2021).

TABLE 4 SGMM Regression Results: Dependent Variable Log of Under-Five Mortality

Variables		(1)	(2)
Initial under-five mortality		0.9850***	0.0011
Log of per capita GDP		0.0120***	0.0014
Labour force participation		−0.0002***	0.0000
Domestic general government health expenditure		−0.0010***	0.0001
Total government expenditure on education		−0.0002***	0.0000
CO_2 emission		−0.0020***	0.0004
Control of corruption		−0.0073***	0.0011
Log of transport infrastructure index		−0.0075***	0.0001
Log of electricity infrastructure index		−0.0009	0.0006
Log of ICT infrastructure index		−0.0017***	0.0002
Log of Composite infrastructure index		−0.0156***	0.0024
Observations			320
Number of ID			47
Hansen_test			36.8000
H0: over-identifying restrictions are valid	Hansen Prob		0.9970
	AR(1)_test		1.8530
H0: first second order autocorrelation	AR(1)_*P*-value		0.0639
	AR(2)_test		1.7370
H0: no second order autocorrelation	AR(2)_*P*-value		0.0825
	No. of instruments		75

NOTES Column headings are as follows: (1) coefficients, (2) standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.

Findings for the effect of infrastructure on under-five mortality are shown in table 4.

The results again showed that past values of under-five mortality rate significantly explain the current value. Findings also showed that increase in per capita income does not translate to a fall in under-five mortality. A 1%-point increase in per capita income raises under-five deaths by approximately 0.012 %. This is against expectation and can be related to high income inequality as stated earlier.

In line with expected results, findings showed that an increase in the labour force participation rate reduces under-five mortality but with a very small magnitude. Similarly, an increase in government spending on health and education translates to a reduction in under-five deaths. With

a 1%-point rise in government spending on health, under-five mortality falls by approximately 0.001%. In terms of magnitude, government spending on education showed very little effect on under-five health; however, the results suggest that investment in human capital in terms of education and health are important in improving child health outcomes.

Surprisingly, findings showed a negative effect of a rise in carbon emission on under-five deaths. With a 1-unit increase in carbon emission, under-five deaths fall by 0.002%. This result is against expectation but can be explained by the fact that increase in carbon emission can be associated with industrialization and hence suggests more labour employment and empowerment that can provide better financial access to health care needs (Olubusoye and Musa 2020). As previously seen, a rise in the control of corruption reduces under-five mortality. With a 1-unit increase in the index for the control of corruption, under-five mortality falls by approximately 0.007%. The result suggests that improvement in institutional quality is vital for achieving a fall in under-five mortality rate.

Findings for infrastructure show that only transport, ICT and the composite infrastructure index have significant effect on under-five health outcomes. The results showed that with a 1%-point increase in transport infrastructure index, under-five mortality falls by approximately 0.008%. And with a 1%-point increase in the ICT infrastructure index, under-five mortality decreases by approximately 0.002%. As mentioned earlier, the result suggests that timely use of health services, associated with transport infrastructure and obtaining health information that is often associated with ICT infrastructure, is important in promoting under-five health (Lungu et al. 2001; Broni et al. 2014; Mimbi and Bankole 2015; Brown et al. 2019). As expected, the results show stronger effect of a rise in the composite index of infrastructure in reducing under-five deaths than other forms of infrastructure. Findings show that with a 1%-point increase in the composite infrastructure index, under-five deaths fall by approximately 0.016%. This result again strengthens the role of infrastructure in promoting health outcomes.

Findings for the effect of infrastructure on maternal mortality are shown in table 5.

The results again show that past values of maternal mortality rate significantly explain the current value. As expected, findings also showed that increase in the labour force participation rate reduces maternal mortality rate, but with small magnitude. The small magnitude of effect can be associated with high informal sector employment. Informal employment

TABLE 5 SGMM Regression Results: Dependent Variable Log of Maternal Mortality

Variables		(1)	(2)
Initial maternal mortality		0.9970***	0.0001
Log of per capita GDP		−0.0008	0.0009
Labour force participation		−0.0003***	0.0000
Domestic general government health expenditure		−0.0006***	0.0002
Total government expenditure on education		0.0002	0.0001
CO_2 emission		−0.0002	0.0001
Control of corruption		−0.0047**	0.0023
Log of transport infrastructure index		0.0025	0.0018
Log of electricity infrastructure index		−0.0004	0.0014
Log of ICT infrastructure index		−0.0041***	0.0004
Log of Composite infrastructure index		−0.0611***	0.0050
Observations			320
Number of ID			47
Hansen_test			40.3300
H0: over-identifying restrictions are valid	Hansen Prob		0.9930
	AR(1)_test		−0.1150
H0: no first order autocorrelation	AR(1)_*P*-value		0.9090
	AR(2)_test		1.6530
H0: no second order autocorrelation	AR(2)_*P*-value		0.0983
	No. of instruments		73

NOTES Column headings are as follows: (1) coefficients, (2) standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.

generally requires low skill and hence low labour productivity and income (Guven and Karlen 2020; International Labour Organisation 2015). As expected, increase in government spending on health reduces maternal deaths. With a 1%-point increase in government health expenditure, maternal deaths fall by approximately 0.001%. Findings also associate a significant effect of the control of corruption on maternal health. With a 1-unit increase in the index for the control of corruption, maternal mortality falls by about 0.005%.

The result for infrastructure index suggests that only ICT and the composite infrastructure index induce improvement on maternal health. Findings showed that a 1%-point increase in ICT infrastructure index is associated with a fall in maternal deaths by about 0.004%. With a 1%-

point increase in the composite infrastructure index, maternal deaths fall by about 0.061%. The insignificant effect of electricity on maternal health is consistent with empirical results by Maboshe and Kabinga (2018) that found negligible effect of access to electricity on the efficiency of maternal and child health service provision in Zambia. Findings for improvement in maternal health due to a rise in ICT infrastructure are consistent with the evidence provided by Abekah-Nkrumah, Guerriero, and Purohit (2014) in Ghana suggesting that ICT promotes maternal health by increasing the use of maternal health care services.

Conclusion

This paper provides findings for the effect of infrastructure on health system performance using a panel of 54 countries in Africa and over the period 2003 to 2018. In line with previous literature, health system performance is measured using population health outcome, specifically life expectancy, infant and under-five mortality as well as maternal mortality rate. Based on data availability, the study made use of hard forms of infrastructure, namely transport, electricity, ICT and the composite infrastructure index. The empirical models applied in the study follow the theoretical foundation of the health production function as presented by Grossman.

Findings are derived using the system GMM estimator based on a large number of cross sections relative to the time span used in the study. Findings validate the role of infrastructure in promoting health system performance. The result for each infrastructure type suggests the significant effect of transport and ICT infrastructure in promoting the length of life and in reducing under-five mortality rate, while all forms of infrastructure exert significant effects in reducing infant mortality. The result further suggests the key role of ICT in promoting maternal health in the African region. Findings hence highlight the fundamental role of ICT in promoting population health based on the significant effect in improving all forms of population health outcome. Interestingly, the index for ICT is shown to have the lowest value across all forms of hard infrastructure used in the study. A more effective way to improve health system performance in Africa in terms of population health is to promote infrastructure improvement with investment in ICT as key. Findings for other control variables that are consistent across population health outcome suggest that a rise in labour force participation and government health care spending improve population health. These variables should

also be given strong consideration in the effort to raise health system performance in the African region.

This study is limited in the sense that the measure of health system performance used is not exhaustive. Other measures, as shown in the literature, could not be explored due to missing time series observation for countries in Africa. While this limitation may be the basis for future research, it does not undermine the findings of this current study as population health outcome is well documented in the literature as a measure of health system performance.

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The Effect of Spatial Unemployment on the Neighbouring Regions' Economies: A Regional Case Study of KwaZulu-Natal in South Africa

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This article investigates the degree of spatial dependence of unemployment on neighbouring economies with possible implications for cross-border community development initiatives. The local municipalities within the KwaZulu-Natal province in South Africa are used as a case study. Spatial econometric techniques are employed that incorporate dependence between regions in close geographical proximity. Disaggregated data and knowledge about the dynamics at a sub-regional level are usually unavailable for designing employment policies, especially for regional economies in under-developed countries. The results suggest an absence of spatial unemployment clustering and autocorrelation between neighbouring economies. The absence of externalities implies that little mutual dependence exists between adjacent economies, and therefore municipal unemployment patterns can be viewed as spatially random. The economy of a region is therefore fundamentally heterogeneous in that its unemployment rates are determined and influenced by its unique and diverse factors rather than neighbouring unemployment trends or patterns.

Key Words: regional unemployment, labour, spatial regression models, spatial dependence, regional impact and influence, neighbours, spatial weights, spatially lagged dependent variables, spatial autocorrelation
JEL Classification: C31, E24

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Introduction

Investment within the built environment is recognised as influencing the 'neighbourhood effect' and ultimately contributes to community development (Wang 2019). In contrast, a continuation of prolonged unemployment could signal the opposite and delay investment. Investigating if the level of unemployment in a particular economy affects the economic activities, level of employment, growth and business profits in an adjacent economy are investigated. Analytical spatial analysis is applied to investigate the plausible spatial clustering and autocorrelation on nearby or proximity economies resulting from regional unemployment. Data from neighbouring economies within the KwaZulu-Natal province in South Africa is applied for this analysis. Understanding these spatial relationships proves to be important, specifically in identifying if there is such a relationship and secondly, if there is, the perceived value that can be gained in breaking the trends to foster community development across boundaries.

Regional or city economic activity may not always be static, suggesting periods of higher employment levels in one region might result in either draining development from its neighbours or simultaneously supporting the development of all the cities or regions in a particular area (Marais and Cloete 2017). In other words, higher employment occurs in one region because of the additional investment, while constraining investments from nearby cities, which subsequently experience higher levels of unemployment (Patacchini and Zenou 2007). Firms will probably locate in economically successful places, resulting in a clustering effect with the associated agglomeration advantages (Sharifzadegan, Malekpourasl, and Stough 2017). Spillover benefits can also accrue from nearby regions because of capital, knowledge, technology, entrepreneurship, and an expanded market (Caragliu and Nijkamp 2016; Delgado, Porter, and Stern 2010; Kleynhans 2016). However, suppose higher economic activity and investments in a city attract funds from abroad in such a way that it arouses interest in all the cities in that part of the area. In that case, all neighbouring cities and regions will benefit.

Regression analysis usually rests on the assumption that the error terms of indicators do not correlate, but when studying nearby regions, such economic data are seldom independent (Bhattacharjee, Holly, and Mur 2018). This study applies spatial analysis, which circumvents these violations associated with observations of nearby or adjacent regions or towns.

Disaggregated data and knowledge about the dynamics at a sub-regional level are usually unavailable for designing employment policies, especially for underdeveloped countries (Mishra and Singh 2019, 176). Thus, this article makes an important contribution relating to KwaZulu-Natal, designing the necessary instruments and deriving important information. Three statistical models will be used to assess the effect from neighbouring cities. It utilises the usual ordinary least square regressions, a spatial lag model, as well as a spatial error model, and derives two models to study the influence of economic activity and figures of other cities in the region nearby.

The second presents the theoretical basis illuminating the concepts of spatial dependence, clustering, and agglomeration. The third section provides the theoretical departure on the possible spatial correlation between unemployment rates, while the urban and rural unemployment realities in the Province of KwaZulu-Natal are presented in the fourth section. The fifth section explains the spatial regression models, starting with the basic spatial autoregressive model, designing the spatial lag regression Y, spatial lagged regression X, and spatial error regression models. The sixth section explains the data used, analysis methods, and the methodology employed during the research. This section also includes developing a spatial proximity or spatial closeness matrix. The application of the Moran's I statistic covers in the seventh section. The empirical results of the research are presented in the eighth section, including the regression model and the estimation of the spatial lag and spatial error models. The summary and conclusions are provided in the last sections.

Theoretical Setting

Spatial autocorrelation is purely investigating how closely (as proxied by distance) objects (variables) correlate with other nearby objects across a spatial area (Coetzee and Kleynhans 2021). Similar or related values located close to each other are associated with positive autocorrelation. On the other hand, negative or inverse autocorrelation holds that dissimilar or non-related values are found close to each other. The relevance of spatial autocorrelation allows or enables the researcher to conceptualise (model) how relevant spatial characteristics (dynamics) is impacting a pre-selected object in space and whether or not a definite relationship (i.e. dependency/association) of objects with spatial properties are present. Significant positive/negative outcomes propose a prominent spatial property in the object with a 'high' correlation. The spatial autocorrelation

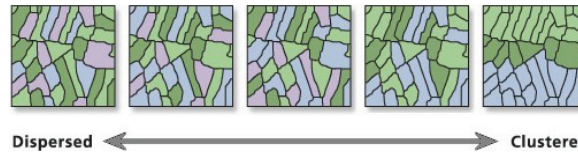


FIGURE 1
Spatial Autocorrelation Range

range is illustrated in figure 1.

Spatial data, or geospatial data, refers to data linked or referenced to a particular location on Earth. Spatial data is significant because it is not just data, but data that can be visualised, located, followed, patterned, and modelled based on other spatial data. Close spatial reliance exists when the spatial characteristics (in the form of data) of a particular area are inferred or impacted by another area (Moralles, Silveira, and Rebelatto 2019). These interactions are best explained through agglomeration or clustering effects. Location's role in agglomeration has only recently been examined within the South African context (Naudé and Krugell 2006). Krugell and Rankin (2012) found that factors beyond firm-level contribute to clustering. Their results suggest that dimensions of distance are important to economic activity and recommend further research focused on the distance over which agglomeration economies work. Cheruiyot (2020) explores this further, this time within the urban context, and found that spatial sector clustering exists near key international transport nodes. Aiming to build on these results, this paper applies spatial analysis to measure if this interconnectivity remains on a regional level.

When studying spatial data, the derived spatial relationships may prevail between the variables and/or error terms (Sharifzadegan, Malekpourasl, and Stough 2017). Agglomeration may be a logical consequence (Vermeulen 2017).

Equation 1 (using ordinary least squares (OLS)), represents the relationship between the dependent (γ) and independent (X) variables as:

$$\gamma = X\beta + \varepsilon. \tag{1}$$

Assuming the best linear unbiased estimator (BLUE), minimising the sum of squared deviations from the 'true' values leads to estimating the object or variable β. To achieve the BLUE principle and derive statistical inference regarding the estimated coefficients requires assumptions regarding the error terms (ε).

The general rule or assumption is that the average random error terms are zero (Anselin 2005), proposing the absence of systematic misspecification or bias. Adherence to the non-bias assumption implies the lack of

correlation between the error terms, and confirms constant variance, i.e. homoscedasticity, and normally distributed error terms.

Theoretical Departure on Spatial Correlation between Unemployment Rates

Unemployment in a region is often a symptom of low economic development and growth. Usually, low levels of development are associated with structural challenges in regions, causing low levels of productivity and a mismatch between supply and demand (Temple 1994). This might cause labour to migrate to adjacent regions to find employment elsewhere. Often, adjacent regions also experience similar unemployment, but those that do find work reduce unemployment in both regions (Barnes, Peck, and Sheppard 2012). This might lead to convergence of employment and growth trends in both regions (Coetzee and Kleynhans 2018a) and that is what this article aims to assess, the answers to which may direct economic development planners towards higher levels of development and better living for their citizens.

Patacchini and Zenou (2007) developed a theoretical model that explains the spatial nature of unemployment. The model is built on neoclassical explanations of wage differentials, low productivity and related structural impediments that cause poor convergence rates in regional labour markets. The model also relies on the Blanchard and Katz (1992) model. Barrett (2014) indicates that the Blanchard and Katz model assumes that different bundles of goods and services are produced and consumed by different regions under constant returns to scale and that both firms and workers are perfectly mobile.

In the Patacchini and Zenou (2007) theoretical model two regions or areas, $i = 1, 2$ and $j = 1, 2$, are used. A worker can, irrespective of the place of residence, consider employment in any of the two areas. Area *i*'s (or area *j*'s) total number of employed and unemployed workers (normalised to the population of 1) can then be expressed by the equation:

$$E_i + U_i = E_{ii} + E_{ij} + U_{ii} + U_{ij} = 1, \tag{2}$$

for $i = 1, 2$ and $j = 1, 2$, where $i \neq j$; where U_{ij} represents the total unemployed workers that reside in i and search in j and E_{ij} the total employed workers that reside in i and search in j.

Patacchini and Zenou (2007) further state that finding a job follows a random Poisson process that suggests several matches or contacts between the two sides of the market in area i per unit of time. The matching

efficiency is expressed as a parameter (m_o) that expresses the relationship between the total unemployed workers ($U_{ii} + U_{ij}$) that search for work in area i and the total job openings (V_i) in the area. The matching parameter in area i is further linked to the tightness of the labour market (θ) in area i (or j), which inherently embraces the effects of all the exogenous variables influencing the levels of unemployment, such as the average population characteristics and dynamics of the area (i or j).

The model then proposes that the total unemployment in region i at period t is a function of the total unemployment in both areas i or j, but at period t equals minus one (one period lagged) and/or the labour market tightness in both areas i or j but at time $t - 1$ (one period lagged) such that:

$$U_{i,t} = f(U_{i,t-1}, U_{j,t-1}, \theta_{i,t-1}, \theta_{j,t-1}). \quad (3)$$

The theoretical model argues that the spatial nature of unemployment is relevant because people both work and search in the area where they do not reside. There are exogenous factors inherent within each area (Coetzee and Kleynhans 2018b).

Urban and Rural Unemployment Realities

Unemployment is a very serious problem in South Africa. It has been identified as one of three key priorities for the government to address. To this end, the national government has developed several policies and strategies focusing on economic growth and job creation. The Provincial Government also has some key responsibilities in the national effort to decrease the national unemployment rate and trajectory (The KwaZulu-Natal Provincial Planning Commission, Office of the Premier 2016). Both these spheres of government have important contributions to make. However, they do not operate at a local level and thus local government must be a vital component in the fight against unemployment. This is especially relevant given that many of the most fundamental economic activities take place at the local level.

In the Province of KwaZulu-Natal (see figure 2), the unemployment rate (official definition) ranged between 15 and 50% in 1996 among the 51 municipalities located in KwaZulu-Natal. This picture worsened to between 20 and 50% in 2019. Unemployment is particularly severe in the more rural areas of the province. On average, the divide between urban and rural (as defined by their contribution to gross provincial product) varied between 25% for urban municipalities and 40% for rural munici-

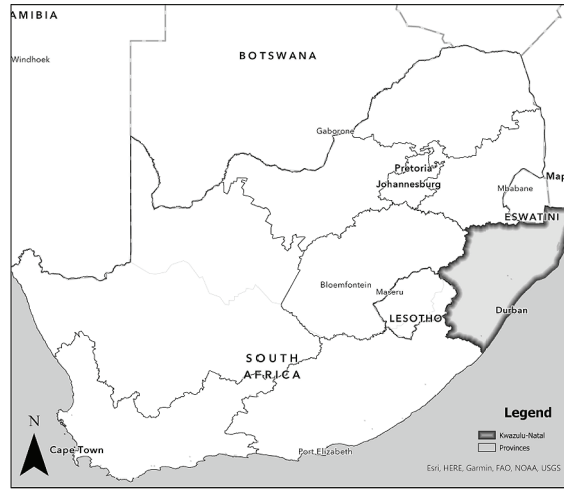


FIGURE 2

Map of Kwazulu-Natal Province, South Africa

palities (Global Insight n.d.). One would expect that if only the National and Provincial governments are important and relevant in terms of unemployment, the unemployment rate range would not be this significant. If local factors did not play a role then there would be no reason for such significant differences in local unemployment rates. Therefore, given the wide range of unemployment rates amongst the municipalities, local factors seem to be both important and relevant. These studies to a large degree test this assumption using spatial regression models.

Policy by itself does not create agglomeration effects or clustering of activity. Instead, it promotes the conditions to benefit economies where interconnectivity occurs (Cortright 2006). The KZN provincial government has at its disposal policy instruments to steer economic development within its borders which the Provincial Growth and Development Strategy (PGDS) aims to achieve. The PGDS aligns with various international and national development goals such as the United Nations Sustainability Development Goals and the National Development Plan (2013) which encourages a clear plan for growth and development throughout the province to improve well-being.

As previously mentioned, this responsibility extends to the local government level. Various policy instruments are at their disposal to facilitate land development, of which the most prominent is land use management through spatial development planning, culminating in an Integrated Development Plan (IDP). The content of the IDP represents the most critical governance needs of the local government for near-term strategic

planning which require attention for economic development. Beyond the planning tools at the disposal of local government, the spatial location of the administrative area could affect how successful these are.

Spatial Regression Models

The Basic Spatial Regression Concept

Observational data emanating from random cities and/or regions can readily suggest the dependence of the observations because of spatial proximity (Shimeles and Nabassaga 2018, 121). LeSage and Fischer (2008) argue that accounting for the regional dependence between data can be facilitated via spatial regression methods. This is because the economic data of regions are often similar to the neighbouring data.

The spatial correlations between cities or regions in close proximity can be linked to several standpoints. The Ertur and Koch (2007) theoretical model, for instance, proposes both human and capital technological interdependence and externalities as possible reasons. This requires including growth rates from neighbouring regions when locational growth rates are estimated (Coetzee and Kleynhans 2018a).

Time dependency recognition is essential when working with time-series data. To this end, it is most probably advisable to include cost adjustments, behavioural frictions and time lags. According to Ertur and Koch (2007), it is also relevant to focus on 'spatial diffusion with friction.' This validates spatial lags due to trends in neighbouring regions (LeSage and Fischer 2008).

Spatial econometrics models spatial dependence, considering the economic geography between nearby regions. To this end, ordinary least square (OLS) regression analysis can be modified to include the spatial dependence of nearby regions (Anselin 2005; LeSage 1999).

Spatial autoregressive models are generally represented as:

$$\gamma = \rho W_1 \gamma + X_1 \beta + \mu, \tag{4}$$

$$\mu = \lambda W_2 \mu + \varepsilon, \tag{5}$$

$$\varepsilon \sim N(0, \sigma_2, In), \tag{6}$$

where γ is a dependent variable.

This incorporates a vector of cross-sectional dependent variables, i.e. $n \times 1$, while X forms a matrix of the dependent variables, i.e. $n \times k$. W_1 and W_2 are variables expressed as a weighted nxn spatial matrix. These also contain contiguity relationships and/or distance functions. λ repre-

sents the spatial observed value lag coefficient and μ is a random error for region *i*.

Special models can then be designed with the inclusion of specific limitations. A first-order spatial autoregressive model may, for instance, be developed when X and W_2 are adjusted to zero ($X = 0$ and $W_2 = 0$), yielding:

$$\gamma = \rho W_1 + \varepsilon. \tag{7}$$

In this equation, the linear variations in the data of neighbouring regions are accommodated (but other explanatory variables are ignored). This approach is like first-order autoregressive models, but now accommodates spatial aspects, yielding the equation: $\gamma_t = \rho\gamma_{t-1} + \varepsilon_t$, where historical data explain the variation in γ_t.

This can then be changed to a mixed regressive-spatial autoregressive model adjusting W_2 to zero, yielding the linear equation:

$$\gamma = \rho W_1\gamma + X\beta + \varepsilon. \tag{8}$$

This corresponds to lagged dependent variable models used in time series data analysis. In the spatial model, variation in y can be better explained when another explanatory variable is incorporated in the matrix X. When the variable W_1 is also adjusted to zero, spatial autocorrelation can be incorporated in the disturbances, and this can be represented as:

$$\gamma = X\beta + \mu, \tag{9}$$

$$\mu = \lambda W_2\mu + \varepsilon. \tag{10}$$

The Spatial Durbin Model is a related approach that applies spatial lags to the dependent and independent variables. It applies the explanatory variable matrix X to normal regression analysis:

$$\gamma = \rho W_1\gamma + X\beta_1 + W_1X\beta_2 + \varepsilon. \tag{11}$$

The dependent variable is then represented by an n by 1 vector y, while parameter ρ is a scalar. W is a spatial weight n by n matrix: $\rho W\gamma$.

Matrix P displayed below is a $n \times n$ binary indicator matrix. The rows coincide with observations of regions 1 to 5. In the matrix '1' represents data from 'neighbours' associated with each row, the 2nd and 3rd observation or region. Measuring the distance from the centre of each location, the '1s' represent the nearest two locations. As an illustration, $P(1, 2) = 1$ and $P(1, 3) = 1$ implies they are the closest regions, where #2 and #3 are the closest neighbours of region #1, meeting the distinction of $m = 2$ neighbours. Similarly, $P(2, 1) = 1$ and $P(2, 3) = 1$ represent regions 1 and 3

in row 2 ($m = 2$), with region #2's closest neighbours, and it is also shown that regions #3 and #4 are neighbouring region #5.

$$P = \begin{pmatrix} 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 \end{pmatrix}. \tag{12}$$

In the *P*-matrix, the diagonal shows all zeros because a region cannot be its neighbour. By dividing all the figures in the *P*-matrix by the figures of its neighbours, it is possible to normalise it to obtain all the row-sums equal to one. This changes it to a spatial weight matrix *W,* with a *row stochastic* form, which will be convenient when the spatial regression models are estimated.

$$W = \begin{pmatrix} 0 & 0.5 & 0.5 & 0 & 0 \\ 0.5 & 0 & 0.5 & 0 & 0 \\ 0 & 0.5 & 0 & 0.5 & 0 \\ 0 & 0 & 0.5 & 0 & 0.5 \\ 0 & 0 & 0.5 & 0.5 & 0 \end{pmatrix}. \tag{13}$$

Multiplying the *W*-matrix with the y-vector of observations of any particular variable of the five regions yields matrix *Wy* displayed below. This product matrix yields an *n* by 1 vector that represents the mean of a particular variable of the neighbours and is referred to as the 'spatial lag' (LeSage 1999; Higazi, Abdel-Hady, and Al-Oulfi 2013).

$$Wy = \begin{pmatrix} 0 & 0.5 & 0.5 & 0 & 0 \\ 0.5 & 0 & 0.5 & 0 & 0 \\ 0 & 0.5 & 0 & 0.5 & 0 \\ 0 & 0 & 0.5 & 0 & 0.5 \\ 0 & 0 & 0.5 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \end{pmatrix} = \begin{pmatrix} 1/2y_2 + 1/2y_3 \\ 1/2y_1 + 1/2y_3 \\ 1/2y_2 + 1/2y_4 \\ 1/2y_3 + 1/2y_5 \\ 1/2y_3 + 1/2y_4 \end{pmatrix}. \tag{14}$$

Following the above, it can be proposed that regions perhaps may be allied to nearby regions in the below distinct ways:

- The *y* value in a specific region might influence (or be related to) a similar variable in an adjacent region, or

- The x's values in a specific region might influence (or be related to) a similar variable in an adjacent region, and
- The residuals (ε) might influence (or be related to) the residuals in a nearby region (spatial heteroscedasticity).

DESIGNING THE SPATIAL LAG REGRESSION y

When there is reason to assume that the variables of an indicator (y) are directly influenced by the data (y) of a neighbouring region or city, it may be appropriate to estimate a spatially lagged y model (Wang and Lee 2018).

This excludes any influence of other covariates specific to i, and there is reason to assume that any other variables might influence the values of y (Diop 2018, 276). In this case, it is assumed that other spatial aspects exist that are not specified, which cause some clustering and the value of indicators y and its unitary size I. To determine this spatially lagged model, the dependent variable y must be continuous.

The spatial lag regression may be represented by:

$$y_i = \rho W_i y_i + x_i \beta_1 + e_i, \tag{15}$$

which can be rewritten as:

$$(I - W_i) y_i = x_i \beta_1 + e_i. \tag{16}$$

In this case, the independent variables are those that are not determined by regions nearby. The ρ (rho) variable is the spatial dependence parameter indicating spatial lag. When ρ is positive it may be assumed that both the values of the region's dependent variable y and that of its neighbour are high, if not higher (Higazi, Abdel-Hady, and Al-Oulfi 2013).

SPATIAL LAGGED REGRESSION X

The model thus far developed is befitting when the spatial variables' behaviour or fate responds to the exogenous observable characteristics of neighbours in so far as:

$$y_i = x_i \beta_1 + W_i X \theta + e_i, \tag{17}$$

where θ (theta) represents the spatially weighted independent variables of the nearby regions.

The spatially lagged independent variables are included in the model (Higazi, Abdel-Hady, and Al-Oulfi 2013).

SPATIAL ERROR REGRESSION

In the spatial error regression model, spatial influence from neighbouring regions or cities is determined by considering the error terms instead of the systematic components. This model may now be represented as:

$$y_i = x_i\beta_1 + e_i, \tag{18}$$

$$e_i = \lambda We_i + \varepsilon_i, \tag{19}$$

where λ (lambda) is the spatially weighted errors of the neighbours. The spatial autocorrelation term in this spatial error regression model then captures spatial dependency (Higazi, Abdel-Hady, and Al-Oulfi 2013).

Methodology

DATA UTILISED

The empirical analysis of this study employed unemployment, population growth, production (income), and literacy figures for 1996, 2003, 2009, and 2015 for the 51 KwaZulu-Natal municipalities (figure 3). This implies that the whole population was included, and the periods were chosen based on the availability of comparable data, ranging over two decades.

This data encompassed average per annum figures for the various municipalities of their:

- Unemployment rate as derived from Global Insight (n.d.) and cross-referenced by Statistics South Africa (n.d.). This entails the number of unemployed people divided by the total population;
- Population growth rate (number of people), as derived from Global Insight (n.d.) and cross-referenced by Statistics SA's annual population estimates;
- Gross domestic product growth rate from the Global Insight (n.d.) database, which is verified by the provincial GDP estimated by the KZN Treasury model (constant 2010 prices);
- Literacy growth rate published by Global Insight (n.d.), which is the number of people with matric and more, divided by the total population.

METHODS OF ANALYSIS

Geographical clusters and/or regions can be analysed and described through the various regional statistics, but also visually. The visual presentation provides a fast perception of the situation, which also intuitively

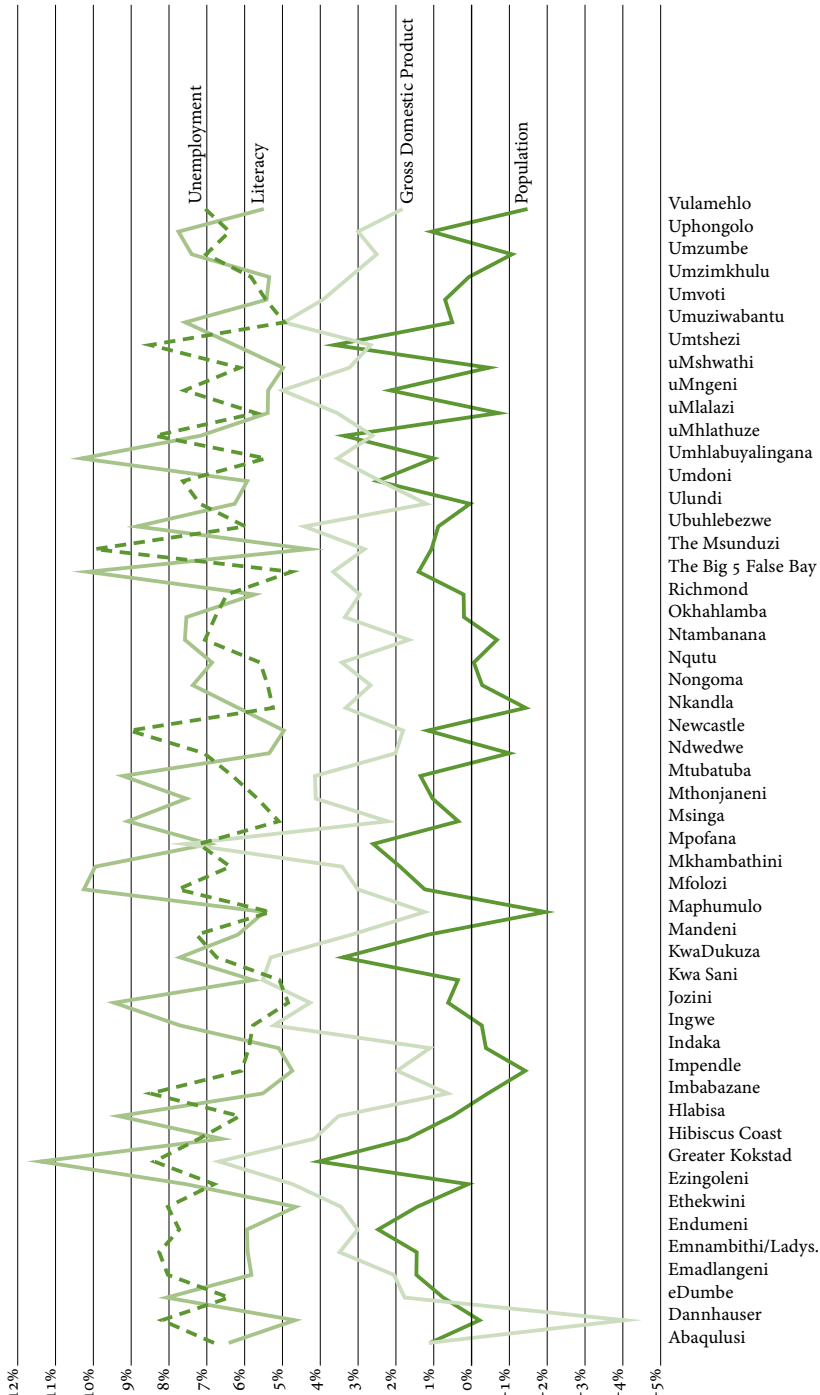
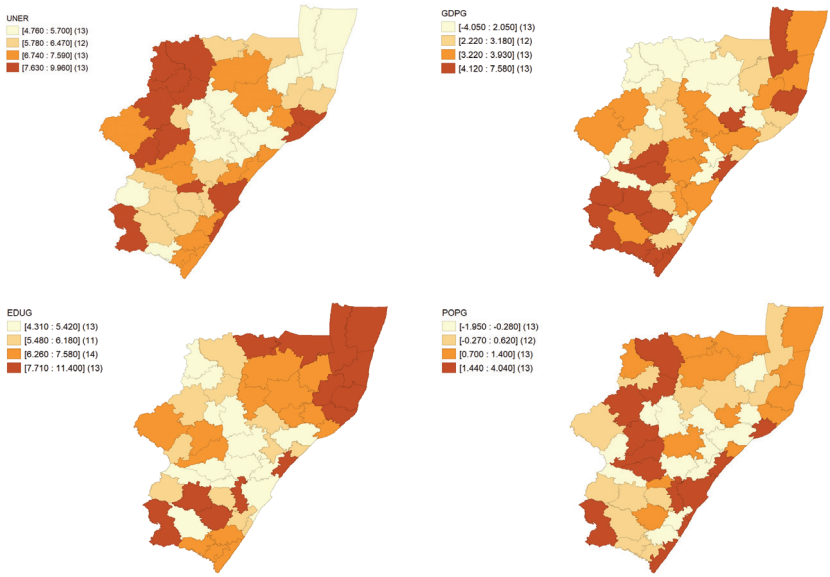


FIGURE 3 Four Variables per KZN Municipality over the Period



NOTES UNER = Unemployment rate, GDPG = Gross domestic product growth rate, EDUG = Literacy growth rate, POPG = Total population growth rate

FIGURE 4 GIS Images per Variable per KZN Municipality over the Period (%) (based on data from Global Insight (n.d.), Statistics South Africa (n.d.) and KZN Treasury (2021))

provides insight into the situation. The individual images in figure 4 represent a coloured picture enabling the spatial pattern visualisation of the variables. The geographical information system (GIS) software QGIS was employed. High/Low levels (rates or growth) are presented in dark/light areas (Thongdara et al. 2012).

Some spatial association seems evident, such as the clustering of dark-shaded regions and the clustering of light-shaded regions. The spatial association seems to support the findings of Yates and Casas (2012) that the average unemployment and literacy rate per municipality are key determinants.

On the other hand, the average GDP and population growth rate variables per municipality seem more dispersed. The images propose that nearby or neighbouring areas are more alike, suggesting a spatial relationship.

The GIS software package GeoDa (see https://geodacenter.github.io/) makes it possible to estimate the spatial lags for the variables (ρW) (Li et al. 2009). GeoDa is an internet computer-based software tool for spatial

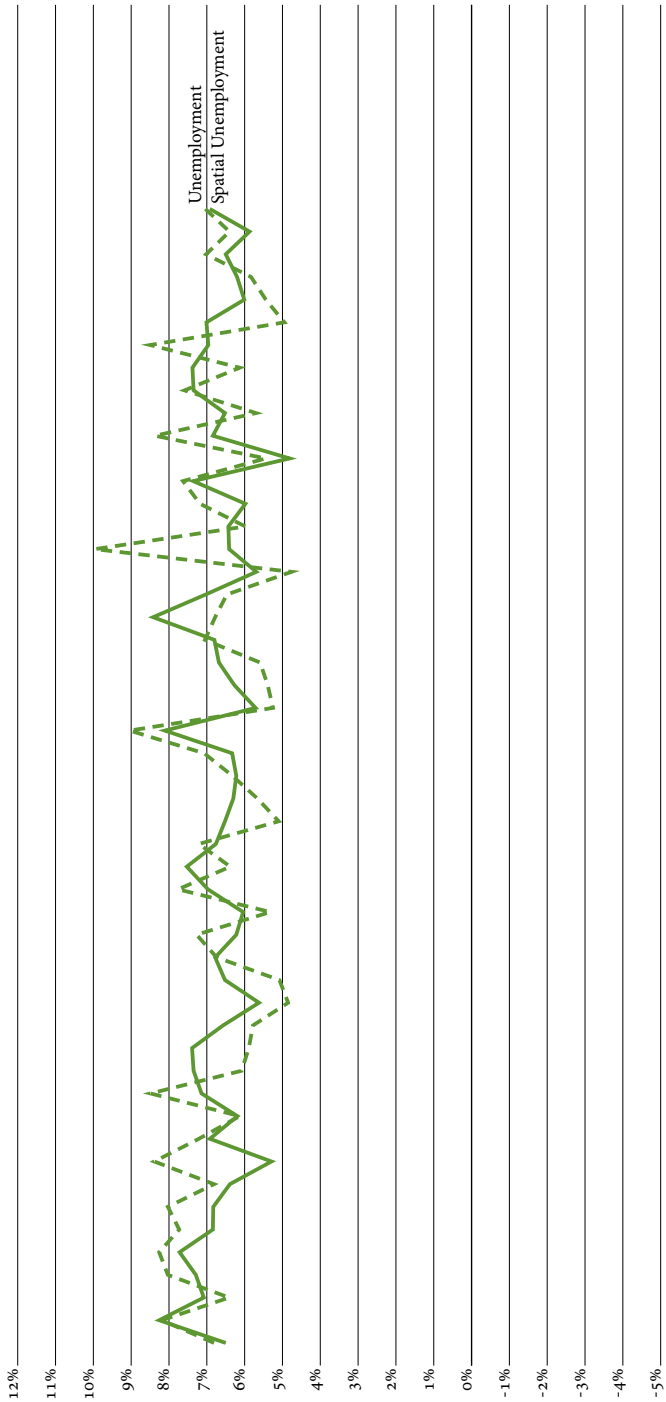


FIGURE 5 Spatial Lag and Average Unemployment Rate per Region

TABLE 1 Covariance and Correlation Analysis of KZN

Variable	Unemployment rate		Unemployment rate*	
	Correlation	*t*-statistic	Correlation	*t*-statistic
GDP	−0.229	−1.647	−0.357	−2.679***
Literacy growth rate	−0.304	−2.239***	−0.441	−3.445***
Population growth rate	0.427	3.305***	0.008	0.061

NOTES * Spatial lag average. *** $p < 0.001$

data analysis, which applies the most recent methods and perspectives of exploration and modelling of spatial trends. For example, figure 5 displays the average unemployment and the spatial lag average unemployment rate per municipality.

Following figure 5 and the associated descriptive statistics (not included), it seems that the actual time series is less smooth than the spatial lag operator. This is also the case for the other variables. Testing for normality (associated *p*-values) confirms that the data of the variables (except for GDP growth rate) are normally distributed. Table 1 presents the covariance and correlation analysis for the variables. Also included is the associated *t*-statistic.

DETERMINATION OF THE SPATIAL WEIGHTS MATRICES

A spatial proximity matrix represents a deterministic transformation of a spatial weights matrix (Smith 2008). Through such a weight matrix, the weighted dependence of n spatial units, where a unit j has a 'spatial influence' on unit i in the order of w_{ij}, can be assessed or estimated. The spatial proximity matrix C with n elements can be developed within a geographical system as:

$$C = \begin{pmatrix} c_{11} & c_{12} & \cdots & c_{1n} \\ c_{21} & c_{22} & \cdots & c_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ c_{n1} & c_{n2} & \cdots & c_{nn} \end{pmatrix}, \tag{20}$$

where the range and nature of influence and distance of the data from nearby units are proxied by cell c_{ij}, commonly between locations i and j (Coetzee and Kleynhans 2021). Constructing a spatial weights matrix yields the following:

$$W = \frac{C}{C_0} = \begin{pmatrix} w_{11} & w_{12} & \cdots & w_{1n} \\ w_{21} & w_{22} & \cdots & w_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ w_{n1} & w_{n2} & \cdots & w_{nn} \end{pmatrix}, \tag{21}$$

where

$$C_0 = \sum_{i=0}^{n} \sum_{j=0}^{n} C_{ij}, \sum_{i=0}^{n} \sum_{j=0}^{n} w_{ij} = 1. \tag{22}$$

The starting point in specifying the spatial proximity weights is to express whether units share common borders (Coetzee and Kleynhans 2021; Anselin 2005). Defining a group of points on the boundary (*bnd*) with unit *i* by *bnd*(*i*), i.e. neighbours are classified as two units that share a common boundary, refers to Queen contiguity weights:

$$w_{ij} = \frac{1,\ bnd(i) \frown bnd(j) \neq \emptyset}{0,\ otbnd(i) \frown bnd(j) \neq \emptyset}. \tag{23}$$

The *k*-nearest neighbour weights (Anselin 2005), are relevant when the centroid, i.e geometric centre of a plane figure, distances between unit *i* to all units $j \neq i$ sorting as: $dij(1) \leq dij(2) \leq \cdots \leq dij(n1)$, then for each $k = 1, \ldots, n-1$, the set of $Nk(i) = j(1), j(2), \ldots, j(k)$ comprises the k closest units to i (in general ties are disregarded, see Anselin 2005). For every given *k* within the *k*-nearest neighbour weight matrix *W*, the spatial weights can then be represented as:

$$w_{ij} = \frac{1,\ j \in Nk(i)}{0,\ \text{otherwise}}. \tag{24}$$

Radial distance weights are necessary if and when the distance between units *d* is important. The minimal influence will be assigned after the spatial threshold distance or bandwidth if the distance is too far (Coetzee and Kleynhans 2021; Anselin 2005). The weighted radial distance matrix *W* can be presented as:

$$w_{ij} = \frac{1,\ 0 \leq d_{ij} \leq d}{0,\quad d_{ij} > d}. \tag{25}$$

Actual distance values propose that distance (between two or more units) is commonly a significant criterion (Anselin 2005). In this case, the actual distance ($1/d$ = inverse of the distance) will have a strong influence on the weighted actual distance matrix *W*, which is:

$$w_{ij} = \{1, \frac{1}{d_{ij}} > 0\}. \tag{26}$$

The current study will mainly apply the Rook-based Contiguity Weight Matrix (Ord and Getis 1995).

Applying Moran's I-Statistic

Moran's I-statistic can be used to measure spatial autocorrelation. The associated methodology is not dissimilar to OLS regressions (Moran 1950; Wu and Liu 2017) with values ranging from minus to positive one, i.e. $-1, \ldots, +1$. If zero, no spatial relationship exists (Mehrotra, Bardhan, and Ramamritham 2020), while positive/negative values represent positive/negative spatial relationships (Coetzee and Kleynhans 2018a). When the expected Moran's I-statistic's value is $E(I) = -1/(N-1)$ then it proposes the absence of spatial autocorrelation (De Dominicis 2014).

Figure 6 shows a scatter plot of Moran's I-statistics showing the average unemployment rate per municipality. The unemployment rates of the municipalities (non-standardised) are given on the horizontal axis, while the vertical axis gives their mean unemployment rates, which implies a lagged Spatial Poverty indication (W) from the nearby municipalities that the Moran's I weight matrix provides (Edwards et al. 2018). Estimating the Moran's I correlation coefficient 'I(d)' can be done using the following equation:

$$I(d) = \frac{\frac{1}{W}\sum_{h=1}^{n}\sum_{i=1}^{n} W_{hi}(y_h - \overline{y})(y_i - \overline{y})}{\frac{1}{n}\sum_{i=1}^{n}(y_i - \overline{y})^2} \text{ for } h \neq i, \tag{27}$$

where n is the sample size, h and i are the locations, W_{hi} is the matrix's size, and W is the sum of values.

The distance function is w_{hi}; y_h equals one and the particular distance groups are y_i where $y_h \neq y_i$ and 0 in all other cases; y_h, y_i are the values of the variables (Coetzee and Kleynhans 2018a; Zierahn 2012).

In his research, Anselin (1996) estimates the global Moran's I-statistic slope of the unemployment rate to be 0.237, indicating a spatial cluster where unemployment is concerned. The associated Moran's I-statistic probability of 0.01 suggests that the chance that such clustering could just be coincidental and thus non-existent is less than one per cent (Stojčić and Orlić 2020; Voss et al. 2006).

Figure 6 shows several municipalities with an unemployment rate above average and adjacent to those whose unemployment rates are also above average situated in the upper right quadrant (Torrens 2008). Those that are bottom left are municipalities with below-average unemployment surrounded by similar neighbours. Those municipalities whose unem-

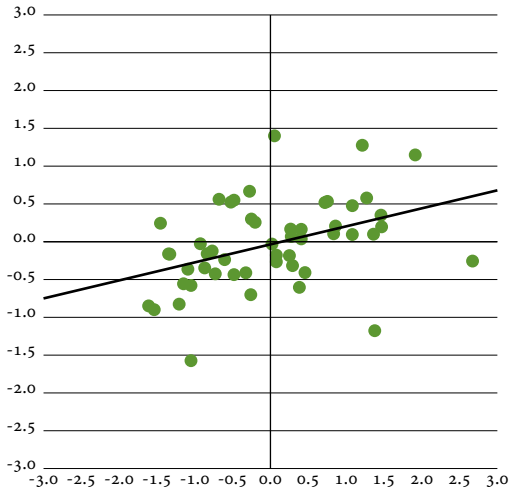


FIGURE 6

Global Moran Scatter Plot, Average Unemployment Rate in KZN

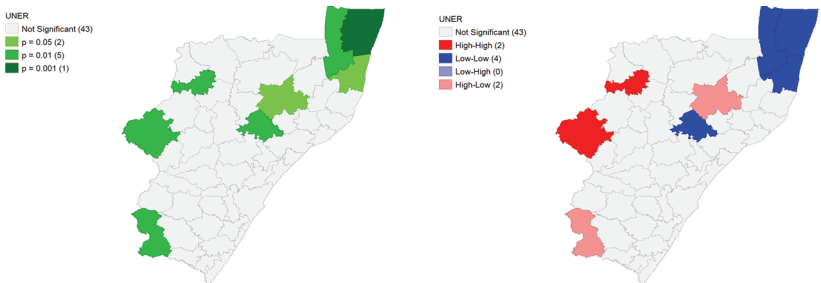


FIGURE 7 LISA Spatial Dependence in KZN

ployment rates are above average and located near cities with unemployment rates below average are situated in the quadrant on the bottom right. The municipalities with unemployment rates below average and located near cities with unemployment rates above average are situated in the top left quadrant (Meliciani and Savona 2015; Li, Calder, and Cressie 2007).

Autocorrelation as a spatial dependence test is rather equivocal. The coloured section on the map of KwaZulu-Natal province in figure 7 indicates autocorrelation. This was indicated by the Univariate Local Indicators of Spatial Autocorrelation 'LISA,' but not all these clusters were statistically significant.

The coefficients of the Global Moran autocorrelation statistic between the average unemployment rate and each explanatory variable per mu-

TABLE 2 Global Moran I-Statistics

Variable	Moran I	Significance Level
Average GDP growth rate	0.097	0.085
Average literacy growth rate	0.403	0.001***
Average population growth rate	−0.060	0.330

NOTES *** $p < 0.001$.

TABLE 3 Results for KwaZulu-Natal Municipalities (OLS Model)

Variable	Estimates	*p*-value
Constant	8.732***	<0.001
GDP	−0.272***	0.002
Population	0.640***	<0.001
Literacy	−0.236***	0.005
Adjusted R^2	0.467	
F-statistic	15.616***	<0.001
Log-likelihood	−64.13	
Akaike info criterion	136.26	
Jarque-Bera norm. test	3.093	0.212
Koenker-Bassett test	0.228	0.972
White test	13.316	0.148
Multicollinearity condit. number	10.850	Extreme Multicollinearity

NOTES *** $p < 0.001$.

nicipality over the period are displayed in table 2. Also displayed are the coefficients' levels of significance.

Results of the Empirical Analysis

SPECIFYING THE REGRESSION MODEL

The classic or standard regression analysis excluding spatial weights is the starting point (using GeoDa, see below). The regression is usual:

$$y_t = \beta X_t + \varepsilon_t, \tag{28}$$

where y is the average unemployment rate per municipality, X is the vector of explanatory variables per municipality (average GDP, average population, and average literacy growth rates), and ε is the usual random error variable. The period ranges from 1996 to 2014, and the results for KwaZulu-Natal municipalities are given in table 3.

TABLE 4 Spatial Autocorrelation Test

Variable	Tests with spatial weight	*p*-value
Moran's I-stats. (error)	0.387	0.698
Lagrange lag multiplier	1.222	0.268
Robust lag LM	3.102	0.078
Lagrange multiplier (error)	0.000	0.995
Robust LM (error)	1.880	0.170
Lagrange multiplier (SARMA)	3.102	0.211

NOTES *** $p < 0.001$.

Perceiving the χ^2 statistic distribution with 2 degrees of freedom, the Jarque-Bera test suggests serious errors in normality ($p > 0.05$). No heteroscedasticity exists according to the Koenker-Bassett ($p > 0.05$) test. Heteroscedasticity among random variables with a specific functional form and trend surface specifications are considered as the residuals of the Koenker-Bassett test are studentised, implying robustness to non-normality.

To test the robustness of the specifications for heteroscedasticity, the White test was conducted as this disregards the heteroscedasticity of specific functional form and the results support the evidence of no-heteroscedasticity shown above. A large group of possibilities are considered by the White test, as it squares all the powers and cross-products of the variables in the model. The plain revealed acceptable results indicating the *X*-variables coefficients that are statistically significant, both individually, as well as jointly. However, nothing has yet suggested a possible special relationship, if any at all.

Adding weights to the ordinary regression analysis (rook continuity estimates that include the spatial weight matrix), gave similar results, but tests for spatial autocorrelation were also conducted. Spatial autocorrelation was assessed using five diagnostic tests and the results are given in table 4. Logically, Moran's I-statistics were determined first. The spatial error Lagrange multiplier and the robust Lagrange multiplier error models were estimated, followed by the Lagrange multiplier lag test (LM-Lag) and a robust Lagrange multiplier lag test as an alternative. Finally, a SARMA Lagrange multiplier model was developed and tested, which represents a higher-order model that includes spatial lags and spatial error terms.

One degree of freedom existed in the data and was distributed as χ^2,

TABLE 5 Spatial Lag Estimates – KZN Municipalities

Model	Spatial lag	*p*-value
Constant	8.733***	<0.001
GDP	−0.272***	<0.001
Population	0.640***	<0.001
Literacy	−0.236***	0.002
Lambda	−0.001	0.995
R^2	0.499	
Log-likelihood	−64.13	
Akaike info criterion	136.26	
Schwarz criterion	143.987	
Breusch-Pagan test	0.204	0.976
Likelihood ratio test	0.000	0.995

with the SARMA LM model having two degrees. The order in which the estimations are done is important and to ensure statistical significance only the robust models and estimations are noted and investigated further. The analysis considered only those that were found to be statistically significant and robust. When the ordinary LM-Lag and LM-Error models are insignificant, the robust models are also insignificant. Most test statistics given in table 4 are statistically significant, implying the absence of spatial autocorrelation.

ESTIMATING THE SPATIAL LAG MODEL

When studying spatial regression models, the traditional measures of regression analysis, for example, the R^2, are not applicable (Anselin 2005). Statistical measures, such as the coefficient of determination, are a kind of pseudo-R^2, which cannot be compared to the usual statistics. In spatial analysis, the Log-Likelihood, Schwarz criterion and Akaike info criterion measures are more appropriate (Breitung and Wigger 2018).

When the results of the Log-likelihood and Akaike info criterion statistics of the ordinary regression analysis (−64.13 and 136.26) are compared to the spatial lag model (−63.47 and 136.94) (tables 3 to 5), the inclusion of a spatial lag specification did not have any effect. The results showed that the spatial auto-regression indicator (ρ) equals 0.19 but is insignificant ($p > 0.05$). Testing for heteroscedasticity using the Breusch-Pagan test in the error terms also revealed no heteroscedasticity.

TABLE 6 Estimation Results Using the Spatial Error Model

Variable	Spatial lag	*p*-value
Constant	7.184***	<0.001
GDP	−0.248***	0.002
Population	0.613***	<0.001
Literacy	−0.205***	0.008
Weight matrix (ρ)	0.191	0.212
R^2	0.515	
Log-likelihood	−63.470	
Akaike info. criterion	136.940	
Breusch-Pagan	0.205	0.976
Likelihood ratio test	1.320	0.250

To improve the spatial autoregressive coefficient of the asymptotic significance test, an alternative test was conducted. As part of the specifications of classic regression analysis, the likelihood ratio test relates the null hypothesis to an alternative spatial lag model. The low probability value also indicated that the spatial autoregressive coefficient is statistically insignificant. The graph in figure 8 displays the spatial lag model, depicting the values of the actual, predicted and residual values of the average unemployment rate per municipality.

ESTIMATING THE SPATIAL ERROR MODEL

Similar results were obtained when estimating the spatial error model. When the results of the log-likelihood and Akaike info criterion statistics of the ordinary regression analysis (−64.13 and 136.26) were compared to the spatial error model (−64.13 and 136.26) (tables 3 to 6), it indicated that the inclusion of a spatial lag specification still had no effect.

The value of lambda, which is the spatial autoregressive coefficient, equals minus 0.0011, reveals to be highly insignificant, and no heteroscedasticity exists among error terms according to the Breusch-Pagan test results ($p > 0.05$). The next test was not a spatial autocorrelation test, while the classic likelihood ratio test substantiated the notion that the spatial autoregressive coefficient has very weak statistical significance ($p > 0.05$). The graph in figure 9 (actual vs. predicted and residuals) displays the spatial error model.

The model results confirm that spatial correlations can indeed be estimated. It measures or assesses which nearby municipalities experience

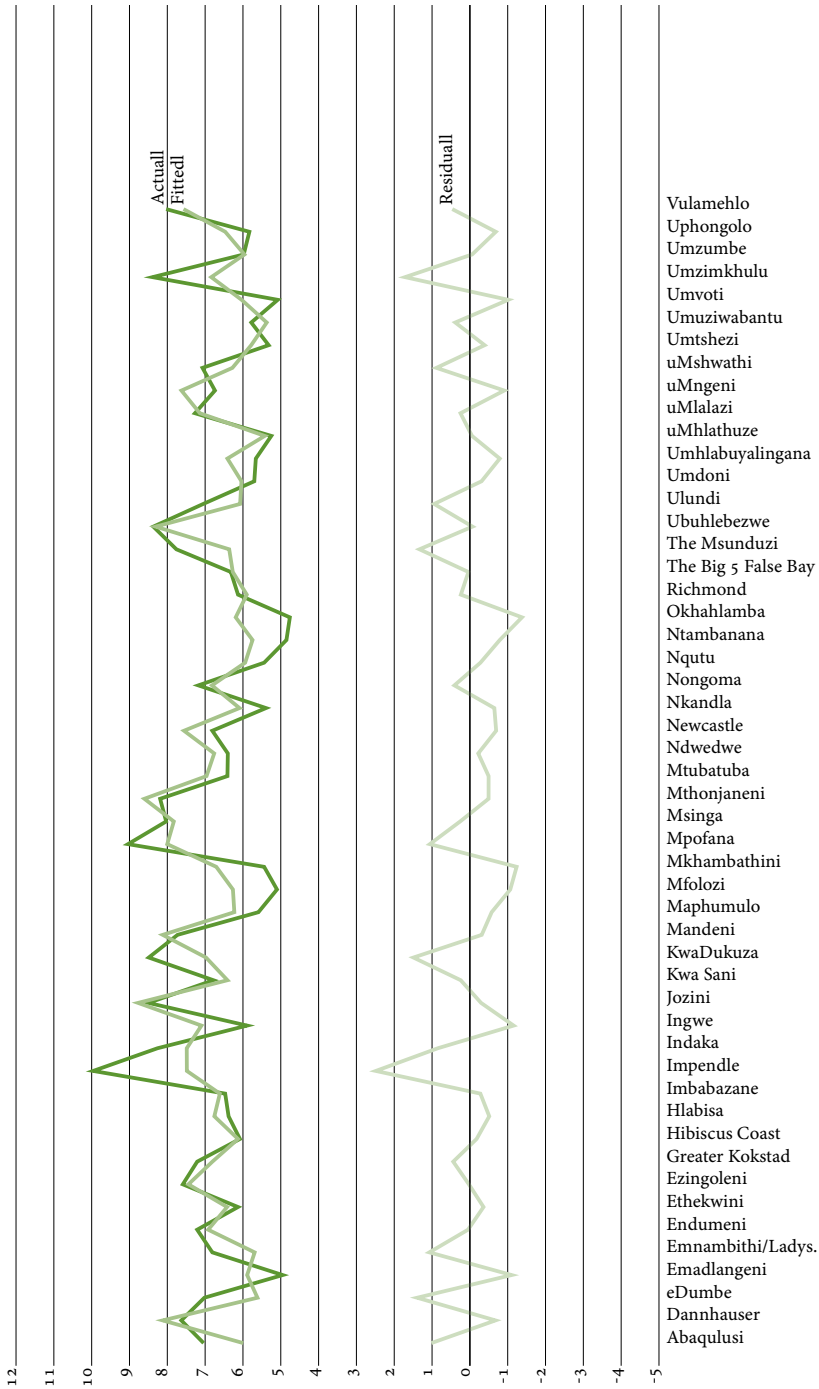


FIGURE 8 Spatial Lag Model

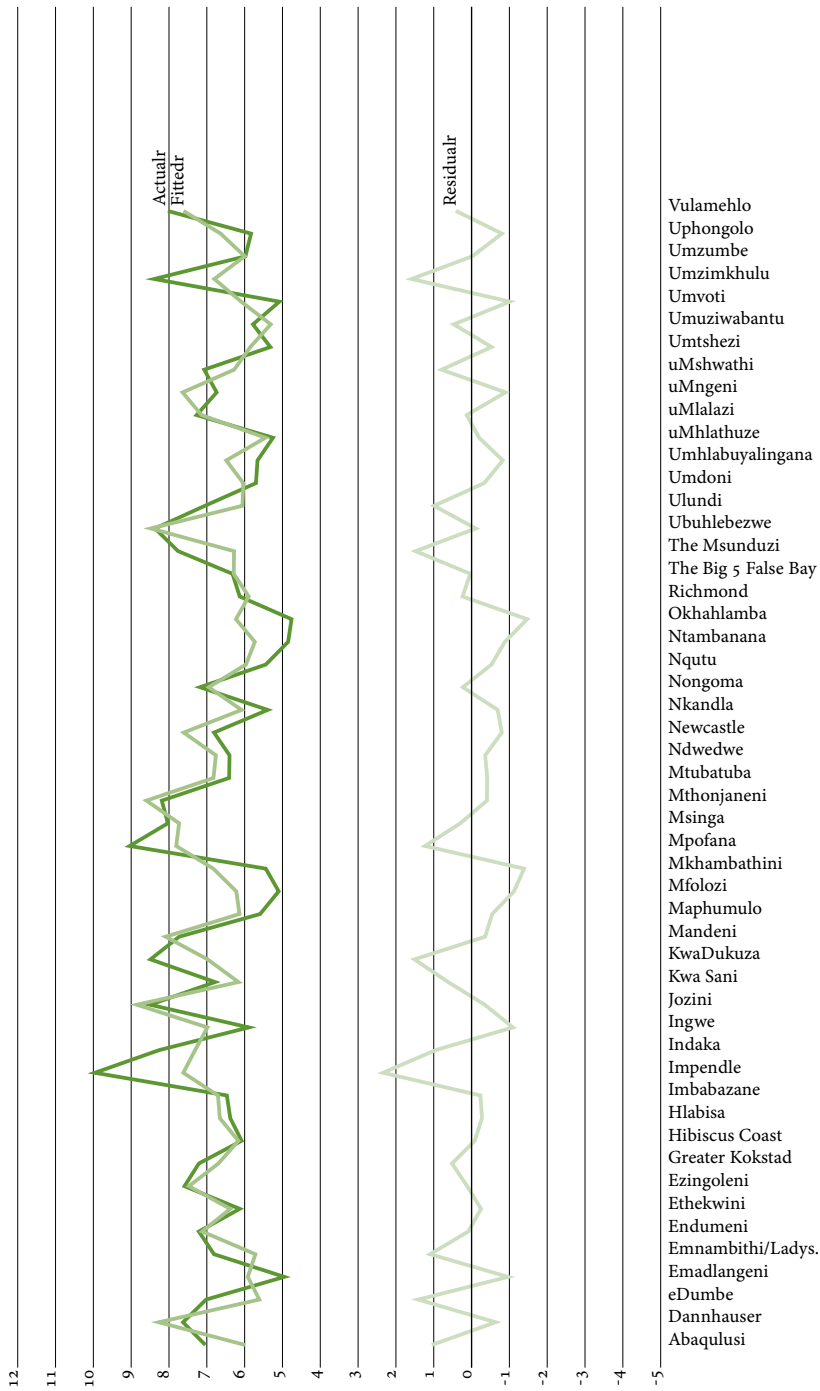


FIGURE 9 Spatial Error Model

similar unemployment characteristics and the degree of influence on one another. The study results suggest that the unemployment rate in a particular municipality is not spatially dependent on or influenced by the economic situation of its neighbours. The evidence suggests complete spatial randomness. This suggests that municipalities are fundamentally heterogeneous, and their unique and diverse municipal factors influence the unemployment rate.

Findings

Unemployment is a critical focus of the Province of KwaZulu-Natal. Amongst the 51 municipalities located within the Province, they register different unemployment rates and changes thereof. To this end, it is relevant to understand the unemployment interaction or relationship between the 51 municipalities and especially the spatial interaction and relationship.

The Moral I spatial autocorrelation of the average municipal unemployment rate proposes the existence of spatial unemployment clusters. Autocorrelation as a spatial dependence test is rather equivocal, although not all the identified clusters were statistically significant.

Based on the spatial regression analysis, the unemployment rate in a particular economy seems not to be spatially influenced by the economic situation of its neighbours, but rather due to spatial randomness. In essence, the spatial analysis proposes that spatial proximity is not a significant determinant or factor, i.e. 'space does not matter.' Thus, the unemployment rate in one municipality is not related to what happens in a neighbouring or nearby municipality.

Conclusions

Rural economies with prolonged unemployment are often associated with low economic growth. This could be a result of structural challenges, low levels of productivity or even a mismatch between supply and demand. However, if this trend is also observed in the neighbouring economies, the question comes to mind whether these economies influence one another.

To measure this, the study employed three statistical models, the usual regression analysis applying least square (OLS), the spatial lag model (SLM) and the spatial error model (SEM) investigating the spatial statistical relationship between contiguous economies (local authorities).

The results reveal that the unemployment rate in a particular economy is not spatially influenced by the economic situation of its neighbours, but rather due to spatial randomness. In essence, the spatial analysis proposes that spatial proximity is not a significant determinant or factor, i.e. 'space does not matter.' Thus, the unemployment rate in one municipality is not related to what happens in a neighbouring or nearby municipality. From a theoretical and logical point of view, this does not make total sense since, in general, the assumption is that leading regions have some influence or impact on lagging regions. This might be an indication of underdevelopment and weak linkages between various districts in the region. This inherent heterogeneity has implications for local- and provincial-level policymakers in terms of governance and economic development policy and projects. A one-size-fits-all agenda for spatial development would not succeed. When designing job creation and economic development programmes and policies this necessitates unique programmes for each authority and urban region.

The results might seem counter-intuitive since it seems plausible that the unemployment rates of neighbouring municipalities should to some degree correlate. Authorities are not autonomous entities operating as closed economies with no movement of labour or capital between them (Coetzee and Kleynhans 2018a). In terms of the theoretical background, and regarding policy and legislation, this is unique to South Africa. According to South Africa's Constitution (1996), every authority is responsible for its development, including economic and spatial policies. Although over-arching national and provincial economic policies exist, every local authority must compile custom and relevant policies every five years, and these policies must be translated into their spatial impact in terms of national legislation and by-laws. When seen in this context, the conclusion of the current study that 'space does not matter,' makes sense to some extent and can even be correlated to authorities that enact the relevant policies and legislation, and those who do not.

The results do, however, need further investigation and analysis which give cause for follow-up studies. It is therefore recommended that further studies include both time series and panel series analysis to augment the current cross-section analysis and either verify or refute the initial results of this particular study.

The current study is nonetheless important since it gives an initial conceptual framework for further study of the spatial relationship between the economic variables of neighbouring economies. It sets the stage to call

for a further research agenda on this particular topic, especially looking at the role of existing policy and legal documents and their appropriateness in encouraging economic development for regional economies, possibly supporting agglomeration or clustering of economic activity to reduce unemployment.

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Ali trenutna priljubljena literatura o voditeljstvu daje prednost transformacijskemu vodenju?
Michael Hagemann

V zadnjih nekaj letih so se pojavili številni modeli, teorije in metodologije vodenja, tako da se postavlja vprašanje, kateri od modelov je najučinkovitejši oziroma kateri je prevladal. Eden od pristopov k temu vprašanju je primerjava različnih modelov v smislu njihovega prekrivanja ali podobnosti. Pričujoča študija temo raziskuje z obratnim pristopom: ali lahko iz priljubljene literature o vodenju izluščimo prednost, ki se jo pripisuje določenemu stilu vodenja ali celo usmeritvi vodenja ali »šoli« vodenja? Vodilno vprašanje je, katere knjige o vodenju se najbolje prodajajo in kateri stil vodenja oziroma elemente vodenja predstavljajo. V ta namen s kvantitativno-kvalitativno raziskavo proučimo Amazonove sezname knjižnih uspešnic s področju vodenja in upravljanja v določenem obdobju in na določenem lokalnem trgu, da bi ugotovili porazdelitev modelov in našli skupne stile ter elemente vodenja, ki jih obravnavajo različni avtorji. Rezultat kaže, da trenutna priljubljena literatura o vodenju odraža predvsem transformacijske modele vodenja z elementi transakcijskega upravljanja. Posebno voditeljsko miselnost in posebne vodstvene aktivnosti, kot sta ciljna naravnanost ali navdihujoča motivacija, je mogoče najti v skoraj vseh najbolj razširjenih modelih.

Ključne besede: transformacijsko vodenje, transakcijski model, teorija vodenja
Klasifikacija JEL: M0, M19
Managing Global Transitions 20 (3): 335–351

Tuja razvojna pomoč in naravnanost makroekonomske politike: temeljni vzvodi rasti v državah PSA v razvoju
Samson Edo, Oluwatoyin Matthew in Ifeoluwa Ogunrinola

Pričujoča študija raziskuje gospodarsko rast držav podsaharske Afrike (PSA) v razvoju, da bi ugotovili relativne učinke tuje razvojne pomoči (TRP) in makroekonomskih politik. Pri ocenjevanju dolgoročnih in kratkoročnih učinkov uporabimo modela GMM in VECM. Kratkoročni rezultati kažejo, da je TRP pri spodbujanju gospodarske rasti v obdobju 1980–2019 močno dopolnjevala zgolj fiskalno politiko. Po drugi strani pa dolgoročni rezultati kažejo, da je TRP pri spodbujanju rasti dopolnjevala monetarno in fiskalno politiko. Rezultati nadalje razkrivajo, da

je imel devizni tečaj nekomplementarno vlogo, gospodarska rast pa se ni bistveno odzivala na lastni zamik. Na splošno so ocenjeni vplivi v skladu s teoretičnimi pričakovanji modelov. Rezultate ocenjujemo tudi kot zanesljive za oblikovanje politike. Možni politični ukrepi, ki izhajajo iz rezultatov ocenjevanja, vključujejo vzdrževanje priliva TRP, okrepitev okvira monetarne politike, vzdrževanje okvira fiskalne politike, povečanje učinkovitosti sistema menjalnih tečajev in omogočanje tržnim silam, da poganjajo gospodarstvo.

Ključne besede: razvojna pomoč, makroekonomske politike, gospodarska rast, države v razvoju
Klasifikacija JEL: E51, F21, F43, O55
Managing Global Transitions 20 (3): 353–374

Infrastruktura in učinkovitost zdravstvenega sistema v Afriki

Uche Abamba Osakede

Empirične raziskave vpliva infrastrukture na učinkovitost zdravstvenega sistema, ki bi se nanašale na različne tipe infrastrukture v Afriki, niso običajne. To je pomembno za ugotavljanje tipa infrastrukture, ki ima na zdravstvene sisteme večji vpliv. Ugotovitve v zvezi s tem so ključnega pomena za Afriko, kjer zdravstveni sistemi delujejo slabo, in prinašajo fiskalne izzive za javno zadovoljevanje zdravstvenih potreb. Pričujoči članek je preučil učinek tipov infrastrukture na delovanje zdravstvenega sistema v Afriki z uporabo podatkov za 54 držav v regiji in v obdobju 2003–2018. Učinkovitost zdravstvenega sistema je zajeta z zdravstveno sliko prebivalstva. Ugotovitve so prikazane z uporabo GMM tehnike ocenjevanja. Rezultati so pokazali pomemben učinek transporta in IKT pri podaljšanju življenjske dobe in zmanjšanju umrljivosti otrok, mlajših od pet let. Izboljšanje IKT je zmanjšalo število smrti mater. Pospešitev vseh tipov infrastrukture (transport, elektrika in IKT) je znatno zmanjšala umrljivost dojenčkov. Glede na rezultate je samo IKT povezana z izboljšanjem vseh spremenljivk zdravstvene slike prebivalstva, ki smo jih uporabili v raziskavi. Ugotovitve kažejo na ključno vlogo infrastrukture pri delovanju zdravstvenih sistemov, pri čemer se je pokazalo, da ima IKT večji vpliv na zdravstvene sisteme kot drugi tipi infrastrukture. Zagotavljanje in uporabo IKT je zato treba pri prizadevanju za boljšo učinkovitost zdravstvenega sistema v Afriki postaviti kot prvo prioriteto.

Ključne besede: infrastruktura, učinkovitost zdravstvenega sistema, zdravje populacije
Klasifikacija JEL: kraticaI15, P46, H54
Managing Global Transitions 20 (3): 375–400

Vpliv prostorske brezposelnosti na gospodarstva sosednjih regij: regionalna študija primera KwaZulu-Natal v Južni Afriki

Clive Egbert Coetzee, Ewert P. J. Kleynhans, in David Dyason

Članek raziskuje stopnjo prostorske odvisnosti brezposelnosti od sosednjih gospodarstev z možnimi implikacijami za čezmejne pobude za razvoj skupnosti. Kot študija primera so uporabljene lokalne občine v provinci KwaZulu-Natal v Južni Afriki. Uporabljamo prostorske ekonometrične tehnike, ki upoštevajo odvisnost med regijami v neposredni geografski bližini. Neagregirani podatki in poznavanje dinamike na podregionalni ravni za oblikovanje politik zaposlovanja običajno niso na voljo, zlasti za regionalna gospodarstva v nerazvitih državah ne. Rezultati kažejo na odsotnost prostorskega grozdenja brezposelnosti in avtokorelacije med sosednjimi gospodarstvi. Odsotnost zunanjih učinkov pomeni, da med sosednjimi gospodarstvi obstaja le majhna medsebojna odvisnost, zato je mogoče vzorce brezposelnosti v občinah obravnavati kot prostorsko naključne. Gospodarstvo neke regije je torej v osnovi heterogeno, saj njene stopnje brezposelnosti določajo oziroma nanje vplivajo njeni edinstveni in raznoliki dejavniki, ne pa trendi ali vzorci brezposelnosti iz soseščine.

Ključne besede: regijska brezposlenost, delo, modeli prostorske regresije, prostorska odvisnost, regijski učinek in vpliv, sosedje, prostorske uteži, prostorsko zamaknjene odvisne spremenljivke, prostorska avtokorelacija
Klasifikacija JEL: C31, E24
Managing Global Transitions 20 (3): 401–431