# APPLICATION OF TWO-STAGE GAME CROSS-EFFICIENCY APPROACH TO PRIMARY HEALTHCARE IN NIGERIA

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**UNIVERSITI SAINS MALAYSIA**

**2023**

# APPLICATION OF TWO-STAGE GAME CROSS-EFFICIENCY APPROACH TO PRIMARY HEALTH CARE IN NIGERIA

**by**

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**Thesis submitted in fulfilment of the requirements**
**for the degree of**
**Doctor of Philosophy**

**April 2023**

## ACKNOWLEDGEMENT

I am grateful to the Almighty God for helping me hitherto. He has indeed done me well and I will live to praise Him forever. I would like to sincerely and humbly express my gratitude to my supervisor, Dr. Majid Khan Bin Majahar Ali, for guiding me through this thesis. He is the reason why the research has reached this point of submission. Thank you, Dr. I also remain thankful to my co-supervisor, Associate Professor Dr. Mohd Tahir Ismail, for guiding me through the research. My profound gratitude goes to the management of Universiti Sains Malaysia (the Apex) and the dean and staff of the School of Mathematical Sciences for creating an enabling environment for me to study. Indeed, I achieved a lot during this my period of research and the knowledge will take me far in life.

To my EPCC brethren, the Cell group and other colleagues at the main campus, I sincerely enjoyed every time of fellowship. May God continue to increase our love.

I dedicate this thesis to my dear wife and my children for bearing my absence and managing the hard times during the course of my studies. I appreciate it. To my siblings, relatives, and friends that continue to express their love for me in cash and in kind, thank you. May God reward you. To every other person that I should have mentioned but could not, you are remembered and appreciated.

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| | |
|---|---|
| AMS | The American Medical Sciences |
| ANC | Antenatal |
| BCC | Banker, Charnes, and Cooper |
| CCR | Charnes, Cooper, and Rhodes |
| CIA | Central Intelligence Agency |
| COLS | Corrected ordinary least square |
| CRS | Constant Returns to scale |
| DEA | Data Envelopment Analysis |
| DMU | Decision making units |
| EC1 | Efficiency changes of period 1 |
| EC2 | Efficiency changes of period 2 |
| Eff | Efficiency |
| EFFCH/EC | Efficiency changes |
| FMOH | Federal Ministry of Health |
| GDP | Gross domestic product |
| HMOs | Health maintenance organisations |
| LGAs | Local Government Areas |
| LMIC | Low-income and middle-income countries |
| LOUS | Ultrasound services |
| MI1 | Malmquist index of period 1 |
| MI2 | Malmquist index of period 2 |
| MPI/ MI | Malmquist Productivity index/ Malmquist index |
| MTFPGI | Malmquist total factor productivity growth index |
| NBS | National Bureau of Statistics |

| | |
|---|---|
| NHIS | National Health Insurance Scheme |
| OLS | Ordinary least square |
| OOP | Out-of-pocket |
| PHC | Primary Health Care |
| PHCB | Primary Health Care Board |
| PHCPI | Primary Health Care Performance Initiative |
| PPMVs | Patent and proprietary medicine vendors |
| R & D | Research and Development |
| Sd | Standard deviation |
| SDG | Sustainable Development Goal |
| SDI | Service Delivery Indicator |
| SFA | Stochastic Frontier Analysis |
| TC1 | Technological changes of period 1 |
| TC2 | Technological changes of period 2 |
| TECH/TC | Technological Changes |
| TFP | Total factor productivity |
| U5M | Under-five mortality |
| UCSF | University of California, San Francisco |
| UHC | Universal Health Coverage |
| UN | United Nations |
| UNICEF | United Nations International Children's Emergency Fund |
| VRS | Variable returns to scale |
| WHO | World Health Organisation |

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**APLIKASI TEORI PERMAINAN DUA PERINGKAT KEPADA KECEKAPAN PENJAGAAN KESIHATAN UTAMA DI NIGERIA**

## ABSTRAK

Kesihatan adalah komponen terpenting dalam kehidupan. Memandangkan kesihatan yang baik penting untuk pertumbuhan ekonomi, sistem penjagaan kesihatan di seluruh dunia berusaha untuk mencapai hasil yang berkesan, cekap, berkualiti tinggi dan saksama. Nigeria menjalankan sistem penyampaian penjagaan kesihatan tiga tingkat, dengan sebahagian besar penjagaan kesihatan terletak pada tingkat penjagaan utama. Penjagaan kesihatan utama (PHC) ialah asas kepada semua sistem kesihatan, malangnya penggunaan sumber penjagaan kesihatan yang tidak cekap, pembiayaan yang tidak mencukupi, kemudahan kesihatan yang tidak efisien, dan sistem pengawasan yang tidak mencukupi dan tidak berfungsi dilemahkan oleh pelbagai cabaran di Nigeria. Kajian ini bertujuan untuk menganalisis prestasi penjagaan kesihatan utama (PHC) di Nigeria dengan menggunakan dua negeri (Benue dan Lagos) sebagai kajian kes dan teknik analisis penyampulan data (DEA) berasaskan teori permainan diperkenalkan. Teori permainan membantu untuk mendedahkan peringkat dominan (pemimpin) unit membuat keputusan dua peringkat (DMU) yang tidak dicerap tanpa pengetahuan sedia ada. Data diperoleh dengan menggunakan kedua-dua sumber primer dan sekunder. Bilangan katil hospital, kakitangan perubatan dan bukan perubatan, pesakit luar dan pesakit dalam, penjagaan sebelum bersalin, bilangan bersalin, dan kualiti penjagaan adalah pemboleh ubah input dan output. Kajian ini adalah untuk tempoh tiga tahun (2017–2019). Indeks produktiviti Malmquist (MPI) dua peringkat untuk 15 PHC di Benue untuk 2017/2018 mendedahkan peningkatan dalam produktiviti dan kecekapan

(teknikal) masing-masing sebanyak 2.3% dan 97%, manakala perubahan teknologi menurun sebanyak 1.2%. Tiada PHC yang cekap dalam tempoh tiga tahun. Laporan dua peringkat menerusi teori permainan daripada 15 PHC di Lagos mendedahkan bahawa tiada daripadanya yang berkesan antara 2017 dan 2019. Dapatan teori permainan mendedahkan bahawa hasil permainan berpusat dan Stackelberg adalah sama pada peringkat 1 dan 2. Di Benue pada 2017, lima dan dua PHC adalah cekap pada peringkat 1 dan 2 untuk Stackelberg dan model berpusat, tiga PHC dan enam PHC untuk peringkat 1 dan 2 pada 2018, manakala pada 2019 mendedahkan dua PHC dan empat PHC cekap pada peringkat 1 dan peringkat 2, masing-masing untuk Stackelberg dan permainan berpusat. Dapatan permainan Lagos untuk 2017 menunjukkan lima PHC setiap satu untuk peringkat 1 dan 2, dua PHC dan empat PHC untuk peringkat 1 dan 2 2018, manakala pada 2019 menunjukkan tiga PHC dan empat PHC adalah cekap untuk peringkat 1 dan peringkat 2 Stackelberg dan permainan berpusat, masing-masing. Keputusan menunjukkan bahawa bahagian kualiti perkhidmatan (peringkat 2) perlu diberi keutamaan untuk ujian berdominasi, iaitu peringkat yang perlu diutamakan. Memandangkan penyelidikan ini menilai kecekapan teknikal, terdapat ruang untuk meningkatkan kecekapan PHC di Nigeria dengan memberi tumpuan kepada pengumpulan data terperuntuk. Tumpuan ini akan menangani masalah pembiayaan yang merupakan kunci kepada kelemahan dalam sistem kesihatan di Nigeria.

**APPLICATION OF TWO-STAGE GAME CROSS -EFFICIENCY APPROACH TO PRIMARY HEALTHCARE IN NIGERIA**

## ABSTRACT

Health is the most important component of life. Due to the importance of good health to economic growth, healthcare systems across the globe strive for outcomes that are effective, efficient, high-quality, and equitable. Nigeria runs a three-tiered health care delivery system, with a significant portion of health care vested in primary care. Primary health care (PHC) is the bedrock of all health systems, but inefficient utilisation of healthcare resources, inadequate funding, inefficient health facilities, and inadequate and non-functional surveillance systems are weakened by many challenges in Nigeria. This study aims to analyse the performance of primary health care (PHC) in Nigeria by using two states (Benue and Lagos) as case studies and the game theory-based data envelopment analysis (DEA) technique is introduced. Game theory helps to uncover the dominant (leader) stage of an unobservable two-stage decision making unit (DMU) in the absence of prior knowledge. Using both primary and secondary sources, data was acquired. The number of hospital beds, medical and non-medical staff, outpatients and inpatients, antenatal attendance, number of deliveries, and quality of care are the input and output variables. The study was for a duration of three years (2017–2019). The two-stage Malmquist productivity index (MPI) for the 15 PHCs in Benue for 2017/2018 revealed an increase in productivity and efficiency (technical) of 2.3% and 97%, respectively, while technological changes decreased by 1.2%. None of the PHC is efficient within the three-year duration. The two-stage report from the 15 PHCs in Lagos revealed that none were effective between 2017 and 2019.The results of game

theory reveal that the outcomes of the centralised and Stackelberg games are identical at stages 1 and 2. In Benue in 2017, five and two PHCs are efficient at stages 1 and 2 for the Stackelberg and centralised models, respectively, three PHCs and six PHCs for stage 1 and 2 in 2018, while that of 2019 reveals two PHCs and four PHCs to be efficient at stages 1 and 2, respectively, for the Stackelberg and centralised games. The Lagos game results for 2017 show five PHCs each for stages 1 and 2, two PHCs and four PHCs for stages 1 and 2 of 2018, while those of 2019 indicate three and four PHCs are efficient for stages 1 and 2 of the Stackelberg and centralised games, respectively. The result indicates that the service quality division (stage 2) should be given priority for the dominating test, i.e., the stage that should be given precedence. Since this research looks at technical efficiency, there is room for improving PHC efficiency in Nigeria by focusing on allocative efficiency data collection. This will address the funding problem that is the key to the flaws in the health system in Nigeria.

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

The right to the best health possible is one of the most important human rights enshrined in the Global Health Organization's constitution (World Health Organization [WHO] , 2018). As a result, all member states of the United Nations (UN) must provide basic, cheap, and universal health care to their people. According to the World Health Organization (WHO), universal health coverage (UHC) is a way to ensure that all citizens have access to the preventive, curative, rehabilitative, and palliative health services they require, at a sufficient level of quality to be effective while also avoiding financial hardship for the user (WHO, Universal health coverage (UHC)).UHC is an intrinsic aspect of the 1948 WHO Constitution, which declared health a fundamental human right, and of the 1978 Alma-Ata Declaration's "health for all" objective (WHO, 2018). UHC is part of Sustainable Development Goal 3 (United Nations, SDG3), and it also plays a big role in achieving the other SDGs by keeping people healthy.

Between 2000 and 2019, life expectancy and healthy life expectancy at birth rose around the world, with the biggest improvement happening in low-income countries. This is partly because of the great progress made in reducing infant mortality and major communicable diseases. In addition, there has been a long-term drop in suicide, homicide, accidental poisoning, and road traffic deaths. Men around the world are more likely to die from injuries than women. In 2020, the COVID-19 pandemic has threatened to derail the SDGs' accomplishments over the last two

decades, highlighting current health inequities within and across countries (WHO, 2021).

While increases in coverage of essential health care have been noted across all socioeconomic levels and service types—with the UHC service coverage index (SCI) growing from a global average of 45 (of 100) in 2000 to 66 in 2017—numerous inequities continue. Progress has slowed a lot around the world and in many countries since 2010, but the poorest countries and those hit by conflict are still far behind.

The provision of sustainable, high-quality care at a reasonable cost is a major goal of health care delivery in both developing and wealthy countries. This is predicated on the concept that quality can be quantified, tracked, and improved. The demand for high-quality, inexpensive health care is fuelled by the world's ever-changing demographic, epidemiological, and political systems, as well as the increasing complexity of illness patterns and consumer preferences (Ephraim-Emmanuel et al., 2018). Patient satisfaction during a health care delivery interaction is widely recognised as a proxy for quality health care delivery and can serve as a barometer for the amount of patient-centred care offered by health care institutions. Indeed, past research has proven a link between the quality of health care services and patient or client satisfaction with the services delivered (Govindarajan et al., 2019; Hughes, 2008; Kalinichenko et al., 2013). Apart from consumerism's growing impact on healthcare, additional factors that influence health care quality include health care providers' knowledge and competence, patient cooperation, health insurance, leadership and management styles in health facilities, teamwork, a readily available referral system, and health care providers' job satisfaction (Mosadeghrad, 2014; Ufuoma John et al., 2014). All people, everywhere, deserve access to the

appropriate level of care in their community. This is the core concept upon which primary health care is predicated.

Primary health care (PHC) addresses the overwhelming majority of an individual's health needs over the course of their lifetime. This term refers to a state of physical, emotional, and social well-being that is centred on individuals rather than disease. PHC encompasses a range of activities, including health promotion, illness prevention, diagnosis, treatment, rehabilitation, and palliative care. A primary health care strategy has three parts: meeting people's health needs throughout their lives; addressing the broader determinants of health through multisectoral policy and action; and giving people, families, and communities the tools to manage their own health (World Health Organization [WHO] & [UNICEF], 2018).

A health system founded on strong primary care can benefit the population by increasing access to health care for underserved populations, improving overall patient care and health, promoting preventative and educational measures (e.g., smoking cessation, early diabetes treatment), directing care in an appropriate and focused manner (i.e., appropriate specialist referral), and reducing unnecessary and inappropriate medical care. It also helps close the gap between socially disadvantaged and socially advantaged groups (Rao & Pilot, 2014).

Countries with a strong emphasis on primary care have fewer low birth weight newborns, lower infant mortality, particularly post neonatal mortality, fewer years lost to suicide, fewer years lost to all causes except external causes, and a greater life expectancy at all ages except 80 years (Starfield et al., 2005; Kruk et al., 2010; Hsieh et al., 2015). Increased access to primary care has also been shown to

improve patient satisfaction with the health care system and cut down on hospitalizations and emergency room visits (Shi, 2012).

Nigeria is located in the sub-Saharan region of Africa. It is Africa's most populous country, with a population of 206,139,589 million individuals as of 2020 (Woridometer, 2022). By 2050, Nigeria's population is expected to reach approximately 390 million, making it the world's fourth largest country (CIA, 2014). The majority of its population is between the ages of 0 and 14 (National Bureau of Statistics (NBS), 2017). Nigeria is a federal republic with a central government and subnational, state, and local governments. According to Alonge (2020), Nigeria has a three-tiered health care system. The federal government is in charge of tertiary and teaching hospitals, the states are in charge of secondary hospitals, and local governments are in charge of primary health clinics (PHCs). Currently, Nigeria's healthcare system is financed through a combination of tax money, out-of-pocket payments, foreign donations, and health insurance (Olakunde, 2012). There are a lot of different ways to obtain funds for PHC in Nigeria, and each one has a different effect on how well it works.

Nigeria has created a robust policy framework for UHC and health in general at the national level. This includes the 2014 Presidential Summit Declaration on Universal Health Care, the 2018 publication of the Second National Strategic Health Development Strategy as a UHC policy framework, and the establishment of the Basic Health Care Provision Fund to generate more financial resources for health. However, little progress has been made in implementing policies. Nigeria is committed to providing UHC and has built a comprehensive national framework for UHC policy development. However, only a small amount of progress has been made toward implementing this system (*The* Academy *of Medical Sciences, 2020*).

As the World Health Organization has indicated (World Health Organization [WHO], 2018), primary health care is the most relevant, unique, and significant component of Nigeria's three-tier health system. Primary healthcare is a purposeful and systematic attempt to build a health care system that fulfils the requirements of the majority population and poor residents while being economical, sustainable, and ensuring high-quality care. It is done in rural and suburban areas by government primary health care centres and faith-based clinics. Secondary and tertiary health care facilities are for people who live in cities.

Additionally, PHC has been shown to be extremely effective and efficient at treating the primary causes and risk factors for health deficiencies. Additionally, it is capable of responding to potential dangers to public health and well-being in the future. It is important to get primary health care to meet the Sustainable Development Goals (SDGs) for health, which are linked to other SDGs for reducing poverty, educational services, jobs and economic growth, disparity alleviation, and climate change policy (Drouin, 2008). Because primary health care is so important, countries around the world spend a lot of time and money to build and keep good PHC systems.

Among the variables influencing the efficacy of Nigeria's primary health care are inadequate or delayed access to quality care; low perceptions of quality care; a lack of enabling factors; a shortage of health personnel; insufficient resources; ineffective health policies; poor governance of health systems; low staff motivation; limited political commitment; and a lack of institutional capacity to establish implementation strategies (Medeiros & Schwierz, 2015; UT, 2015; FO, 2015; Kalu et al., 2017; Ajayi & Akpan, 2020).

Nigeria does poorly on a number of UHC metrics, including government spending on health (which is among the lowest in the region) and the proportion of health expenditure accounted for by out-of-pocket expenses (which is among the highest in the region). As a result, health results are substandard. For example, life expectancy has increased at a slower rate than in other African countries (The Acedemy of Medical Sciences, 2020). PHC must be revitalised and placed at the centre of efforts to promote health and well-being for three reasons: PHC characteristics allow the health system to adapt and respond to an ever-changing and complicated world. With an emphasis on promotion and prevention, addressing determinants, and a people-centred approach, PHC has been shown to be a highly effective and efficient way to address the primary causes and risk factors for poor health, as well as emerging challenges that may threaten health in the future. The World Health Organization and the UHC goals, as well as the health-related Sustainable Development Goals can only be achieved sustainably with a stronger emphasis on PHC (World Health Organization [WHO] , 2018)).

Primary health care is critical for achieving the Sustainable Development Goals (SDGs) relating to health, which are intimately linked to the other SDGs such as poverty eradication, inclusive education, work and economic growth, inequality reduction, and climate action (Chotchoungchatchai et al., 2020).

## 1.2 Problem Statement

Indeed, inefficient use of health resources frequently results in a reduction of resources available to address other emergent health demands that could increase community well-being. It is critical that Nigeria evaluates its health care system, specifically the primary health care system, preferably among peers, and allocates

available resources efficiently. This assessment is unquestionably important when it comes to making decisions about how to run healthcare systems better in different places.

The absence of a fully developed and functional primary health care system continues to constitute a development challenge in Nigeria. The situation threatens the achievement of health-related sustainable Development Goals (SDGs) as well as other health objectives. One of the major challenges facing the health sector in Nigeria is the weakness of the country's primary health care system. Unfortunately, system weaknesses and long-term neglect have made ideal primary health care impossible to achieve, hence the National Primary Health Care Development Agency (NPHCDA) declared a set of minimum standards. NPHCDA sees the minimum standards as a temporary measure that will give way to a more robust system in the near future. Adherence to a set of minimum standards for the PHC system is fundamental to the effective functioning of any PHC facility and is an essential element for the delivery of quality healthcare. It is crucial to know the productivity of the PHCs and their advancement in the areas of efficiency and technology.

Efficiency is defined simply (technically) as the ratio of the weighted sum of outputs to the weighted sum of inputs. Each decision making unit (DMU) is evaluated using a self-evaluation technique in which the weights are calculated in such a way that their efficiency relative to the other DMUs is maximised (Wöber, 2006). On the other hand, (Sexton et al., 1986) proposed the concept of cross-efficiency as a peer-reviewed review that calculates each DMU's efficiency using the weights provided by the other DMUs for inputs and outputs. This technique enables improved discrimination of DMUs without imposing additional constraints (Doyle &

Green, 1994; Doyle & Green, 2016), as well as classification of DMUs into good and poor performers. The cross-efficiency of the game ensures that the rating is unique and that it is acknowledged by all DMUs. This method has never been used in healthcare and hence represents an unfilled need.

Another issue with PHC is a lack of quality care. In the majority of healthcare research, the efficiency of the health system is determined by the inputs (expenditure, hospital beds, and medical staff) used to produce outputs. Nonetheless, numerous issues have arisen on the output side of previous research as a result of their failure to address appropriate healthcare quality indicators (Gearhart, 2016). Numerous healthcare outcome metrics, in particular, are not attributable to health system interventions but rather are influenced by a variety of factors external to the health system (Papanicolas & Cylus, 2017). The health sector's primary objective is to deliver high-quality, safe services that meet the demands of patients. Improved service quality can result in increased adherence to medical treatment and more efficient use of health care (World Health Organization & Regional Office for Europe, 2000). Understanding the elements that influence users' views of the quality and safety of healthcare may lay the groundwork for developing effective policies aimed at increasing access to and the quality of health services (Nikoloski & Mossialos, 2013).

It appears logical to predict that resource constraints will force health managers to make trade-offs between the quality and quantity of care offered in Nigeria's health systems. More precisely, optimising PHC production efficiency may result in a decline in product quality. On the other hand, quality enhancement may necessitate additional resources, resulting in a reduction in manufacturing efficiency (Mitropoulos, 2021). There is a need to establish an efficiency analysis framework

that evaluates the performance of PHCs by focusing on not only the volume and quantity of health services delivered, but also the quality of those services. A two-stage DEA series network can give a thorough and accurate assessment by evaluating both the individual stage efficiencies and the overall system efficiencies. The relational model created here is more precise in measuring service system efficiencies and, thus, in identifying the sources of inefficiency. Our technique gives extensive information on each evaluation stage, showing where policymakers can concentrate their efforts in order to enhance the overall performance of the health system. This is a prominent gap that requires closure.

Data envelopment analysis (DEA) is a mathematical model that uses linear programming to measure the efficiency of a number of decision-making units such as production units, banks or hospitals, by determining the optimal mix of its inputs (hospital resources) and its output (hospital services) based on actual performance. It aims to identify efficiencies and inefficiencies in the use of resources available to these institutions, and the most appropriate allocation of these resources by assessing the quality of their inputs and outputs (Girginer, Köse, & Uçkun, 2015; Yu, and Zhang, 2017).

To account for longitudinal data and conduct dynamic analysis of the PHC productivity changes in Benue and Lagos states from 2017 to 2019, we constructed the Malmquist index. The Malmquist index tracks technical (efficiency) and technological (productivity) developments. The Malmquist index has been used to establish a baseline for showing variations in PHC across time.

Traditional DEA models employ a "black box" approach to measure the efficiency of activities and do not relate the reasons for the inefficiency of processes

to their various stages. However, this method is inadequate for measuring the efficiency of two-step (or sub-process) activities in which the outputs of one stage are the inputs of the next stage (Chen et al., 2012). When measuring the efficiency of a two-stage process using the classic black-box method, it is not always possible to identify the sources of inefficiency. Using a two-stage DEA model to assess the overall efficiency as the combination of two independent efficiency ratios, i.e., the efficiency ratio of stage 1 and the efficiency ratio of stage 2, it is feasible to determine not only the overall efficiency of the activities but also the efficiency status of their sub-processes. Game theory can aid in measuring the efficiency of the internal structure and identify the source of inefficiency. The interconnections and potential conflicts between internal organisational activities that arises as a result of the intermediate measures that acts as outputs and inputs in the first and second stage of production system cannot be ignored. The game theory is therefore employed to address the cooperation (Centralised game) and the conflicts (Stackelberg non-cooperative game). Obviously, this is a better way to measure total efficiency than just looking at the ratio of outputs to inputs for the whole system. In addition, by removing the black box and employing the two-stage DEA models, the decision-making units (DMUs) and activities can be optimised by adopting several alternative scenarios. It can be done by (i) optimising the efficiency of stages 1 and 2 of a two-stage process at the same time, (ii) optimising the efficiency of stage 1 as the more important and leader stage first, and then optimising stage 2 as the less important and follower stage, or (iii) optimising the efficiency of stage 2 first, and then stage 1.

## 1.3 Objectives of the Research

PHC has been shown to be extremely effective and efficient at treating the underlying causes and risk factors for health deficiencies. Furthermore, it is capable of responding to emergent public health and well-being issues. Because primary health care is so important, countries around the world spend a lot of time and money on building and maintaining successful primary health care systems (Alonge, 2020).

**General:** The researcher's ultimate purpose in this study is to analyse primary health care in Nigeria by utilising two states as case studies using the game theory approach of Data Envelopment Analysis (DEA).

Specific:

(i) To ascertain the technical and technological efficiency of primary health care in Nigeria, as well as the rate of change in productivity over time, using DEA Malmquist productivity index.

(ii) To assess primary health centres' cross-efficiency in order to effectively differentiate between high and low performers and to give unique ordering across DMUs, employing the aggressive, benevolent secondary goals and Maverick model.

(iii) To determine the network system's and various subsystems' efficiency in the two-stage primary health care network by using game theory method.

## 1.4 Scope of the Study

This study focuses solely on the production of health care services in primary health care facilities. The study focuses on health production activities in 15 basic

health care institutions in the Nigerian states of Benue and Lagos. Primary and secondary sources were utilised to acquire data from the Primary Health Care Board of each state and the primary health care facilities. The input and output variables are the number of beds, the number of medical and non-medical personnel, the number of outpatients and inpatients, the number of antenatal visits, the number of births, and the quality of care. The study was conducted between 2017 and 2019 (3 years). Using R-coded programmes, the following models are employed: Data Envelopment Analysis (DEA), aggressive and benevolent cross-efficiencies, the Malmquist productivity index, and the game theory method. The opinion-seeking questionnaires are open to primary health care management personnel, health professionals, and medical personnel. All patients and outpatients must be at least 18 years old and must have visited the facilities at least once during the preceding two years.

## 1.5 Significance of the Study

To evaluate primary healthcare centres, the research study developed a two-stage game theory approach. The following are some of the research's implications:

The following are some of the research's implications:

i. This research has the potential to provide the Primary Healthcare Board with the tools they need to carry out their stewardship responsibilities. Additionally, managerial attempts to improve the efficiency of these institutions will be bolstered by an understanding of their efficiency levels and the causes of efficiency.

ii. Healthcare administrators, particularly those responsible for public health facilities, are entrusted with a share of society's resources to

produce health services. Healthcare institutions can help alleviate poverty by promoting economic development and reducing mortality and morbidity.

iii. By 2030, it is estimated that establishing a viable and sustainable primary health care system in low- and middle-income countries such as Nigeria will save at least 60 million lives and increase average life expectancy by 3.7 years (World Health Organization, 2019).

iv. Nigeria requires a robust primary health care system to stop the country's already overburdened secondary and tertiary health care systems from collapsing. The additional load placed on secondary and tertiary health institutions in Nigeria aggravates basic service delivery challenges and puts these underfunded institutions' merger resources to the limit. Thus, Nigeria's failure to establish a sustainable primary health care system meant that the country's already frail public health system would soon disintegrate.

v. The findings of this study add to the growing body of evidence that shows community-based research can help with social change efforts, like making it easier for people to get basic healthcare.

vi. By investigating the factors influencing access to primary healthcare in Benue and Lagos, we generated data that the Benue and Lagos PHC centres, as well as their respective boards and healthcare administrators, can use to build and distribute a healthcare model from the ground up that meets the expressed needs of rural Benue and Lagos residents. Additionally, private-practice healthcare practitioners could adapt

elements of the concept to improve patient care in private-practice settings. In the long run, such initiatives by healthcare providers may help to improve resident access to healthcare in Benue and Lagos, as well as contribute to the decrease in healthcare disparities.

vii. DEA is a technique of mathematical programming that enables the determination of a unit's efficiency based on its inputs and outputs, and compares it to other units involved in the analysis. Mathematical model is considered to be the goal behind the results reached by DEA performance estimation. DEA contains solutions for several mutually connected linear programming mathematical models for each of the DMUs such as PHCs and these models addresses managerial issues that provides useful results in PHCs, as well as health disciplines and concepts. Mathematics have provided models for estimating efficiencies of decision making units. The fractional linear programming is converted to Linear programming (LP) and are employed to estimate the efficiencies of a DMU and the LP formulations of the PHC estimate the efficiency of a DMU at the given scale of operations.

## 1.6 Outline of the Thesis

This research is organised into six chapters, the first of which serves as an introduction to the subject. The project's context, objectives, and a section on the study area's relevance and breadth. The second chapter conducts a literature review of significant works on health, efficiency, and data envelopment methodologies and models. The third chapter discusses the research methodology in detail. The third

chapter describes the study's methodology in detail, including model creation and data analysis methodologies. Chapters four and five are devoted to the presentation and analysis of data generated by the models and methodology outlined in Chapter three for the two state study areas of Benue and Lagos, respectively. Chapter six is the last chapter in this research. It sums up the study's findings, conclusions, and recommendations.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

The last chapter talked about how important it is for global health care systems to keep, restore, and improve the health of the world's people (Pelone et al., 2015). We x-ray the global health system and the deference from the African continent, particularly Nigeria. This chapter briefly reviews the literature on the healthcare system and various components of the data envelopment analysis. In Section 2.2, the healthcare systems of developed and developing countries, as well as that of Nigeria, were reviewed. Section 2.3 examines the existing methods used in determining efficiency in primary health care. The Malmquist productivity index, a measure that helps in estimating technical and technological changes over time, was the focus of Section 2.4. Section 2.5 discusses the DEA's cross-efficiency and game theory techniques, while Section 2.6 looks into the two-stage processes of DEA efficiency. The established gaps in the literature were pointed out in Section 2.7. A brief summary of the chapter caps off the chapter in Section 2.8.

## 2.2 Healthcare System

Every country has a healthcare system. In this aspect, some have a more complicated system than others. The majority of industrialised countries, including the United States of America, Canada, the United Kingdom, Singapore, Germany, France, and Australia invest significantly more in healthcare and make an effort to meet their citizens' basic health needs (Evans & Stoddart, 2017; OECD, 2020). On the other hand, poor and undeveloped countries face significant challenges in

providing adequate medical care to their citizens. Additionally, a country's infrastructure is critical. This indicates that the general environment, ideas, methods, fundamental structure, and government policy all contribute significantly to the delivery of health care services to patients (Wallace et al., 2016). Rural areas in the majority of developing and impoverished countries are in poor condition, and citizens lack access to fundamental infrastructure. As a result, they are unable to get proper care in the event of a medical emergency, and by the time they reach a large hospital in a major city, it is frequently too late for them.

There has been considerable debate over the last 15 years or so over global health policy in general. Global health refers to the organisations, institutions, and overall resources (financial and human) that are linked to the provision of health care services that meet the demands of the entire population (Zhang et al., 2010). It is critical to focus on low- and middle-income countries since they require external money for disease programmes, particularly for medications, and for the development of their total health infrastructure (Acharya et al., 2017). Thus, the underlying difference in healthcare delivery systems between industrialised, developing, and underdeveloped countries is in terms of resources, which include money and basic health infrastructure. The health systems of wealthy countries such as the United Kingdom, Canada, and the United States, as well as Singapore, France, and Australia, as well as those of middle-and low-income countries, will be studied.

### 2.2.1 Healthcare systems in developed countries

Since the beginning global crisis, most countries have been under tremendous pressure to reduce public spending. Health care has been largely affected by extensive austerity measures that drastically affect the living standards of poorest

social groups especially in countries with low incomes (Mitropoulos, 2021). However, the magnitude of the recession varied from country to country. Health systems performance in the different countries were affected rather differently (Thomson et al., 2015). These differences provide a unique opportunity to examine and better understand how policy-makers may efficiently use their resources.

Comparative analysis of the healthcare systems across countries is extremely useful because it increases the understanding of how each country perform relative to others and the reasons of developing different policies (Mitropoulos, 2021).

No two countries organise and deliver health care in the same way. The knowledge provided by different countries gives an opportunity to learn about various health systems.

The developed countries listed discussed below are countries that invest more in healthcare and try to address the basic health needs of their populations (Stoddart, G.L., & Evans, 2017).

#### 2.2.1.1 Canada

Canada employs a single-payer health care system. The government pays for health insurance in Canada, yet the private sector also provides a significant amount of care (Gatrell & Elliott, 2014). Insurance is administered on a province-by-province basis. Many Canadians also receive extra private insurance through their employer to cover the cost of medications, dentists, and optometrists. The government is responsible for over 70% of all healthcare expenditures. (Hutchison et al., 2011; Carter et al., 2016; Giplaye, 2019).

The government spends over 80% dollars on all healthcare. Canada spend ten percent of their GDP on the healthcare system. The quality of healthcare is also up to the mark in Canada, usually patients have to wait for extra time, and some patients had to wait more than four months for elective surgery, and that is why it proves to be an inconvenience for them. (Giplaye, 2019; Pelone et al., 2013).

#### 2.2.1.2 Britain

Britain implements a single-payer health care system. Britain's medical system is entirely socialised: the government not only finances care, but also builds the National Health Service (NHS). The overall coverage is extensive, and the majority of services are provided for free to the general public. The system is funded by the government through taxes, although there is a private system that operates alongside the public system. In this regard, nearly 10% choose private insurance ( Giplaye, 2019; Kusuma, 2021). In Britain, people have easy access to health care services, often they do not have to wait long. The outcomes of the facilities are excellent. Further, there has been a burden on National Health Services of Britain, but still, they ensure that patients do not have to wait longer ( Roland et al., 2012; Pelone et al., 2013; Giplaye, 2019).

#### 2.2.1.3 United States

The United States' healthcare system is comprised of several concepts, including: private insurance through work; single-payer Medicare, which is mostly for the elderly population aged 65 or older; state-administered Medicaid, which is available to some low-income individuals; and private insurance mandated by the Affordable Care Act. Additionally, nearly 28 million people lack insurance and

private hospitals exist (Murray et al., 2013; Squires & Anderson, 2015; Dickman et al., 2016; Emanuel, 2018; Papanicolas et al., 2018; Giplaye, 2019).

#### 2.2.1.4 Singapore

Singapore's healthcare system is unique in its approach. Primary care in the wards of the state-run hospital is reasonable and, in certain cases, free, with extra care provided in private rooms for a fee. Additionally, Singapore's working class contributes approximately 37% of their income to mandated savings accounts, which are primarily used for healthcare, education, and other social initiatives. The government assists in cost containment. Also, the government makes investment decisions on new technology. Furthermore, the government saves money on pharmaceuticals, oversees the overall number of medical students and doctors in the country, and regulates their remuneration. Singapore's overall system is cost-effective (Bai et al., 2012). In general, it is regarded that Singapore delivers relatively good care to its residents on a modest budget, while some say that quality is not uniform at all levels due to disparities in providing services to the wealthy and the less fortunate (Haseltine, 2013; Khoo et al., 2014; Tan, 2014; Tan et al., 2021).

#### 2.2.1.5 France

In comparison to many other healthcare delivery systems, the country offers a broad range of services. In this sense, everyone in France is required to purchase health insurance, which is sold by small non-profit organisations that are typically funded by taxation. 70–80% of costs are paid by public insurance in this regard. The remainder of the cost can be handled by voluntary health insurance, resulting in a significantly lower out-of-pocket expense. In France, about 95% of the population is

covered by voluntary health insurance. Budgets and funds are allocated by the Ministry of Health. These budgets and finances are used to determine the number of hospital beds and the purchase of equipment. Additionally, medical students receive training as a result of such support. The ministry establishes the fees for surgeries and medications. In general, the French system is relatively costly, accounting for 11.8 percent of the country's GDP. However, if anything is not covered, patients are responsible for the difference. Numerous physicians are self-employed and work in a variety of settings. The majority of hospitals are public. Furthermore, the government pays for 85 percent of outpatient care (Chevreul et al., 2015; Giplaye, 2019; Tikkanen et al., 2020; Eilin Stene et al., 2021).

#### 2.2.1.6 Australia

In Australia, public hospitals provide free inpatient care, which includes access to medical services and prescription medications. Additionally, a voluntary private health insurance system is in effect, providing individuals with access to private hospitals and certain services not covered by the public system. In this aspect, the government pays for over 85% of outpatient care (Adrian, 2009; Wiese et al., 2011; Nicholson et al., 2012; Giplaye, 2019).

#### 2.2.1.7 Switzerland

The country's healthcare system is universal. Everyone is required to purchase insurance. To a large extent, the plan is identical to that provided in the United States under the Affordable Care Act, which is supplied by private insurance firms at varying prices depending on factors such as the availability of specialist consultation (Wilson et al., 2016). Subsidies are available to over 30% of the

population. These plans are supplied on a purely charitable basis (Djalali et al., 2015; Pietro et al., 2015; Giplaye, 2019; Understanding Switzerland's Healthcare System: An Expat's Guide, n.d.).

#### 2.2.1.8 Germany

The vast majority of Germans, or 86% of the population, are covered by the national public health system, while others opt for voluntary private health insurance. In this regard, the majority of premiums for the public system are derived from wages and salaries paid by employees and employers. Subsidies are available for the amount, but there is a $65,000 income ceiling (Nikoloski & Mossialos, 2013). Patients have a plethora of options for doctors and hospitals, and the overall cost sharing is not prohibitively high. The cap is intended for low-income individuals and is reduced for those who have a serious ailment or chronic condition. Furthermore, there is no government subsidy for private health insurance; however, the government regulates premiums, which can be quite high for people with pre-existing conditions. Numerous physicians' work in a fee-for-service setting with varying charges. There are some restrictions on the amount they can be paid annually in this regard (Wahner-Roedler et al., 1997; Giplaye, 2019; Blümel et al., 2020; OECD, 2020, 2021).

#### 2.2.1.9 Basic characteristics of developed countries

From the attributes of the healthcare systems from the various countries above, the four primary features of these developed countries are as follows:

i. They provide universal coverage and remove financial barriers, allowing people to receive treatment when and how they need it.

ii. They invest in primary care systems to make sure that high-quality services are available to all residents in all communities, which reduces the chance of discrimination and unequal treatment for people in different communities.

iii. They alleviate administrative burdens on patients and doctors, which consume valuable time and effort and might impede access to care, particularly for disadvantaged minorities.

iv. They spend money on social services that make it easier for everyone to get food, education, child care, community safety, housing, transportation, and employee benefits, which leads to a healthier population and less needless health care (Schneider et al., 2021).

### 2.2.2 Healthcare systems in developing countries

Primary healthcare (PHC) has become a very important way to improve the health of the general population and the effectiveness, responsiveness, and quality of healthcare systems in recent years.

Despite this increased emphasis on PHC's relevance, PHC systems generally, and particularly in low-and middle-income countries (LMIC), perform poorly. To attain the SDGs and achieve UHC, significant improvements in PHC systems and service delivery are required. This is because the current state of PHC research in low- and middle-income countries isn't organized, doesn't have a lot of money to spend on it, and doesn't have a lot of attention paid to it (Bitton et al., 2019).

Recent investigations have highlighted the shortcomings of low-and middle-income countries' healthcare systems. In the 75 countries that account for more than

95% of maternal and child deaths, for example, the median proportion of births attended by a skilled health worker is only 62 percent (range, 10 to 100 percent), and women without money or insurance are much less likely to receive this service than women with the means to pay (WHO, 2010). Due to a lack of financial protection for the expense of health care, roughly 100 million individuals are pushed below the poverty line each year by health care costs (Health systems financing, WHO, 2010), and many more will forego care due to a lack of funds.

Several countries and their development partners have been trying out new ways to pay for, plan, and deliver health care because of these systemic problems. In 2001, the World Health Organization's Commission on Macroeconomics and Health came up with a way to classify problems with the health care system. This framework has been used a lot since then. In low- and middle-income nations, a major source of concern is a lack of financial aid for those in need of health care, which discourages service utilisation and drains household resources.

When social (public) health insurance and pre-paid private insurance are combined, only 38% of health care financing in low- and middle-income countries is consolidated into risk-sharing funding pools. This compares to 60% in middle-income countries and 80% in high-income countries, which have more risk-sharing funding pools. Many people in low- and middle-income nations cannot afford health care on their own or through insurance, meaning that progress toward improved financial protection will be modest. Table 2.1 below summarises some of the observable limits prevalent in low- and middle-income nations.