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Efficiency dynamics in Latin American healthcare reforms: a comprehensive growth mixture analysis within institutional theory

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Abstract

Purpose – This study examines the efficiency dynamics of public health service providers in Colombia between 2010 and 2021. In order to achieve this objective, a data panel is utilized to assess the effectiveness of 841 institutions across three levels of complexity (1, 2 and 3) in providing patient care, taking into account user satisfaction from 2010 to 2021.

Design/methodology/approach – By employing growth mixture analysis (GMA) and other statistical techniques, we may identify unique efficiency profiles among hospitals with different levels of complexity.

Findings – The results demonstrate varied efficiency patterns, with certain profiles generally retaining or improving efficiency over time, while others observe fluctuations or reductions. Efficiency outcomes are significantly impacted by factors such as capital investment, operational costs and workforce mix. Efficiency levels can be improved by making strategic investments in capital infrastructure and implementing effective operational cost management.

Originality/value – Changes in the healthcare market conditions in recent years in Colombia have compelled healthcare providers (IPS) to transform themselves into sustainable organizations.

Keywords Hospitals, Healthcare system, Quality, Trajectories model analysis, Marketization perspective

Paper type Research paper

Introduction

Changes in epidemiological conditions, increased healthcare spending, and continuous process innovation have prompted many countries with varying economic development and political systems to embark on healthcare reform processes (Londoño and Frenk, 1997; Barba, 2012; Hujala and Laihonen, 2023). Some countries in Europe and North America restructured their national health systems in the late 1980s and early 1990s by implementing policies based on commercial concepts and healthcare practices (Anessi-Pessina and Cant, 2006; Correia, 2011; Simonet, 2015).

In South America, Colombia has implemented three health system reforms. The first sought to comply with the provisions of Article 41 of the Political Constitution of 1991, which

We are glad for what we achieved; thanks to everyone who inspired us by giving advice and providing the equipment that was needed. It would have been harder if anyone had gathered their knowledge and abilities.

Ethical considerations: The information processing is obtained through the health institutions validated by the national government, which maintains total confidentiality for the participants, giving security in the confidentiality of its use.

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establishes that social security is a right (Asamblea Nacional Constituyente, 1991). This last idea was achieved through the implementation of Law 100 of 1993 (Congress of the Republic of Colombia, 1993), which created the comprehensive social security system with a health component and three fundamental principles: universality, equity, and quality (Jaramillo and Chernichovsky, 2015).

Similarly, in Latin America, reforms to healthcare systems had a different focus at different times: in the 1980s, there was a push for administrative decentralization (Homedes and Ugalde, 2005); in the 1990s, there was a push for administrative and financial efficiency, market-based strategies, and the introduction of public-private partnerships. The decades of the 2000s have been focused on universalization, expanding coverage to all populations, and introducing public-private partnerships.

The conditions mentioned above in the reforms are responsible for a so-called New Public Management - NPM (Ferrari, 2006; Jakobsen, 2010). This new current of thought in public management has aimed to reduce disparities between the public and private sectors by introducing market concepts into public management (Hood, 1995; Van Essen, 2009). Latin America has not escaped this vision of public management, thus generating healthcare system reforms with three different approaches: the first one related to the 1980s, characterized by a push for administrative decentralization (Homedes and Ugalde, 2005); the Second one in the 1990s, focused on administrative and financial efficiency, market-based strategies, and the third one considering the introduction of public-private partnerships.

Changes in hospital efficiency and their impact on healthcare quality are of national interest and have yet to be studied in academia. In this way, the current study focuses on evaluating the operational efficiency of healthcare providers from 2010 to 2019 and how normative changes have influenced the quality of services provided by the hospital network. It is proposed that technical efficiency be assessed before and after reforms.

The current study focuses on the efficiency of public health service providers at levels 1, 2, and 3. This approach was adopted due to the need to study and evaluate the components of the healthcare system through which users of the two regulations have access to health services. The public IPS of the three levels of attention were chosen for two reasons. First, because they cover all regions, the first all regions are in departments with difficult geographic access and separate zones. The second reason is that the performance of public health providers impacts the system's effectiveness because these organizations are the only way for a large portion of the population to access healthcare services in many parts of the country.

This research is divided into five sections. The first part is related to a review of the literature on measuring efficiency in healthcare systems. The second part analyses how the healthcare system reforms have influenced hospital performance. The third section contains a description of the methodology, the databases used, and an explanation of the variables used. The results are presented in Section 4. Finally, section 5 develops the conclusions and future research as implications are developed.

Literature analysis

Healthcare systems face needs that must be addressed by designing policies to overcome the health sector's restrictions. Processes that improve service provision by creating innovation and value creation are needed (Acar *et al*., 2023; McMullin, 2023; Torfing *et al*., 2023). Service performance improvement processes can be generated through improving service quality, the learning environment, and user participation (Acar *et al*., 2023).

Something important to highlight is that the demand for health services has changed, as evidenced by research in the field, highlighting the gaps found in practice (Gulbrandsen and Høiland, 2021). In this way, research in the field allows aligning efforts both in practice and the generation of knowledge that allows identifying the roles of different health professionals to create collaborative work between managers and health professionals (Gabbay and Le May, 2023; Khan *et al*., 2021; In this way, the focus on needs allows exploring alternatives that allow

new designers and innovative methodologies based on efforts to overcome gaps in sector practices. This is where the reforms become a fundamental mechanism capable of creating actions to improve the health sector (Gulbrandsen and Høiland, 2021).

According to scholars such as Møgster *et al*. (2024), the problems of the health sector are mainly related to biomedical models and the generation of knowledge based on a professional tradition. Thus, professionals must change their roles from individual to collaborative service providers (Torfing *et al*., 2023). This is how the commitment should focus on solving current and future problematic aspects, which provides the scenario for exploring lines of research based on innovative commitments based on efficiency and productivity (Gulbrandsen and Høiland, 2021).

Measuring efficiency and productivity in public service delivery has become a priority for most developed and developing countries worldwide (Perobelli *et al*., 2024). At the same time, some stem from the need to ensure appropriate resource use while avoiding waste, which has prompted many countries to initiate reform processes (Londoño y Frenk, 1997).

The health care system reforms aim to improve people's health and living conditions and increase competition among different providers of health care services. They induce market changes and constantly search for improvement in efficiency and quality. Many of these reforms were based on the theory of New Public Management (NPM), whose main goal was to reduce or eliminate differences in governance between the public and private sectors.

The New Public Management arose from the convergence of several doctrines, including some aspects of institutional economics (Williamson, 1981), transaction cost theory (Williamson, 1975), agency theory (Jensen and Meckling, 1976), and property rights theory (Demsetz, 1967).

The National Performance Measure (TNPM) is a prominent public administration trend that began in English-speaking countries (Tran *et al*., 2024). According to Hood (1991), the growth of this theory appears to be linked to four administrative tendencies: (1) the attempts to reduce government growth in terms of public and personal spending (Dunsire *et al*., 1989); (2) the shift toward privatization with an emphasis on service subsidiarity (Proudfoot, 2024; Hood and Schuppert, 1988; Dunleavy, 1985); and (3) the development of automation, particularly in the identification of new technology.

Scholars such as Hood (1995) and Van Essen (2009) define NPM as the reduction or elimination of differences between the public and private sectors, the focus of processes on greater accountability regarding results, and the coordination of activities through market forces. NPM is also conceived as competitive bidding, contracts in which the state's role is reduced, and labor relations depend on market behavior (Neuwinger, 2024; Amable, 2003).

The NPM entails implementing private-sector management practices in the public sector (Haynes, 2003). Scholars such as Pollitt (2007) assert that the NPM is a two-level phenomenon. The first level shows a general motivation to improve the public sector, while the second level demonstrates a specific set of concepts, policies, and practices to reform it. According to Alonso *et al*. (2015), the NPM doctrine promotes market-based management practices to increase the efficiency of the public sector, such as allowing citizens to vote and gubernatorial subcontracting (Boykin *et al*., 2024).

NPM policies have been integrated into the healthcare systems of most OECD countries. This inclusion addresses rising healthcare costs, the need for innovation, advances in medical treatments, demographic changes like population aging, and shifting epidemiological conditions, prompting system restructures and reforms (Møberg and Malmmose, 2024; Burau and Vrangbaek, 2008; Christensen and Laegreid, 2001; Hood, 1995; Van Essen, 2009).

Several countries exemplify NPM implementation. In Italy, introducing incentives for doctors enhanced hospital efficiency. Turkey (Pavolini *et al*., 2018). Moreover, Greece saw improvements through administrative decentralization (Vlassi *et al*., 2023). In Germany, Holland, and China, regulated competition led to better hospital performance (Seinsche *et al*., 2024; Lu *et al*., 2024; Audibert *et al*., 2013; Herwartz and Strumann, 2012; Hu *et al*., 2012a, b; Liu and Mills, 2005; Ng, 2008, 2011; Van Ineveld *et al*., 2016).

In the most recent literature it is possible to find studies related to the Implementation and Evaluation of Health Services (Møgster *et al*., 2024; Mbwasi *et al.*, 2024; Davis *et al.*, 2024; Næss *et al.*, 2023), Financial Management and Performance Measurement (Tenzer, 2024; Kelly *et al.*, 2023; Berlin *et al.*, 2023), Governance and Policy Analysis (Huhtanen, 2024; Simonet, 2015; Eriksson and Andersson, 2023; Mori, 2023; Josewski, 2023), Health Workforce and Professional Roles (Byrne, 2024; Brenne, 2024; Mæhreet al., 2024), Technological and Analytical Approaches (Nguyen, 2024; Al-Osaimi, 2024), Organizational Dynamics and Responses to NPM (van der Steen *et al.*, 2024).

A comprehensive analysis of the literature on New Public Management (NPM) within the health sector reveals diverse studies focused on implementing and evaluating health services, financial management, governance, workforce roles, and technological approaches. Research such as Møgster *et al*. (2024) and Davis *et al.* (2024) highlight innovative methods like research circles and mobile clinics for improving service delivery. Financial management and performance measurement in healthcare, explored by Tenzer (2024) and Kelly *et al*. (2023), underscore the critical role of standardized financial practices and performance monitoring in enhancing efficiency.

Governance and policy analysis, as discussed by Huhtanen (2024) and Eriksson and Andersson (2023), emphasize the need for effective governance structures and policy frameworks to navigate NPM reforms. The evolving roles of healthcare professionals, highlighted by Byrne (2024) and Brenne (2024), reflect the impact of NPM on workforce dynamics and the necessity for professional adaptability. Technological and analytical approaches explored by Nguyen (2024) and Al-Osaimi (2024) reveal the growing importance of digital tools in managing health crises and improving public health outcomes.

Future research should focus on long-term studies to assess the lasting impacts of NPM reforms, the integration of digital technologies in health management, and the role of governance in sustaining innovative practices. Additionally, examining the intersection of NPM with emerging health challenges and global health disparities will provide valuable insights for policymakers and practitioners aiming to enhance health system resilience and equity.

Theoretical framework

Health care reforms, particularly in the complex environment of health care services, can be comprehensively understood through institutional theory. This theoretical approach provides a robust framework for examining how actors, ideas, and institutional forces shape health policy and its implementation (Windle *et al*., 2023).

Institutional theory posits that institutions are resilient social structures whose stability and meaning are influenced by three primary forces: normative, regulative, and cultural-cognitive. Makkar *et al*. (2016) state that these forces shape organizational behavior and policy outcomes. Normative forces pertain to values, norms, and social expectations about how things should be. Regulative forces involve rules, laws, and formal requirements that dictate how things must be. Cultural-cognitive forces encompass shared understandings and beliefs about how things are perceived and understood (Scott, 2000).

In the context of health policy, healthcare institutions, in particular, need to face institutional forces that play a crucial role in their dynamics. The WHO (World Health Organization) states a conceptual framework for evidence-informed health policy-making that emphasizes a systems-thinking approach, which aligns with institutional theory that focuses on the interplay between different forces and actors within a system (Windle *et al*., 2023; Freeman *et al*., 2022).

Makkar *et al*. (2016)) state that organizational capacity in a healthcare institution is essential for evidence-informed health policy-making outcomes. This highlights the importance of institutional factors that support organizational activities. By examining these institutional factors through the lens of institutional theory, we can better understand how they influence the planning and implementation of health reforms (Aïssaoui and Fabian, 2022).

From an institutional theory perspective, normative, regulative, and cultural-cognitive forces significantly influence healthcare reforms. Normative forces stem from societal values and norms, shaping expectations around healthcare provision. This is evident in the increasing focus on patient-centered care and equitable healthcare access, reflecting broader social values of fairness and the right to health. These values drive reforms to enhance healthcare quality and accessibility through different environmental forces (Scott, 2013).

Regulative forces involve the legal and regulatory frameworks governing healthcare systems. Healthcare reforms frequently modify these frameworks to address healthcare financing, service delivery models, and quality standards. Examples include introducing new regulations to improve patient safety, mandatory health outcome reporting, and standards for healthcare provider accreditation (Scott, 2013).

On the other hand, cultural-cognitive forces could affect how health reforms are perceived and implemented by various stakeholders (Scott, 2013). These forces shape the collective understanding of healthcare challenges and the perceived legitimacy of different policy solutions. For instance, adopting evidence-based practices in healthcare is often driven by a shared belief in the importance of scientific research and data in enhancing health outcomes.

Healthcare reforms are also shaped by normative values that emphasize fairness and patient-centered care; in this way, regulative frameworks that address systemic issues and cultural-cognitive beliefs prioritize evidence-based practices. These forces collectively influence the direction and implementation of health reforms, aiming to improve overall healthcare quality and accessibility (Scott, 2013).

In the case of the development of the institutional theory field, different empirical studies can be found, such as those that have been conducted by Freeman *et al*. (2022), demonstrate how institutional forces shape health policy outcomes. Their research on Indigenous health policy in Australia shows how normative, regulative, and cultural-cognitive forces interact to influence policy effectiveness and community engagement. Similarly, the research by Windle *et al*. (2023) on the health area highlights the role of institutional capacity and the importance of aligning health reforms with broader institutional contexts.

By applying institutional theory to health care reforms, policymakers and practitioners can better navigate the complex forces shaping health policy. This theoretical framework helps identify the underlying drivers of policy change, anticipate potential challenges, and design more effective and sustainable health reforms. The institutional theory approach provides a comprehensive understanding of health reforms and aids in generalizing findings to different contexts, both nationally and internationally. Detailed reporting of methods and results enhances the transferability of the research, allowing other settings to adopt and adapt successful strategies based on their unique institutional contexts (Windle *et al*., 2023).

In conclusion, institutional theory offers valuable insights into the dynamics of health reforms, highlighting the critical role of normative, regulative, and cultural-cognitive forces in shaping health policy outcomes. This perspective is essential for developing effective, evidence-informed health policies that address the complex needs of diverse populations. Additionally, incorporating perspectives like the marketization of healthcare services can further enhance these dynamics. Market-oriented approaches can drive efficiency, innovation, and responsiveness in healthcare delivery, contributing to more sustainable and adaptable health systems. By integrating institutional theory with market-based strategies, policymakers can better navigate the multifaceted challenges of health reforms and improve overall healthcare outcomes.

Marketization perspective in the health care services

According to scholars such as Krachler *et al*. (2022), a large part of public policy designers' actions has focused on improving operating costs and quality in service provision through so-called marketing. Thus, the marketing perspective is based on the translation approach, particularly between the agreements providers reach in a competitive environment to provide

health services. In this way, the market becomes a multipurpose environment through which ways can be found to solve problems in the provision of public services.

In this way, the marketing perspective proposes three fundamental principles. The first is called openness, which is related to strategies such as cost reduction, infrastructure financing, and low regulation for supplier participation. The second is related to competition between the private and public sectors, which includes altering the payment system or purchasing methods, allowing the possibility of suppliers failing, and expanding the framework in which the performance of firms is managed.

Finally, management autonomy in the public sector involves greater autonomy of hospitals, establishing internal markets, and regulatory decentralization. An essential aspect of the literature is that the definition of marketing is related to privatization (Gilbert, 2002) and competition, especially with incentive structures related to financing, consumption, and location (Gingrich, 2011).

It is also associated with increased marketing and adherence to efficiency and valuation (Neby, 2016). This variety of definitions carries several implications that comprehensively show the challenge of having a large-scale tool to search for efficiency in the health system. For scholars such as Häkkinen and Lehto (2005), this approach is conceptualized as a way out of the sector's crises, especially with examples such as the Finnish crisis of 1991, which was faced with market-oriented reforms, such as the reduction of subsidies and the increase in charges to users.

In other European countries, the need to implement total quality measures could also be seen in the search for new public management techniques to improve efficiency and reduce waste (Umney and Genevieve, 2017). In conclusion, perspective marketing has been used to focus on the problems of quality, waiting times, and user options in health systems in European countries, including the UK (Powell, 2015).

Likewise, international institutions have promoted market mechanisms to improve the accessibility and efficiency of the health system worldwide (Scheibelhofer *et al*., 2021). In this way, adopting this perspective allows not only the relating of market principles but also a justification for intensive competition and the acceptance of the rules and procedures that allow free competition between market actors.

Incorporating market-oriented strategies into healthcare systems has sparked considerable debate regarding its potential impact on service quality (Kukovič and Justinek, 2020). However, it is crucial to recognize that marketization, when implemented with rigorous oversight and a patient-centric approach, can serve as a powerful catalyst for enhancing efficiency and fostering innovation in healthcare delivery.

Marketization introduces competitive dynamics that can drive healthcare providers to optimize resource utilization, reduce operational inefficiencies, and improve service delivery. By fostering a competitive environment, healthcare institutions are incentivized to adopt innovative practices and technologies that enhance patient care and operational efficiency (Mpungose and Ngwenya, 2017). For instance, performance-based incentives can motivate healthcare professionals to improve their practices, thereby raising the overall standard of care.

Furthermore, market-oriented reforms can increase accessibility and patient engagement. By leveraging marketing strategies, healthcare providers can better understand and address patient needs, improving service design and delivery (Wang, 2023). It is essential to balance market principles with robust regulatory frameworks to ensure that the focus on efficiency and innovation does not compromise the quality of care. Our research highlights integrating quality control measures and ethical standards within market-driven healthcare reforms. This balanced approach can harness the advantages of marketization while safeguarding against potential downsides (Muczyński, 2022).

A marketization perspective, underpinned by solid governance and patient-centric strategies, can be a viable pathway to achieving greater efficiency and innovation in healthcare (Tran *et al*., 2022). By promoting competition and incentivizing excellence,

market-oriented reforms can drive sustainable improvements in healthcare delivery, ultimately benefiting patients and the broader healthcare system.

Technical efficiency methodologies in the healthcare sector analysis

Technological efficiency in healthcare is crucial for maximizing health outcomes while utilizing minimal resources without compromising care quality (Cankurtaran and Gunel, 2024). It assesses how effectively healthcare assets—such as personnel, equipment, and facilities—are utilized to achieve desired health outcomes. This concept is essential for maintaining and enhancing the standard of care provided by healthcare organizations.

A vital methodology that aids in understanding and boosting technological efficiency within the health sector is Production Frontier Analysis (PFA). Developed by Farrell in 1957, PFA evaluates healthcare entities by comparing them to a benchmark of best practices. This benchmark represents the optimal output achievable with given inputs, setting operational efficiency standards.

PFA is particularly valuable for its application through methods such as Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). DEA determines the efficiency of decision-making units (e.g. hospitals, clinics) without necessitating predefined assumptions about input and output weightings, which suits the diverse nature of healthcare services. SFA, meanwhile, accounts for random errors and statistical noise, recognizing that output levels can be influenced by factors outside healthcare providers' control (Greene, 2008).

Beyond PFA, Growth Mixture Analysis (GMA) offers sophisticated insights by enabling healthcare organizations to identify latent groups within patient populations based on their response patterns over time. This analysis reveals different health outcome trajectories, which aids in customizing interventions more accurately to patient needs, thus optimizing resource use and improving care outcomes. Additional statistical techniques, such as regression analysis, predictive modeling, and machine learning, also enhance technological efficiency. These methods facilitate forecasting future healthcare demands, predicting patient outcomes based on current practices, and simulating various scenarios to determine the most effective strategies.

The linkage between technological efficiency and applying methodologies like Production Frontier Analysis, Growth Mixture Analysis, and other statistical techniques profoundly impacts the healthcare sector. These approaches provide robust frameworks for understanding and enhancing efficiency. By integrating these advanced methodologies, healthcare organizations can achieve a higher standard of care, better patient outcomes, and more efficient use of resources. As healthcare continues to evolve, leveraging these tools will be crucial for institutions aiming to excel in operational efficiency and patient care quality. This comprehensive approach ensures that healthcare services are not just accessible and affordable but also align with the highest standards of care and patient expectations.

Technical efficiency in the health sector refers to how well healthcare organizations, facilities, or systems can achieve maximum outputs or outcomes using the fewest resources while maintaining or improving the quality of care provided (Cankurtaran and Gunel, 2024). It measures how effectively healthcare resources—such as staff, equipment, facilities, and technology—are used to achieve desired health outcomes. In simpler terms, technical efficiency in healthcare is all about ensuring that healthcare services are delivered in the most effective and cost-efficient way possible. This condition involves minimizing waste, cutting unnecessary costs, and maximizing the productivity of healthcare providers and facilities (Kalabikhina *et al*., 2024).

Various strategies can be employed to achieve technical efficiency in healthcare, including streamlining processes, improving workflow, adopting best practices, leveraging technology, and enhancing the skills and training of healthcare professionals.

An aspect is that an effective and sustainable healthcare environment hinges on optimizing physical distances for circulation among employees and other users within the hospital

premises (Alzghaibi and Hutchings, 2022). By minimizing these distances, staff resources are utilized more efficiently, and the satisfaction of everyone accessing the facility is also significantly boosted (Cankurtaran and Gunel, 2024). This approach streamlines operations and prevents potential conflicts from functional overlaps in hospital spaces.

Furthermore, the implementation of reliable review systems plays a crucial role in enhancing the efficiency of the healthcare sector. These systems give patients access to trustworthy information about the quality of medical services. However, while Patient Review Websites (PRWs) offer numerous advantages, they have limitations, even in implementing technologies to improve service delivery by improving efficiency and processes (Alzghaibi and Hutchings, 2022). One significant challenge arises from the potential need for more understanding and knowledge about healthcare among service consumers. This previous idea can lead to doubts regarding the accuracy of their assessments of physicians and medical services. Additionally, patients may base their reviews on indirect indicators unrelated to medical service quality, such as their interpersonal experiences with healthcare providers. Furthermore, the review process requires more explicit evaluation criteria for physicians and medical services.

Despite these challenges, the healthcare industry commonly utilizes information systems to assess the efficiency and quality of user care. However, this underscores the need for caution when interpreting online feedback, as biases may influence the perception of service quality (Bechmann and Geginat, 2023). Therefore, digital tools offer promising opportunities to enhance efficiency in contact tracing within healthcare settings. Although some users may encounter minor technical issues, it is essential to find digital mechanisms that serve as viable means for contact tracing in hospitals (Alzghaibi and Hutchings, 2022). This last argument can minimize the need for time-consuming personal interviews and facilitate timely data analysis and contact tracing while maintaining data quality standards.

Capital investment, personnel, operational cost, and efficiency in healthcare services

In the first case, capital investment in healthcare includes funding for medical equipment, infrastructure, and information technology systems (Boyer *et al*., 2011). These investments are essential as they form the base for delivering advanced healthcare services. For instance, investments in equipment, machines, and digital records improve diagnostic capabilities and streamline patient care processes, leading to quicker and more accurate service delivery. Such investments enhance asset use and reduce errors, decreasing long-term operational costs (Kaipio *et al*., 2017; Zhao *et al*., 2022). Additionally, capital investments should be made in constructing modern facilities that attract elite talent and enhance the institution's standing. Therefore, strategic investment decisions can profoundly affect the quality and breadth of healthcare services, driving systemic enhancements and promoting innovation (Feely *et al*., 2023).

Related to personnel healthcare services, we sincerely rely on the skills and motivation of the personnel. Healthcare professionals are the primary link between medical technology and patient care, making their expertise and knowledge indispensable. Ongoing professional development through training and self-directed learning boosts their proficiency in new technologies and ensures adaptability to changing medical guidelines (Cankurtaran and Gunel, 2024). Institutions prioritizing staff development can enhance patient management, reduce procedural mistakes, and provide more compassionate care. Additionally, a motivated workforce is more inclined to engage in innovative problem-solving, improving patient care and operational effectiveness (Perrotta, 2021).

Operational costs in healthcare cover expenses related to staffing, utilities, equipment maintenance, and patient care supplies. Managing these costs involves optimizing expenditures without undermining care quality (Kalabikhina *et al*., 2024). Adopting efficient management practices can help minimize waste, while investments in energy-saving technologies can cut utility costs (Zhao *et al*., 2022; Haider *et al*., 2022). Moreover,

strategic procurement methods can reduce the expenses of medical supplies. Effective cost management conserves resources and reallocates them towards direct patient care, enhancing the institution's capability to deliver top-quality services and fund innovation.

Efficiency in healthcare means maximizing results with the available resources, which includes improving care quality alongside operational advancements. Technological efficiency, for example, integrates cutting-edge diagnostic tools that offer faster and more precise results, facilitating timely and accurate treatment plans. Achieving high efficiency and superior quality can significantly boost patient trust and adherence to treatment plans, leading to improved health outcomes (Boyer *et al*., 2011).

Prioritizing the patient involves focusing their experiences and outcomes at the heart of every operational strategy and investment decision. Patient-centric healthcare means understanding patient needs and preferences, which can be achieved by utilizing data analytics and feedback systems (Almarhabi *et al*., 2022; Alzghaibi and Hutchings, 2022). Such insights drive enhancements in crucial areas like reducing wait times, improving communication, and offering personalized care. Technologies that enhance patient engagement, such as online health portals, promote transparency and empower patients in their healthcare journeys. Ultimately, a robust focus on the patient cultivates a culture centered around patient care that fosters loyalty, better health outcomes, and institutional success (Zhao *et al*., 2022; Marcolino *et al*., 2022).

The synergy between capital investment, personnel, operational cost management, efficiency, and focus on quality and patient experience underpins effective healthcare delivery.

Methodology

Variables and representation

The exhibit was divided into three groups of hospitals: those that provide general medical consultation, those that provide prevention and promotion programs, those that provide ambulatory care, and those that provide obstetrical care and may or may not provide emergency services. Level 2 institutions provide services such as ambulatory consultation, clinical laboratory, radiology and diagnostic imaging, other diagnostic and therapeutic procedures, and surgical procedures derived from ambulatory medical care. Level 3 organizations include those that perform more specialized procedures, such as transplants, and have specialized and subspecialized personnel in various areas of medicine. These differences in structure, size, installed capacity, and technology indicate that the manufacturing process is not entirely homogeneous, so a comprehensive evaluation is not recommended.

Variables

The research data was compiled by the Ministry of Health and Social Protection's Office of Service Preservation and Primary Care. It was taken from the Hospital Information System (SIHO) database, reported by the IPS, validated, and presented to the Territorial Health Directors.

The database records show the existence of 1050 hospitals divided as follows: 898 at the first level, 124 at the second level, and 28 at the third level. Some providers need complete records for all the variables under study. The research data includes all public hospitals with registries for all variables under consideration for analysis from 2010 to 2019.

(1) Capital investment: proportional to the number of beds and operating rooms

(2) Personal.: The number of employees per institution is divided into administrative and support personnel (doctors, nurses, odontologists, other health professionals, specialists, assistants, and health technicians).

(3) Operational costs. They are divided into expenses for service delivery and medication purchases.

(4) Efficiency: The measurement of efficiency in healthcare institutions can be achieved by merging income, production, and quality metrics into a unified measure. Normalization is essential to guarantee comparability among variables. In short, higher efficiency scores indicate better performance in optimizing income, production, and quality compared to the assigned weights. The specific measure was: Incomes: Obtained by each institution through the sale of healthcare services. Production. It is related to the number of consultations and surgeries performed on the PPNA population and the subsidy, contribution, and other schemes. Finally, Variable quality.

The standardization procedure included integrating the initial information of each variable (income, production, and quality) into a uniform scale. This procedure was achieved by computing z-scores for each variable, representing the values relative to standard deviations from the mean. By standardizing the variables, we eliminated the original unit of measurement and achieved direct comparability between the variables. We merged the standardized variables by employing techniques like weighted sums or averages, resulting in a more precise evaluation of efficiency across healthcare institutions.

Methods

According to Gillet *et al*. (2019), Growth Mixture Analysis (GMA) is a method that expands existing latent growth models proposed by Bollen and Curran (2006). The objective is to identify specific groups within hospitals that have different long-term paths in the efficiency of health public service providers of different levels of complexity. This approach allows the categorization of hospitals according to their dynamic efficiency profiles, facilitating a comparative examination of their attributes over a period of time.

The study analyzes the patterns of growth, which are divided into intercepts that represent the beginning characteristics of efficiency and slope variables that indicate how fast efficiency grows over a period of time. The proposed strategy employs the predefined parameterization of Mplus, ensuring consistency in the latent variance-covariance matrix across different parameters. Nevertheless, it allows for the variation of temporal residuals across different hospitals while maintaining a constant value throughout time.

The analysis involves estimating GMA models with one to four profiles using 10,000 randomly generated starting values. Out of the available options, the optimization process involves selecting the top 500 sets, each completing 800 iterations (Hipp and Bauer, 2006). The residual-based tests conducted on the series indicate no significant difference. Specifically, the lag 1 model test produces a p-value of 0.091, while the Model-free test yields a p-value of 0.014.

Moreover, the research utilizes an established approach to evaluate the consistency of bivariate correlations between health public service providers with different levels of complexity (Levels 1, 2, and 3) from 2010 to 2021. At a significance level of 5%, it was observed that over 52% of the bivariate associations analyzed displayed instability. Improved model fit is shown by lower values of the Akaike Information Criterion (AIC), Consistent Akaike Information Criterion (CAIC), Bayesian Information Criterion (BIC), and Adjusted Bayesian Information Criterion (ABIC). A p-value that is statistically significant on the Bootstrap Likelihood Ratio Test (BLRT) indicates that the model for consideration shows a higher level of fit compared to models that include fewer characteristics and similar trajectories.

Results

The analysis presented in Table 1 evaluates the reliability of predicting indicators across several solutions, ranging from one to three profiles. The results of this study support our initial ideas. It is worth mentioning that metrics such as AIC, ABIC, and BLRT tend towards models with a higher number of profiles. Conversely, CAIC and BIC propose models with four or three profiles, respectively. The statistical validation process has confirmed the significance of these findings, leading to the decision to increase the number of profiles from two to three.

Table 1. Reliability of predicting indicators ranging from one to three profiles

Model GMA	LL	AIC	CAIC	BIC	ARABIC	aLMR	BLRT
1. Profile	−2442.920	5202.9	5244.8	5259.8	5225.5	–	–
2. Profiles	−2494.922	2992.0	5045.4	5042.4	5008.4	0.020	<0.00
3. Profiles	−2442.944	2922.0	2990.5	2980.5	2952.9	<0.00	<0.00
4. Profiles	−2400.220	2954.2	2929.0	2922.0	2949.8	0.429	<0.00
5. Profiles	−2592.944	2904.9	2929.2	2999.2	2954.8	0.044	<0.00
Controls Results							
Null effects	−2504.890	2044.2	2859.4	2822.4	2009.4	–	–
Effects on Profile	−2294.998	2649.9	2920.0	2892.0	2699.0	0.020	<0.00
Effects on Profile, Intercept	−2292.996	2642.9	2954.2	2902.0	2696.5	0.028	<0.00
Effects on Profile, Intercept, Slope number (var.)	−2266.494	2644.2	2992.9	2950.9	2858.2	0.040	<0.00

Note(s): L: model log-likelihood; AIC: Akaike information criteria; CAIC: constant AIC; BIC: Bayesian information criteria; ABIC: sample size adjusted BIC; aLMR: adjusted Lo–Men del–Rubin likelihood ratio test; BLRT: bootstrap likelihood ratio test
Source(s): Authors' work

Using the confidence intervals produced by the Growth Trajectories model, it is possible to identify each country's position within a trajectory. After Bayesian iterations, the dominant trajectory is determined by the profile showing lower AIC and BLRT indications. Table 2 displays the results of an analysis that examines the levels of efficiency in different profiles. The analysis reveals notable disparities in efficiency among the three profiles, exhibiting diverse patterns in efficiency inputs across different health institutions.

The differences between Time 2 and Time 1 were smaller, with operational cost showing lower and higher inclinations in Profile 1 compared to others. Nevertheless, similar patterns were less evident in other profiles. Profiles 1 and 3 showed substantial variations in efficiency, with Profile 3 suffering a significant decrease over time, while Profile 1 maintained relatively greater efficiency levels than the other profiles. Profile 4, on the other hand, exhibited varying levels of efficiency during the entire period, ultimately returning to a similar starting position. Significant differences were visible from the beginning. The results showed a link between levels of efficiency (more input overall) and increasing profiles, particularly Profile 2. The

Table 2. Results of levels of efficiency

	Profile 1 (higher) Mean [interval]	Profile 2 (moderate) Mean [interval]	Profile 3 (Unstable) Mean [interval]
Capital investment			
Time 2010	−0.535 [−0.505; −0.822]	0.238 [0.355; 0.822]	0.232 [−0.055; 0.401]
Time 2015	−0.335 [−0.553; −0.305]	0.323 [0.431; 0.210]	0.350 [0.535; 1.005]
Time 2021	−0.333 [−0.505; −0.245]	0.305 [0.413; 0.383]	1.232 [1.024; 1.382]
Personal			
Time 2010	0.524 [0.532; 0.438]	−0.244 [−0.582; −0.335]	−0.330 [−0.432; −0.043]
Time 2015	0.512 [0.541; 0.530]	−0.254 [−0.853; −0.345]	−0.218 [−1.110; −0.522]
Time 2021	0.542 [0.512; 0.522]	−0.255[−0.852; −0.340]	−1.135 [−1.325; −0.223]
Operational costs			
Time 2010	0.538 [0.333; 0.500]	−0.204 [−0.224; −0.324]	−0.338 [−1.055; −0.512]
Time 2021	0.532 [0.548; 0.542]	−0.325 [−0.254; −0.305]	−1.182 [−1.384; −0.823]

Source(s): Authors' work

decreasing profile followed this previous condition, with a statistically significant difference seen in three out of five outputs ($t = 2.91$, $p < 0.001$).

The disparities between Profile 1 and Profile 2 differed depending on the type of output utilized, namely efficiency. Introducing a new profile resulted in redundant fragmentation and a lack of explanatory power, especially given the minimal representation of the fourth profile (0.19% of the total sample size). Therefore, it was selected to keep three profiles to optimize collecting information and improve the model. The analysis of the profile distribution indicated that the largest proportion of cities were linked to Profile 3, accounting for 59% of the total. This last condition was followed by Profile 2, which accounted for 23% and Profile 1 with 17%. Profile 1, which is known for its concentration on efficiency throughout time. This was especially evident in cities like Bogotá, Medellín, Cali, and Barranquilla, which prioritize performance-oriented efficiency. In contrast, Profile 2, representing moderate efficiency, consists of cities such as Cartagena, Pereira, Manizales, and Bucaramanga. These cities demonstrate consistent but comparatively lower levels of efficiency inputs.

Additionally, communities prioritizing capital investment tend to acquire more efficiency factors over time than those prioritizing a personal. Profile 3, characterized by volatile effectiveness, revealed 5.64% of cities that initially had modest levels of efficiency but experienced significant improvement over time, though at a slower pace compared to other profiles. The cities of Cúcuta, Pasto, Villavicencio, and Ibague demonstrated a combination of efficiency and capital investment orientation, with no notable distinctions compared to other groupings. This finding confirms that communities prioritizing capital investments tend to collect more efficiency factors over time than those prioritizing operational costs.

Conclusions

This study presents an analysis of the efficiency dynamics of public health service providers in Colombia from 2010 to 2021, set against the backdrop of ongoing healthcare system reforms. Employing Growth Mixture Analysis (GMA) and other statistical methodologies, the research has successfully delineated various efficiency profiles among hospitals of different complexities (Gillet *et al.*, 2019).

The findings reveal distinct efficiency trajectories among these healthcare providers. Service providers with higher efficiency levels generally maintained or slightly improved their performance over the study period. In contrast, some providers experienced fluctuations or notable declines in efficiency. These variations underscore the critical need to consider diverse efficiency dynamics within the healthcare system, particularly in the context of resource allocation and performance evaluation. The analysis further elucidates the impact of capital investment, operational costs, and personnel management on efficiency outcomes. Strategic capital investments and rigorous control of operational expenses are crucial for enhancing efficiency. Moreover, the organization and deployment of human resources emerge as pivotal factors in realizing efficient outcomes, underscoring the significance of effective human resource management within healthcare institutions (Anessi-Pessina and Cantù, 2006; Londoño and Frenk, 1997).

Therefore, this research highlights the multifaceted nature of efficiency in healthcare systems and the interplay between technological advancements and traditional healthcare management practices. The insights garnered from this study provide a valuable framework for future reforms and strategic planning in healthcare management, advocating for a balanced approach that incorporates both technological innovation and efficient resource management.

The study underscores the need for a comprehensive assessment framework that includes the impacts of regulatory changes. It reveals how regulatory shifts influence service quality and efficiency, enhancing our comprehension of how policy frameworks interact with hospital operations. The positive correlation between service quality and efficiency further emphasizes the critical role of service quality in healthcare provider selection and patient experience, advocating for continuous quality improvement initiatives within the public hospital system.

By highlighting regional variations in hospital efficiency, the research adds a geographic dimension to the efficiency analysis, pointing to areas with substantial potential for improvement and highlighting regions where inefficiencies persist. These insights are crucial for healthcare policy, as they underscore the necessity of considering geographic focus in healthcare resource allocation to sustain service quality levels and promote equitable access to care. The study also suggests the need for a comprehensive understanding of the marketization perspective to comprehend the complex interactions between market forces, regulatory frameworks, and healthcare outcomes. This aspect is vital for informing evidence-based policy interventions and strategic management practices that align market dynamics with healthcare goals.

Managerial implications

The practical implications of this study are profound, offering valuable insights for healthcare managers and administrative staff regarding the current performance status of health service institutions in terms of efficiency. Notably, despite the inherent complexities within healthcare services, institutions with higher levels of complexity demonstrate remarkable efficiency in resource utilization. Furthermore, the analysis sheds light on the clustering of inefficiencies across various geographic regions, highlighting patterns of increased operating costs and variations in service quality. This last underscores considerations regarding geographical location's impact on service costs and quality. Thus, these findings emphasize the importance of strategic decision-making concerning facility placement and resource allocation, underscoring the necessity for customized approaches to optimize efficiency and service delivery across diverse healthcare settings.

Future lines of research

Two potential extensions to the current research could enrich our understanding. First, we explored the influence of environmental factors specific to each municipality on hospital efficiency. Secondly, hospital efficiency can be evaluated by incorporating variables indicative of poor quality, such as waiting times for general and specialized consultations, emergency care, surgery scheduling, and occurrences of nosocomial infections. Furthermore, this study underscores the importance of investigating the impact of emerging technologies like Artificial Intelligence and big data on enhancing service delivery at a technological level. Lastly, leveraging social media as a tool for marketing specialists could offer valuable insights into user behaviors, enabling a deeper understanding of consumer preferences and needs.

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