

Modelling Healthcare Output in India: An Empirical Study of Production Factors

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ABSTRACT

The Healthcare sector is considered one of the crucial components to drive the productivity of an economy. This research paper aimed to analyse trends and the relation between the factors of production and overall value added in the Indian healthcare sector. Using the time-series data from the Indian KLEMS database, a trend and regression analysis was conducted between 2001 and 2023. Based on the Cobb-Douglas production function, the study identified which of the factors significantly affected the total gross output of the Indian healthcare sector. The findings revealed that capital, material and service inputs positively affected the gross output of the healthcare sector. Capital was the input variable with the largest positive relationship with gross input as a 1% increase in capital input led to a 0.57% increase in gross output. Interestingly, for every 1% increase in labour, there was a 0.85% decrease in gross output. Finally, Energy input was the only input that did not have any significant impact on the overall value added. Hence, there are many ways to increase the value added in the Indian healthcare sector, such as increasing the significant factors of production or implementing policies changing the labour and energy landscape within the sector. One such policy could be improving working and living conditions in rural areas so that healthcare workers can be reallocated from urban to rural areas to reduce diminishing labour productivity. Therefore, resources should be efficiently distributed to improve the output in the Indian Healthcare system.

Keywords: Capital, Labour, Energy, Materials, Services, Healthcare, Output

INTRODUCTION

General Background

The factors of production affecting economic output have been widely explored worldwide in the existing studies. One such study conducted by Abdul Halim et al. (2020) aimed to investigate how capital, labour and energy consumption impact the growth of the Malaysian economy. They used GDP, capital, labour and energy consumption as their independent variables. These data covered a 35 year span, between 1982 and 2017. From the results, it was found that there is a long-term relationship between capital, labor, electricity consumption, and economic growth. Capital and energy consumption can be determinants of

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economic growth both in the short and long term. However, the labour force doesn't impact the overall GDP of the country since some of them are unemployed or work in jobs that don't significantly impact the GDP of Malaysia. To increase the GDP, policymakers should encourage Malaysian companies to increase r&d and spending towards electricity and energy saving methodologies (Abdul Halim et al., 2020). Moreover, expenditure on social and economic infrastructure will help increase labour productivity, which will boost the Malaysian economy.

Similarly, Nakajima (2008) undertook a data-driven study aimed at analyzing the labour requirements per monetary unit of output and the value added productivity of labour. The study used data across 24 different sectors, from 3 different countries, Japan, the US and Korea, between 1960 and 1985. Findings of the research showed that productivity and labour requirements were strongly correlated with each other (Nakajima, 2008). Essentially, in industries that required more labour, the overall productivity tended to be lower. When economies were expanding rapidly, this link was greater, but as economies developed, it became weaker. This showcases that the role and efficiency of labour change as a country grows in size.

The magnitude of the impact of these factors has also been analysed using multiple approaches. In the same realm, Mandal et al. (2021) used the Cobb-Douglas production framework to theoretically predict healthcare production by using not only quantitative variables but also taking into account factors like governance and public awareness. When healthcare production has increasing returns to scale, tax rates should increase to provide more resources for healthcare facilities (Mandal et al., 2021). The model predicts that if resources are increased when healthcare production has increasing returns to scale, the return will be disproportionately larger (Mandal et al., 2021). While the findings are interesting, it should be noted that this study does not link any variables such as capital, labour, energy, materials or service inputs, and therefore there are also no elasticities or coefficients using real world data.

Acharya et al. (2019) set out to investigate the relationship between changes in Indian healthcare system productivity and changes in healthcare expenditure productivity across 17 states. The study analysed a 10 year timeframe, starting from 2004-05. Using a per capita model, this paper concluded that productivity was volatile, as indicated by its coefficient values. Despite this, the paper did describe the healthcare system's productivity and the healthcare expenditure productivity changes as "mixed in nature." This means that these two variables do influence each other, but it is inconclusive as to the degree or magnitude. While Acharya et al. (2019) find a volatile, mixed relationship between healthcare productivity and expenditure across Indian states, Natarajamurthy (2025) approaches the same link from a macro angle, tying other factors to healthcare expenditure trends. By assimilating data from various government sources between 2010 and 2022, Natarajamurthy (2025) wanted to find patterns between healthcare expenditure in India and other economic factors: GDP, central and state share in public healthcare, key health financing indicators, and more. By conducting a correlation analysis and using CAGR values, the researchers were able to deduce the following: During the time period of the study, public healthcare spending and spending per capita had grown rapidly. It was found that public healthcare expenditure in India has a strong correlation with GDP as well as population growth. Despite this increase, the paper still critiques the low healthcare expenditure, citing how India has too low a share of

healthcare expenditure compared to GDP. This paper also explains how lack of accessibility, inadequate infrastructure, and shortages of skilled labour still act as a barrier for many to receive an acceptable quality of healthcare. Lastly, the paper covers how out of pocket spending is still very prevalent in India and often has serious negative implications for individuals or families involved.

Gu and Morin (2014) aimed to investigate the efficiency and productivity of healthcare providers and the increase in healthcare spending in the Canadian healthcare industry. To do this, the paper used an experimental direct output measure. The paper was more focused on the methodology, investigating a direct output measure, an area that was identified as the rationale of the paper. The paper concluded that direct input models do not take into account an increase in productivity of certain input variables and therefore might not truly depict overall progress in the sector. However, this paper does believe that direct output measures are much more effective overall to determine whether increased spending does increase productivity, specifically in the Canadian healthcare sector. This concern raised by Gu and Morin (2014), that direct input models can understate true productivity gains, is relevant to Acharya et al. (2019) in the previous paragraph. While Acharya et al. (2019) did find healthcare systems productivity and the healthcare expenditure productivity changes as “mixed in nature”, in the end it was inconclusive as to what degree or magnitude.

Praveenkumar and Yashoda (2018) attempted to showcase how influential FDIs are to the Indian healthcare system, especially to support the world's second largest population at the time of publishing. Naturally, FDIs only aid private healthcare in India, however, this paper states that the private sector is significantly larger than the public sector in Indian healthcare. The paper cites well over 3 billion USD in FDIs between April 2000 and June 2015. The paper discusses how FDIs facilitate technology collaboration, capital investment, and collaborative ventures across various segments, including diagnostics, medical equipment, hospitals, education and training. The paper talks about how mergers and acquisitions have become more common within the Indian healthcare sector, another factor which has helped improve the scale at which the Indian sector operates to meet the larger population's demands. While FDIs have been significantly influential in growing the Indian healthcare industry, there are also other factors that have aided this rapid development. Medical tourism has only been increasing and contributing to the Indian healthcare sector. Mishra and Shailesh's (2012) paper aims to find why India has rapidly attracted so many people from international sectors and what implications it has. As of 2012, medical tourism to India was growing at an annual rate of 25 to 30% (Mishra & Shailesh, 2012). This was due to the fact that Indian healthcare found itself in the perfect sweet spot. They had highly skilled labour with international degrees and accreditations, making them some of the most qualified and therefore trusted doctors and surgeons in the world. This, paired with the fact that the surgical procedures cost significantly less, made India an extremely sought after destination for medical tourism. The paper states how a hip replacement surgery could cost up to 75% less in India compared to the US. Additionally, wait times for these surgeries were much shorter in India compared to other nations. While there were some policy and ethical concerns, with the backing of the Indian government, medical tourism continues to grow in India. Together, Natarajamurthy (2025), Praveenkumar and Yashoda (2018) and Mishra and Shailesh (2012) collectively suggest healthcare sector growth in India stems from public and foreign

capital investment and a skilled labour force, though these factors are typically studied separately rather than modelled jointly.

At a conference, Shivdas & Ray (2017) sought to investigate pharmaceutical companies' resource allocation and then provide a framework to optimise sales based on their findings. Using data from over 115 pharmaceutical companies for the fiscal year 2013-14, they were able to make the following conclusions: Expenditure on research and development, human capital, and physical capital led to an increase in sales. All three of these variables significantly affect pharmaceutical companies' sales in a positive way. There have also been different models to link input and output variables, such as the direct output measure that Gu and Morin (2014) used. While Gu and Morin (2014) and (Shivdas & Ray, 2017) offer valuable methodological precedents for measuring healthcare output and modelling production factors, respectively, no study in this review jointly applies a KLEMS-based regression framework to Indian healthcare output.

Literature Gap and Rationale

While there has been extensive research on labour productivity, energy input, labour quality and the value added to the economy, there has not been anything very specific to the healthcare sector. While there has been research urging for improvements in labour productivity, there has never been extensive research on which factor truly affects value added. Even within the Indian healthcare sector, there have been very few studies based on a heavy data-driven approach.

This research is crucial in the modern-day world, as some healthcare systems are not able to bear the weight of the rising demand. The Indian healthcare system itself has many inefficiencies, on both the macro and micro scales (Sehgal & Kour, 2024). This boils down to the fact that inputs and resources in the health sector are used in a suboptimal manner; this study is needed to find ways to optimise resources to produce a standard level of quality healthcare on a large scale. This necessity of optimisation comes with the rising population of India, one that will require it to operate on a more efficient basis to support the needs of the nation. The use of the KLEMS framework will enable those in the healthcare sector to truly draw direct correlations between input variables and overall value added.

METHOD AND MATERIALS

Research Aim and Objectives

The aim of this research paper is to evaluate the impact of input variables on gross value added in the Indian healthcare sector. To assess the following objectives were considered:

- To identify the trends of the input variables and the gross value added under the Indian healthcare sector

- To estimate the magnitude of impact of the input variables (KLEMS) on the output generated by the healthcare sector in India
- To propose policies that can alleviate the healthcare sector in India

Research Hypothesis

The following null hypotheses are tested in this research.

- NH_1 : There is no significant impact of capital on output in the healthcare sector
- NH_2 : There is no significant impact of labour on output in the healthcare sector
- NH_3 : There is no significant impact of energy on output in the healthcare sector
- NH_4 : There is no significant impact of materials on output in the healthcare sector
- NH_5 : There is no significant impact of service on output in the healthcare sector

Data

The data of input and output variables for the Indian healthcare sector from 2001 to 2023 was analysed, which was presented in a time series format. The secondary data collected for this study were obtained from the (*KLEMS - Reserve Bank of India, 2023*). The variables that are used in the research are as follows: Gross Output at constant 2011-2012 prices (in Crores of ₹), Energy input at constant 2011-2012 prices (in Crores of ₹), Material input at constant 2011-2012 prices (in Crores of ₹), Services input at constant 2011-2012 prices (in Crores of ₹), Number of persons employed (in 1000s) and Capital Stock at constant 2011-2012 prices (in Crores of ₹).

Description of Variables

- Output (Y) - The indicator of the output in the healthcare sector is the Gross Output at constant 2011-2012 prices (in Crores of ₹). Gross output is an appropriate indicator of the value added, as it enables the tracking of where this added value comes from.
- Capital (C) - Capital Stock at constant 2011-2012 prices (in Crores of ₹) is considered to quantify capital in this study. Capital is one of the key factors affecting the gross output of any sector as it has the ability to expand productivity through ways such as but not limited to: machinery, hospitals, information and communication technology etc (Strassner et al., 2005).
- Labour (L) - Using the number of persons employed (in 1000s), it is easy to compare between sectors. Labour essentially measures how much work gets done in the process of production, factors such as more hours worked or more efficient labour can all increase the gross output of a sector (Strassner et al., 2005).
- Energy (E) - Analysing energy input at constant 2011-2012 prices (in Crores of ₹) is the indicator used in this paper for energy. Energy enables processes to be carried out, a higher amount of energy or cheaper energy can increase productivity of machinery which will increase the gross output of the sector (U.S Bureau of Labor Statistics, 2025).

- Materials (M) - Measuring Material input at constant 2011-2012 prices (in Crores of ₹) adds value to the sector as raw materials are then transformed into finished products. More or more highly valued products contribute towards increasing the total revenue of a sector (BEA et al., 2015).
- Service (S) - Analysing services input at constant 2011-2012 prices (in Crores of ₹) is crucial as services can act as sources of information, improve logistics and business-support function, all factors that can improve efficiency and scale (BEA et al., 2015).

To analyse the data, this research paper will use the Log-Cobb-Douglas Function, and hence, the natural logs of these variables were estimated before the analysis. Using the logged versions enables working with smaller, much easier scales to read. In addition, the results can be analysed as percentage changes. To measure these variables, constant prices are more accurate in being able to deduce trends as they are adjusted to take into account inflation, offering more accuracy to be compiled and analysed.

Data Analysis Method

The collected data has been analysed using trend analysis and regression analysis. In the trend analyses, observable data and patterns are explained and justifications are provided. In the regression analysis, the coefficient depicts whether the variable has a positive or negative on the gross output and to what degree.

To analyse the data, Output is considered as a function of capital, labour, materials, energy, and service. The Cobb-Douglas Production function has been used to represent the output.

$$Y = f(K, L, M, E, S) = a_0 K^{a_1} L^{a_2} E^{a_3} M^{a_4} S^{a_5}$$

This paper uses the log-log transformation of the Cobb-Douglas function, as it enables finding the direct percentage change caused by each variable measured.

$$\ln(Y) = \ln(a_0) + a_1 \ln(K) + a_2 \ln(L) + a_3 \ln(E) + a_4 \ln(M) + a_5 \ln(S) + e$$

where a_0 is the intercept coefficient and a_1 , a_2 , a_3 , a_4 , and a_5 are the slope coefficients measuring the impact of capital, labour, energy, materials, and services on output, respectively. The data was analyzed using STATA 18 software.

RESULTS AND DISCUSSION

Trend Analysis

Figure 1

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Trendline of Gross Output in the Indian Healthcare Sector between 2001 and 2023

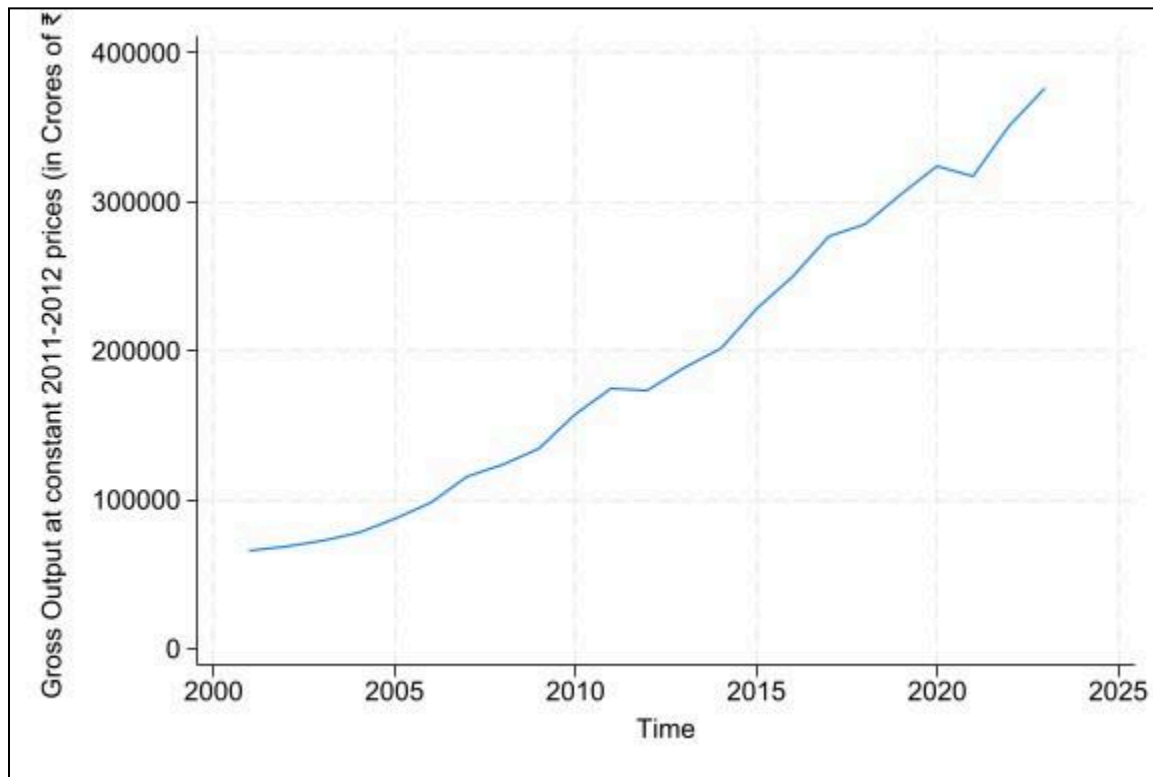


Figure 1 shows the year-by-year data of the gross output of the Indian healthcare sector between 2001 to 2023. Overall, the graph has a positive gradient. The gross output of the healthcare sector of India increased between 2001-11, however between 2011-12 the output plateaued. Subsequently, from 2012-20, the gross output increased at a faster rate compared to 2001-11. This was due to the increase in non-communicable diseases: diabetes, high blood pressure, cardiac condition and cancer (Barik & Arokiasamy, 2016). This drastic increase in the number of patients also led to an increase in revenue across the healthcare sector. Another factor was the surge in medical tourism, as between 2012-20, India had both the facilities and good quality healthcare while also having good English language proficiency (Kumar, 2023). With more patients seeking more advanced and therefore expensive treatments increased the gross output of the entire Indian healthcare sector. In 2020-21, the gross output of healthcare sector in India declined for the first year. In 2020, COVID-19 ravaged the world, significantly affecting healthcare sectors worldwide, as well as India (Mistry, 2021). Although this seems counterintuitive, there are various factors influencing this decline. Firstly, people avoided coming to hospitals unless it was critical due to the fear and uncertain implications of contracting the virus (Shamsundar & Choudhary, 2022). In addition, hospitals reduced the number of elective surgeries, a major part of revenue. These surgeries consisted of orthopaedic surgeries - joint replacement and fracture repairs according to Bansal (2020), cancer surgeries

reported by Economic Times and general surgeries - hernia repairs, cholecystectomies, abdominal wall repairs discovered by Bhandoria et al. (2021). There was also a major demand for medical supplies such as ventilators and hospital beds causing significant resources to be diverted that way rather than towards resources that would yield more output. However, the supply chain for these supplies was breaking down due to workers falling ill and new policies to combat the spread of the virus slowing production. This sharply reduced production negatively influenced the gross output. However, after COVID-19, from 2021-23, the Indian healthcare sector continued to observe a yearly increase in overall gross output.

Figure 2

Capital Stock Trend in the Indian Healthcare Sector between 2001-23

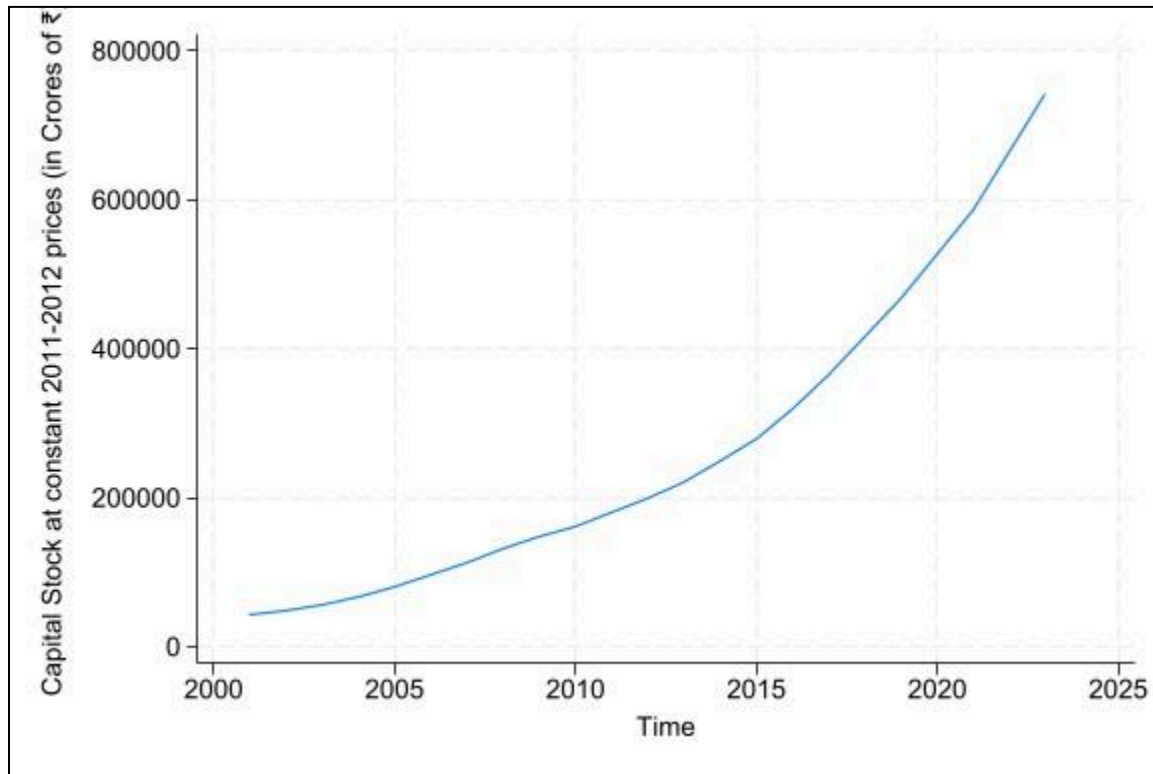
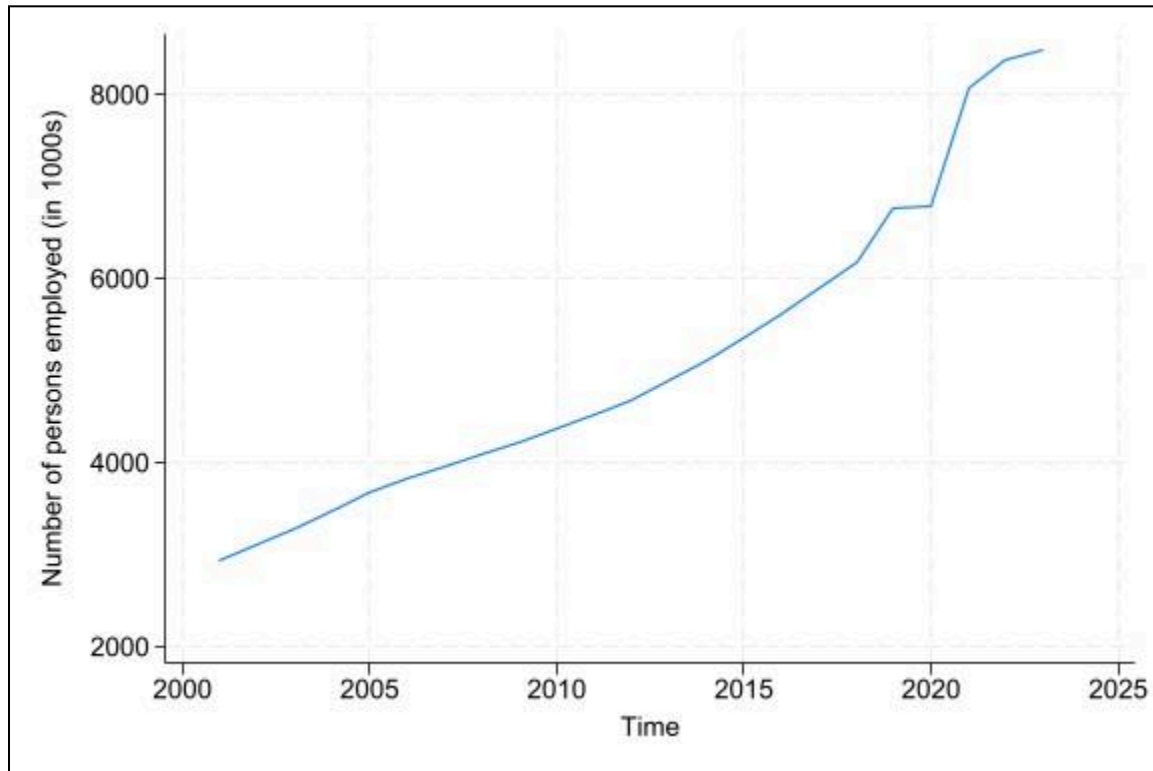


Figure 2 examines the change in capital stock throughout most of the 21st century. Every year between 2001 and 2023, the capital stock of the healthcare sector has increased. It increased reasonably steadily between 2001 and 2015, then from 2015 to 2023 it increased at an even higher rate. This is because leading up to 2015 there was a boom in terms of income across India. As the years went on, the middle class in India constantly kept growing in terms of wealth. In 2015 this translate into middle-class residents being ready to pay for better, more expensive premium private healthcare (Paneri et al., 2024). Since more expensive healthcare was being consumed on average the gross output of the entire sector increased rapidly. In addition, there were many policies passed by the government to increase healthcare sector spending. These policies led to public financed healthcare insurance schemes benefiting privately owned hospitals (Jaffrelot & Jumle, 2020). Because of these insurance schemes, a higher number of people from

lower income backgrounds could receive healthcare that was covered by the government (Prinja et al., 2023). Due to this increase in people who could receive healthcare, the government had to build over 5000 new facilities and renovate almost 9000 other healthcare facilities (Government of India Ministry of Health and Family Welfare, 2018). This large scale infrastructural movement led to the increased rate of change in the capital stock.

Figure 3

Number of Persons Employed Trend in the Indian Healthcare Sector between 2001-23



The number of persons employed in the Indian healthcare sector has grown every year since 2001 as observable in figure 3. It had a relatively steady rate of increase per year between 2001 and 2018. Then it can be observed that there was an increased rate of change between 2018-19 and 2020-21, however plateau in 2019-20 due to Covid-19 stopping most routine hiring (Altido, 2025). After 2021, it continued to increase, but at a lower rate than 2018-19 and 2020-21, but higher than 2011-18. The fastest rate of growth from the Indian healthcare sector in the data analysed is between 2020-21. This rapid increase comes directly from the increase in demand for labour that was caused by the COVID-19 pandemic. There was an increase in personnel needed, such as nurses, people testing others, and people administering vaccines (Bachmann et al., 2022).

Figure 4

Material Trend in the Indian Healthcare Sector between 2001-23

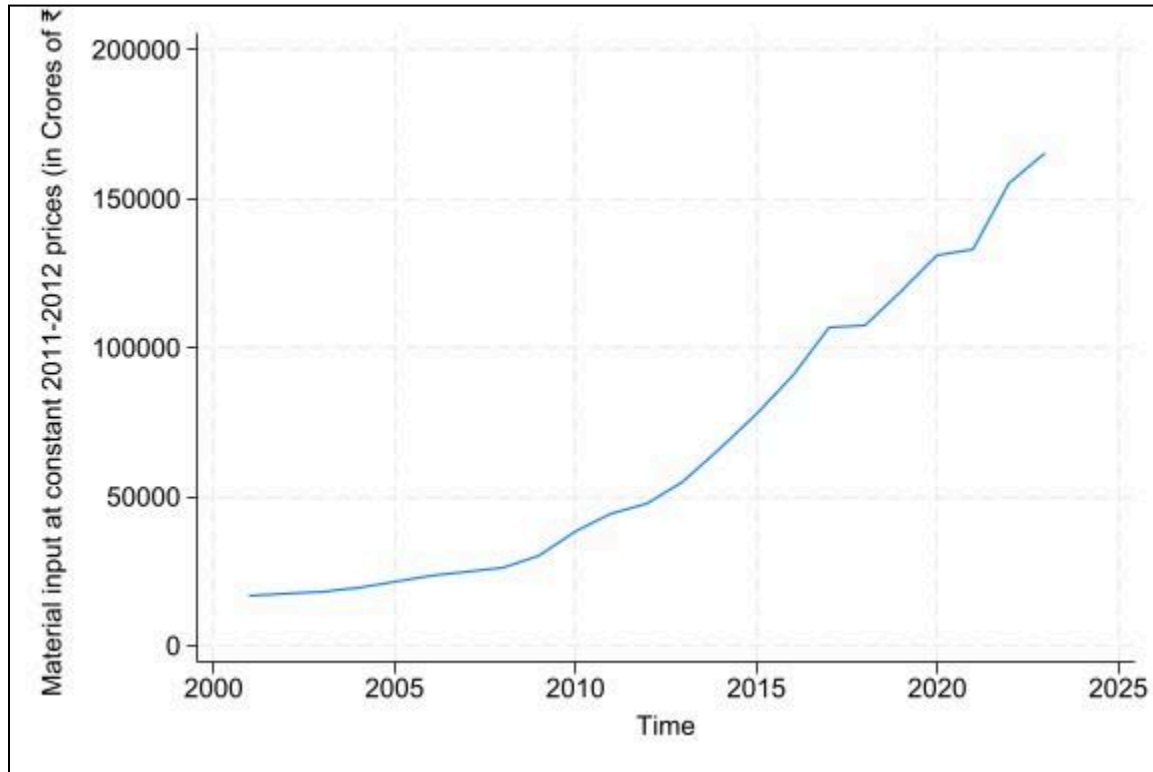
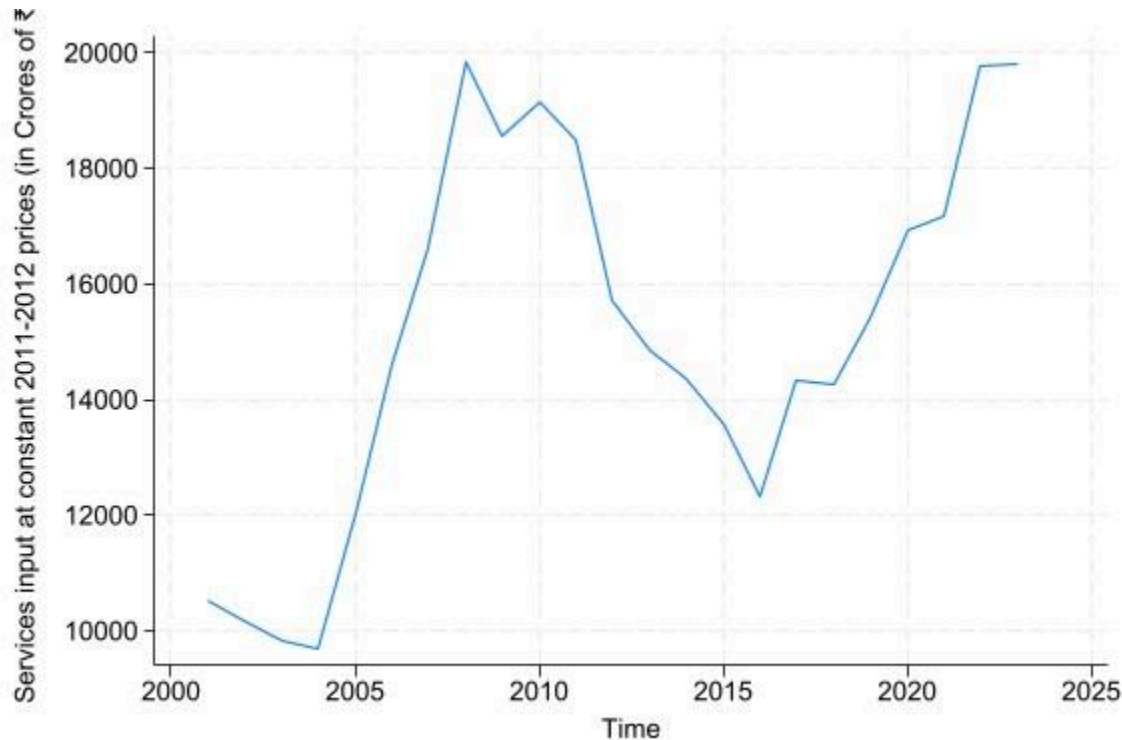


Figure 4 shows the Material Input between 2001-23 in the Indian healthcare sector. From this we can observe there was a steady but slow increase in material input from 2001 to 2009. From 2012-17, there was much more rapid growth and an increase in the amount of materials used in the Indian healthcare sector. This occurred due to the fact that more people started to be hospitalised due to the rise of non-communicable diseases (Kastor & Mohanty, 2016). Therefore hospitals observed a rise in demand for supplies such as disposable equipment, wound care and personal protective equipment (National Statistical Office et al., 2019). Between 2017-18 and 2020-21, there was almost no change in the amount of material input. From 2018 to 2020, there was a steady increase. From 2021-22, the steeper increase was observed in the material input. This continued into 2022-23, however at a slower rate. This highest increase in material input that occurred between 2021-22 was a result of the Covid-19 pandemic, more specifically, that large scale vaccination of the Indian population. It was reported that during the peak of the nationwide vaccination, there were 25 million vaccines being administered (Kant, 2019). All these doses of vaccinations were being given through single-use disposable syringes, therefore leading the material input to increase drastically that year (Purohit et al., 2022). In addition to that the number of PPE kits being manufactured ramped up from 47,000 per year to 450,000 per day according to Yadav (2020) and over 200,000 N95 masks were also produced daily. These massive changes in demand and amount of production caused the material input to grow.

Figure 5 shows the trend of the service input in the Indian healthcare sector from 2001 to 2023. Overall, the service input price in the Indian healthcare sector was very volatile. From 2001 to 2004, there was a slight decrease on a yearly basis. Then, from 2004 to 2008, there was a sudden massive increase in the service input prices. While it depends on a yearly basis, the overall trend of the graph from 2008 to 2016 is a negative trend, losing almost Rs. 8000 crores of value at a constant price.

Figure 5

Service Trend in the Indian Healthcare Sector between 2001-23



Once again, between 2016 and 2023, there was an overall positive trend, but in some years, service input prices stayed the same. In the end the service input price in 2023 was around the same as 2008, before the decline. Between 2004-08 there was rapid expansion in the Indian healthcare system, especially in rural areas due to the National Rural Health Mission (NRHM), allowing more people to have access to healthcare (EH News Bureau, 2016). The NRHM facilitate the upgrade of facilities across rural areas, which fostered more jobs for service providers, especially towards rural areas who did not have access to specific services. Since more people had access to healthcare, the number of surgeries such as: cesarean sections, cataract operations, hernia repairs and appendectomies all increased during that time period (Bhasin et al., 2010). For these surgeries to be carried out, an increased amount of medical services such as imaging, pathology, physiotherapy and more was outsourced to other service providers. Between 2008-16, there was a shortage in skilled labour professionals in the healthcare sector in terms of technology. This was because until 2016, most IT training curricula did not teach the specific material

necessary to work in a hospital's IT department, as stated by Srinivasan et al. (2020), leading to much more staggered growth in infrastructure for IT and modern facility management (LSI Finance, 2021). From 2016 until 2023, service input increased due to large-scale digitalisation in the sector. Services such as digital healthcare and telemedicine became increasingly more prominent in society, enabling IT and software companies to become more involved in the healthcare sector (PwC India et al., 2016).

Regression Analysis

As seen from the p-values in Table 1, the variables of capital (0.00), labour (0.00), materials (0.00) and services (0.004) are significantly impacting the gross output in the Indian healthcare sector at a 1 per cent level of significance. However, the p-value of the energy variable (0.973) is greater than 0.1, implying that energy input in the healthcare sector does not significantly impact the gross output even at a 10 per cent level. The R-squared value of the model is 0.9988, showing that 99.88 percent of variations in gross output are explained by the input variable considered in the framework.

In the Indian healthcare sector, capital positively impacts the overall gross output. From the coefficient it is depicted that as capital increases by 1 percent, output will increase by 0.572 per cent. This is likely due to the rapid increase in foreign investments and what they entail and facilitate. The FDI (Foreign Direct Investment) in the Indian healthcare sector has increased by over USD 47.5 billion between 2000-01 and 2019-20, a time period largely overlapping with our study (NITI Aayog et al., 2021). NITI Aayog et al. (2021) found that a rapid increase in FDI occurred because of the ease of business. FDIs did not need government approval for construction of hospitals, Greenfield - Healthcare, Biotechnology and Pharmaceuticals, as well as medical devices and insurance. With this increased amount of resources provided by FDIs, hospitals were able to continuously invest into new technologies. With these new technologies providing more advanced services at higher prices than before, enabling the hospitals to generally profit more from each patient they received (Sielska & Nojszewska, 2022). FDIs all resulted in rapid development in infrastructure, enabling hospitals to take on larger patient loads and increasing profit (Sunitha L F & Babu R, 2013).

Table 1

Regression results with the dependent variable logY

logy	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
logk	0.572	0.073	7.88	0	0.419	0.725	***
logl	-0.858	0.119	-7.22	0	-1.109	-0.608	***
loge	-0.001	0.041	-0.03	0.973	-0.087	0.085	
logm	0.406	0.06	6.77	0	0.279	0.532	***
logs	0.151	0.046	3.3	0.004	0.054	0.247	***

Constant	6.519	0.578	11.27	0	5.298	7.739	***
Mean dependent var	12.03			SD dependent var	0.571		
R-squared	0.9988			Number of obs	23		
F-test	2895.794			Prob > F	0		
Akaike crit. (AIC)	-104.723			Bayesian crit. (BIC)	-97.911		
*** $p<.01$, ** $p<.05$, * $p<.1$							

In addition to this, the digital Indian healthcare sector has been growing rapidly ever since the turn of the century. From 2020, the digital infrastructure of the Indian healthcare sector has grown at a CAGR of 25% per annum (Hazra & Bora, 2025). In summary, increase in capital in the Indian healthcare sector, largely funded by FDIs, enables hospitals to invest in new technologies and infrastructure to increase both their capital stock as well as their average treatment costs and reach a wider range of patients respectively, making them more profitable. This increase in profit and ability to reach a wider range of patients also stems from the fact that the digital healthcare infrastructure has grown so rapidly.

Labour in the healthcare sector of India is inversely proportional to the gross output. Hence, as labour increases by 1 percent, output will decrease by 0.85 percent. It seems counterintuitive that an increase in labour would decrease the overall value added in the healthcare sector, however this phenomenon occurs due to the poor distribution of healthcare staff across the nation (Anand & Fan, 2013). There are many hospitals in India that are short-staffed, contrariwise, there are also a lot of hospitals in India that are overstaffed. Most of the skilled professionals in the healthcare sector in India work in urbanised cities due to factors such as: better salaries, better quality of life, accessibility to resources, and good education for their kids (Smile Foundation, 2025). Therefore, due to this influx of skilled professionals in urbanised Indian cities, on numerous occasions there are multiple doctors managing the workload of one (Mehta et al., 2024). This significantly impacts labour productivity as the healthcare system becomes increasingly inefficient as it pays multiple salaries, but only profits to the equivalent of one doctor. Furthermore, the healthcare sector cannot generate more revenue from the rural localities in India as they are understaffed and cannot provide healthcare to all seeking healthcare immediately, leading to a gap in overall revenue nationwide.

When analysing the Indian healthcare sector, gross output is positively affected by the material input. From the regression results it is seen that the output will increase by 0.41 percent for every 1 percent increase in materials. As discussed earlier, in India, the government allows for automatic FDIs to fund the manufacturing of healthcare devices. Due to this, India was among the top 20 exporters of medical devices worldwide as of 2021. The medical devices and equipment manufacturing sector had been steadily increasing at a CAGR (Compound Annual Growth Rate) of 15 percent between 2018-19 to 2020-21 (NITI Aayog et al., 2021). The medical devices and manufacturing sector in India is projected to

be worth USD 50 billion in 2025 (NITI Aayog et al., 2021). Since the scale of the Indian medical devices and equipment manufacturing sector is growing, so too are the facilities and the number of jobs increasing. Fundamentally, materials in healthcare are not just costs but productive inputs that enable patient treatment, diagnostic services, and medical procedures. Therefore, the material input and the gross output will always be correlated as the more patients treated, the more material input needed to sustain that, consequently resulting in an increased amount of revenue (Bansal et al., 2022). The combination of these factors enable an increase in materials to increase the gross output.

Subsequently, there will be a 0.15 percent increase in total gross output for every 1 percent increase in services in the Indian healthcare sector, as there is a positive coefficient. According to figure 5, from 2004 to 2023, the Indian healthcare sector's service input grew by 104% . During the period of study, many hospitals came to the conclusion that outsourcing services, especially ones that related to new technologies such as diagnostic, maintenance and IT services, came with multiple benefits. Firstly, these hospitals did not have to venture into unknown territory and go into a field they were not confident in. Outsourcing to these specialist companies ensured that customers had much better quality of services (S. K. Barik & Rout, 2019). Secondly, paying these companies in the long run was much cheaper than setting up a new in-house department as these companies already had more facilities and more tried and tested methods to yield positive results (Rawat, 2026). That is why outsourcing services to specialized companies helped the Indian hospitals and entire sector increase quality of customer care and efficiency, consequentially maximizing profits.

The regression analysis found that energy input did not have a significant impact on the gross output of the Indian healthcare sector as it had a p-value of 0.973. Energy input does not significantly impact the gross output of the Indian healthcare sector due to the nature of the sector. The Indian healthcare sector is a service based sector, gross output stems largely from consultations, surgeries, diagnostics, therapy, and nursing. Labour, materials and services accounting for approximately 85-90% of the entire sectors costs (Chatterjee et al., 2013). Contrariwise, energy auxiliary was only around 2-5% as derived from the empirical study of Chatterjee et al. (2013). In context of the Indian healthcare sector, energy is essential for services such as: sterilization of environment, storing medicine, heating, imaging and much more (*Powering Healthcare - Delivering Integrated Clean Energy Solutions to Improve Service Delivery and Reduce Emissions in India.*, 2023). However, energy is an enabler, it also process to be carried out, but it is not a driver of growth.

Finally, it was noticed that the India healthcare sector is currently showing diminishing returns to scale. If every input variable is increased by 1%, then the output will increase by 0.27%, which is low enough to represent diminishing returns. Therefore, increasing the inputs in similar quantities does not lead the output to increase at a similar rate in the Indian healthcare sector. Thus, there is a need to focus on specific policies that can increase the rise in healthcare output.

CONCLUSION

Increasingly, there is more and more strain on the Indian healthcare sector due to a rapidly growing overall and aging population. The research conducted in this paper was analysing the input variables that had the most significant effect on the overall productivity of the Indian healthcare system. By doing this analysis, the magnitude of effect caused by these input variables could be measured. Furthermore trends could be identified on which policies could be proposed to increase overall productivity and release strain on the sector. This paper used secondary data from the Indian KLEMS database 2023, which consisted of data from 2001 to 2023. Using the Cobb-Douglas production function, the relationship between the KLEMS variables, including capital, labour, energy, materials, services and their overall value added, was analysed.

The results of the research showcased how the input variables- capital, labour, material and service all have a significant impact on the gross output of the Indian healthcare sector, as they all have a p-value of less than 0.005. However, energy was not considered to be significantly impacting the productivity of the healthcare sector since it had a p-value of over 0.1. Through the coefficient values, the research found that an increase in capital, material and service leads to an increase in total gross output of the sector, while labour input and gross output are inversely proportional. Out of the factors that are positively correlated with gross output, capital had the largest impact as a 1% increase in capital led to an 0.57% increase in gross output. The increase in capital stock in the Indian healthcare sector was largely funded by FDIs. These FDIs enabled private hospitals in particular to invest in more advanced technology and treatment methods, enabling them to provide more advanced as well as expensive care, leading to larger profits. Capital input was followed by material input, as a 1% increase in material input caused a 0.4% increase in gross value added. Materials support rising demand; therefore, in many cases, there needs to be an increase in material input to ensure that it is not the limiting factor in the healthcare sector. Due to this, an increase in materials enables an increase in gross output, since they enable patient treatment, diagnostic services, and medical procedures. As material input grows, so does the number of patients treated and value added. The last variable part of the study with a positive coefficient was service. There was a 0.15% increase in the gross value added for each 1% the service input. Increasing service input in the healthcare sector leads to increased productivity and better cost management for healthcare providers. As hospitals started outsourcing services to service providers such as food, laundry, and online security, they realised that, firstly, it was cheaper and more efficient than starting their own department in-house. Additionally, these service providers had much more expertise in their specific services, which can be very crucial, for example, online security systems which have private patient data. Lastly, a 1% increase in labour input led to 0.85% decrease in gross output. While it may go against the common notion that an increase in labour enables a larger gross output, there are other factors to consider. Primarily, in the Indian healthcare sector, the urban and rural landscapes starkly differ. Urban healthcare is overcrowded with skilled healthcare professionals, which therefore leads to many healthcare workers not needing to work to their full capacity, reducing overall productivity. Contrariwise, hospitals in rural communities are vastly understaffed,

leading to an untapped stream of revenue. The Indian healthcare sector can work towards a constant return to scale by increasing capital, service and material input and more effectively distributing labour across urban and rural areas.

Policy Recommendations

From the results of the research conducted, labour input was the only input variable that actually caused a decrease in overall gross output. Addressing this issue requires the massive misdistribution of healthcare workers between urban and rural areas to be rectified. In recent years, the Indian government has attempted to incentivise more and more healthcare workers to work in rural communities. Such as in Andhra Pradesh, those who have spent time working in rural communities are often favoured for certain post-graduate program seats (Shroff et al., 2013). Additionally, in Orissa, healthcare workers were given financial incentives to work in rural communities (Chakravarthi, 2012). However, Shroff et al. (2013) and Chakravarthi (2012) show that these two types of incentives still only make healthcare workers stay in rural communities for the short-term. After post-graduation, many doctors and nurses move to urban cities, and even healthcare workers in Orissa, with financial incentives, have moved back to urban cities quite rapidly. This is because the quality of life in rural communities is not to the expectation of the healthcare worker; in so many cases, it is so much lower, and healthcare professionals feel it is not worth the financial incentives. The key issues brought up in terms of quality of life are housing, transport, safety, education for children and spousal employment. This does not mean a full urbanisation of rural areas, but if these specific areas of rural communities can be strengthened and reinforced, along with financial incentives, it will ensure that rural hospitals will not be severely understaffed (Murthy et al., 2012).

In addition to financial incentives, to ensure that healthcare workers will stay long-term in rural areas, healthcare workers need a strong idea of their career progression. That means guaranteed promotions, rises in wages after a high-quality period of time working in rural areas. Another way to increase productivity is to give performance-based bonuses to rural healthcare workers (Chakravarthi, 2012).

Policies that work towards these solutions may even make service input and gross value added proportional instead of inversely proportional. Increasingly, in this century, Indian hospitals have started outsourcing services such as food, laundry and security services for added productivity. This is shown by our research as the gross value added in the Indian healthcare sector increases by 0.15% per 1% increase in the service input. Therefore, the Indian government should divert more resources to reducing approval times for cybersecurity certifications or food safety audits from 6–12 months to 90 days (The Indian Express Private Limited, 2026). Making it faster for companies to start operating to help hospitals. However, this does not mean not to take the appropriate measures to ensure that these companies are legitimate, but rather means to have more people checking to make the process faster.

Another arm of the service sector is telemedicine. Telemedicine is becoming more and more common in the global healthcare sector; as a result, India has a nationwide platform, eSanjeevani. However, eSanjeevani was launched relatively recently, in 2019, and it is still evolving and, on occasions,

inefficient. The platform should incorporate artificial intelligence and algorithmic triage tools to make the experience more streamlined for both patients and doctors. That means finding a general practitioner or specialist based on request and symptoms, or ensuring that patients and doctors can speak common languages. Currently, eSanjeevani provides free telemedicine services to Indian citizens; however, it can become profitable while adding almost no cost towards patients, increasing the gross value added. If eSanjeevani starts using the Ayushman Bharat scheme to fund telemedicine healthcare, it will increase the overall revenue of the healthcare sector. The current return to scale is 0.27% increase in gross output if every input variable is increased by 1%. However, with policies suggest perhaps the Indian healthcare sector can move to have an increase by 1% or more in gross output for every 1% increase in each input variable.

Limitations

The scope of this research was to analyse the Indian healthcare sector as a whole, therefore there are ways to make the research more specific as well as broader. Firstly, this paper analysed the urban and rural healthcare sector together. However, their healthcare landscape often drastically differs, therefore needing starkly different solutions. The urban healthcare system suffers from a lack of efficient use of resources, particularly healthcare workers. Overcrowding of hospitals due to patients not going through proper referral mechanisms is also another problem to be addressed to increase productivity (Fatma et al., 2025). The rural healthcare sector simply suffers from weak infrastructure, as well as poor living and working conditions for staff (Smile Foundation, 2025). Another division that this paper does not take into account is that private and public healthcare systems require differing solutions to increase gross output. Most public healthcare systems are constrained by input variables such as funding, staff and maintenance (Rao, 2023). The private healthcare system requires regulations to be tightened so that wasteful over-treatment does not repeatedly take place; this will increase the gross value added in the sector (Rao, 2022). Lastly, this research can be conducted with a larger scope and sample size. For example, conducting similar research to analyse trends with emerging countries like the BRICs. Another analysis could be from a regional standpoint, such as Asia, or more specifically, the Indian subcontinent. Finally, data can be analysed on a global scale, and research about overall global trends over the course of the past 25 years.

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