An assessment of traditional knowledge-based medicine companies and western medicine companies: a comparative study of efficiency

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AN ASSESSMENT OF TRADITIONAL KNOWLEDGE-BASED MEDICINE COMPANIES AND WESTERN MEDICINE COMPANIES: A COMPARATIVE STUDY OF EFFICIENCY

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Abstract

Indian traditional medicine comprises indigenous medical traditions (Bode, 2006). This ancient Indian predictive and personalized medicine system is still relevant today (Lemonnier, 2017). Yet, this medical system suffers many challenges due to the practice of western medicine. Therefore, there is a big need to study the existence and performance of these medicines through different companies. Coming to western medicine has made significant progress around the world over the past century. Many life-saving new drugs have been discovered to deal with various infectious and fatal diseases. Despite the undeniable benefits of modern medicine, which relies on scientific assays and results to establish the diagnosis and fight disease, a large portion of the world continues to rely on modern forms of Traditional, Complementary, and Alternative Medicines (CAM). Therefore, our paper focuses on studying the efficiency across Traditional Knowledge-based (TKBM) and Western Medicine (WM) companies using the data envelopment analysis (DEA) model. The study is a comparative study of ten years, from 2009-2018, using the CMIE Prowess IQ database. The second test concentrates on the effects of some firm-specific and financial variables on the efficiency of the respective companies. Lastly, the paper suggests that adopting cost management techniques will help these companies to improve their profit.

Keywords: **Traditional Knowledge-based Medicine; Western Medicine; Efficiency; Data Envelopment Analysis.**

1. Introduction

Our nation has been endowed with an abundance of medicinal plants; as a result, India is frequently referred to as the world's medicinal garden. In this context, India holds a remarkable place in the world, as a number of recognized indigenous systems of medicine, including Ayurveda, Siddha, Unani, Homeopathy, Yoga, and Naturopathy, are used to care for people's health.

Traditional medicine has a long history in India, and traditional healthcare systems have thrived for centuries. India's materia medica contains detailed information on various traditional practices and aspects of important natural products for therapeutical purposes (Mukharjee, 2001). Traditional knowledge-based medicines originated from about 1500 BC to 1000 BC in India. This system comprises Ayurvedic, Yoga, Naturopathy, Unani, Siddha, Homeopathy, and Sowa-Rigpa. Among all the traditional treatments, ayurvedic, Siddha, yoga, naturopathy, and sowa-rigpa have originated in India. In comparison, Unani has been derived from the Arabic country to India. Homeopathy has been introduced by a German physician Samuel Hahnemann, then introduced in India by the early 19th century. All these traditional methods of health practices come under the Ministry of Ayush, which was formed on 9th November 2014. This ministry's target is to revitalize the great expertise of age-old medicine systems for the optimal advancement and propagation of the Ayush healthcare systems.

As we know, natural and traditional remedies have been of great importance in our country for the last 5000 years to till now. Yet, indigenous medical practices have been affected due to the influence of modern-day medical procedures, which can be considered one of the challenges our country faces. Here, our study concentrated on the efficiency analysis of Ayurvedic, Unani, and Homeopathic medicine firms with western medicine firms. In the current study, we have analyzed the efficiency among traditional knowledge-based medicine companies. Then, the efficiency across traditional knowledge-based and western medicine companies have been discussed. To measure the efficiency of these companies, we have used the DEA (Data Envelopment Analysis), a non-parametric model. This study will become helpful for the further development and promotion of drug discovery in the Indian pharmaceutical industry. It will also help to reimburse the position of the traditional knowledge-based medicine industry as it is the eldest form of medical practice by knowing its need for further development.

2. Literature Review

In this context, we have discussed various kinds of literature that have been made to analyze the efficiency of traditional knowledge-based and modern western medicine companies. The following studies have focused on these companies in the form of Indian pharmaceutical companies.

Saranga et al. (2008) evaluated 44 Indian pharmaceutical companies' operational efficiency for 1992-2002 to investigate the effect of managerial and strategic parameters by using the DEA model and

regression analysis. The conclusion indicated that domestic companies enjoy higher efficiencies than multinational pharmaceutical companies. Also, the study resulted in firms or companies with advanced innovation or R&D investments and older establishments enjoying higher efficiency compared to fewer R&D-intensive and younger counterparts.

Mazumdar et al. (2009) used Pastor, Ruiz, and Sirvent (PRS) DEA model to examine the competitiveness of 2492 Indian pharmaceutical firms by analyzing their technical efficiency from 1991 to 2005. Their study concluded that analysis was made on technical efficiency, which revealed that none of the variables, i.e., R&D, export expenditure, and imported technology, could improve firms' technical efficiency.

Tripathy et al. (2009) studied the efficiency of 90 selected pharmaceutical companies in India from 2001-2007. For the efficiency analysis, in the first stage, an input-oriented VRS-DEA model was incorporated by taking three inputs, i.e., cost of raw materials, sales & wages, and advertising & marketing, respectively. In the second stage, the impact of the firm's age, export of goods, imports of capital goods, R&D intensity, ownership, patent regime, and foreign direct investment on efficiency was evaluated using the Tobit model. The study resulted that R&D-intensive firms are more efficient compared to non-R&D-intensive companies. Also, the Malmquist productivity index resulted in a similarity in the total factor productivity of the selected firms throughout the study. The contributing factors are the export of goods, the new patent regime, the presence of foreign direct investment, the firm's profitability, and the R&D intensity.

Pannu et al. (2011) analyzed the relative efficiency and productivity change in 146 Indian pharmaceutical companies using the BCC DEA model and the Malmquist productivity index between 1998 and 2007. The study also analyzed the impact of firm size on the performance measures of the companies. Lastly, the study concluded that innovative firms, alongside R&D and patents, have higher efficiency compared to non-innovative firms.

Singh et al. (2014) used the CRS and VRS-based DEA models to analyze technical efficiency and total factor productivity growth for 30 major Indian pharmaceutical companies. The period of study was from 1991 to 2011. The study concluded with a necessity to decrease the technical, managerial, and scale efficiencies to ensure capacity utilization efficiency.

Dash et al. (2015) examined the significant impact of marketing efforts on the sales performance of nine pharmaceutical MNCs from 2002-2011. The analysis was made using the DEA model, and further, they used random effects maximum likelihood panel regression to evaluate the importance of the impacts of marketing efforts. The findings suggested a significant result of a marketing effort on the respective companies' linear and non-linear efficiency scores.

Saranga (2017) conducted a study by taking 44 Indian pharmaceutical companies from 1992-2002. Among these, 29 were indigenous, and 15 were multinational entities. He used multiple objective-based DEA models to study various stakeholders' interests, i.e., consumers and merchants simultaneously in the pharmaceutical industry.

Goyal et al. (2017) analyzed the study by taking 193 Indian pharmaceutical companies for 2015-2016. A DEA model measured the respective companies' overall technical efficiency, pure technical, and scale efficiencies. The findings of the study suggested that in resource utilization, there is a necessity to eliminate managerial efficiencies of the companies.

Gupta (2017) studied the performance growth of 26 Indian pharmaceutical companies by using BCC VRS-DEA multistage slack calculation method for the years 2010-2011. The findings suggested that the pharmaceutical industry must give more importance to exports for better performance and growth of the companies.

Mahajan et al. (2018) analyzed the efficiency and determinants in the pre and post-product patent regimes of 141 Indian pharmaceutical firms from 2000 to 2012 using an input-oriented CCR-DEA (Data Envelopment Analysis model). The study's findings suggested that the industry had a higher overall inefficiency due to inefficient input shift into output instead of through scale inefficiency. The study also found the adverse effects of product patents on efficiency. Variables like capital import intensity, ownership, and ownership were positively related to efficiency, whereas variables like age, time dummy, and size square were negatively associated. So, the findings concluded that there is a need for merging small firms into larger entities or manufacturing pharmaceutical products for other companies to increase the operational scale and advance capacity utilization.

From all the above studies, we can conclude that no such research has been done comparing the efficiency performance of traditional knowledge-based and western medicine companies. They included a few traditional knowledge-based medicine companies to study the performance of the Indian pharmaceutical companies as a whole, along with western companies. In some studies, they have only considered western medicine companies. Many studies have used input-oriented CCR and VRS DEA models to study the efficiencies of Indian pharmaceutical companies. But, in our research, we have used an output-oriented CCR-DEA model to study the overall technical efficiency of traditional knowledge-based and western companies. The output-oriented DEA model measures technical efficiency as a proportional increase in output, keeping inputs constant. Since both traditional and western medicine companies are driven by profit maximization, output orientation is preferable in our case. Lastly, none of the above studies have tested the relationship of efficiency scores with determinant variables, which has been done in our research. These tests have helped us find the hindrances which will help minimize the efficiency gap among the companies. So, in the following section, we have discussed our objective.

4. Data, Variables, and Methodology

In this study, the database used to collect information is known as the Centre for Monitoring Indian Economy or CMIE ProwessIQ. From this database, we have chosen 71 Indian pharmaceutical companies with respect to the National Industrial Classification 2008 (NIC-2008). The database has provided data for 22 traditional and 49 modern pharmaceutical companies from the financial year 2009 to the financial year 2018. The structure of the data is a panel at the firm level. Along with CMIE ProwessIQ, we have used databases like the Annual Survey of India (ASI) and the Economic Adviser Ministry of Commerce and Industry, Government of India.

We have used the 2011-2012 price index to construct the variables, as it is the currently available price index. The price indices have been used as the deflator to get the variables in the production function. The respective price indices have been collected from "Index Number of Wholesale Prices in India, base 2011-2012= 100", published by the Economic Adviser Ministry of Commerce and Industry, Government of India.

For this study, we have used the DEA model to obtain the efficiency score of both traditional and western pharmaceutical companies, respectively. All the samples are analyzed using four inputs and one output in the first stage of the study. Then, in the next section, we discussed data and variables-related information. The second stage of this study has been composed of the given models, i.e., the Fixed Effect model and the Random Effect model, to test the factors responsible for influencing efficiency scores. Here, the efficiency score obtained in the first stage has been taken as the dependent variable. At the same time, some firm-specific variables and financial variables have been taken as independent variables to regress the efficiency scores.

We have taken four inputs and one output to derive the efficiency scores of the respective TKBM and WM companies through an output-oriented CCR-DEA model. Therefore, Capital, Labour, Energy, and Material have been taken as inputs. The real value of output has been taken as output. The determinant variables include Experience, Cash flow, Liquidity, Asset Turnover Ratio, Profit, Market Size, and Market Competition.

5. Regression Framework

In our study, we have used Random effect, and Fixed effect regression models to study the impact of firm-specific and financial variables on the efficiency of traditional knowledge-based and western medicine companies. Here, the data are panel in nature. So, the general equation form has been given below.

$EFF_{it} = f(EXPit, CF_{it}, LQ_{it}, ATR_{it}, PR_{it}, MS_{it}, MC_{it})$ …. (1)

Where,

The left side of the equation shows the dependent variable, and the right side shows the independent variables for the company i at t time for all the companies. EFF_{it} is the efficiency score, EXP_{it} is the experience, CF_{it} is the cash flow, LQ_{it} is the liquidity, ATR_{it} is the asset turnover ratio, PR_{it} is the profit, MS_{it} is the market size, and MC_{it} is the market competition.

First, we have employed the Random effect model with time effect for traditional knowledge-based medicine companies, which can be seen in equation 2. Similarly, in equation 3, we have analyzed the Fixed effect model with time effect for western medicine companies. Then, we analyzed their relationships in terms of more experienced, less experienced, better asset management, and less asset management.

$$EFF_{it} = \alpha + \beta_1 EXP_{it} + \beta_2 CF_{it} + \beta_3 LQ_{it} + \beta_4 ATR_{it} + \beta_5 PR_{it} + \beta_6 MS_{it} + \beta_7 MC_{it} + v_t + u_{it} + \varepsilon_{it} \quad \textbf{…. (2)}$$

$$EFF_{it} = \delta + \gamma_1 EXP_{it} + \gamma_2 CF_{it} + \gamma_3 LQ_{it} + \gamma_4 ATR_{it} + \gamma_5 PR_{it} + \gamma_6 MS_{it} + \gamma_7 MC_{it} + v_t + u_{it} \quad \textbf{…. (3)}$$

In the above equations, α is the intercept for traditional knowledge-based medicine companies, and δ is the intercept for modern allopathic medicine companies; β_1 to β_7 means slope coefficients of the independent variables for traditional knowledge-based medicine companies and γ_1 to γ_7 means slope coefficients of independent variables for modern allopathic medicine companies; EFF_{it}, EXP_{it}, CF_{it}, LQ_{it}, ATR_{it}, PR_{it}, MS_{it}, and MC_{it} have been defined prior; v_t represents the time effect across the panel; u_{it} represents between company error, and ε_{it} means within company error.

5. Results and Discussion

5.1. DEA Result

In the first section of our study, we obtained the CRS efficiency result for traditional knowledge-based medicine companies. Here, we have considered CRS efficiency results to get the Overall Technical Efficiency (OTE) score of the respective companies, with a score of "1" to indicate a company is efficient and "0" or "less than 0" to tell a company is inefficient. The analysis has been done with respect to the efficiency score among 22 TKBM companies for ten years, i.e., from 2009 to 2018. The

OTE result for the nine companies in 2009, ten companies in 2010, seven companies in 2011, nine companies in 2012, eight companies in 2013, seven companies in 2014, nine companies in 2015, six companies in 2016, five companies in 2017, and six companies in 2018 have perfect relative efficiency, respectively. Here, in the end, the TKBM companies like Amrutanjan Health Care Ltd., Dabur India Ltd., Emami Ltd., Patanjali Ayurved Ltd., Sandu Pharmaceuticals Ltd., Shree Baidyanath Ayurved Bhawan Pvt. Ltd., Shree Dhootapapeshwar Ltd., Siddhayu Ayurvedic Research Foundation Pvt. Ltd., and V L C C Personal Care Ltd. are mostly efficient companies throughout the ten years of our study. Sandu Pharmaceuticals Ltd. is a perfectly efficient company among the TKBM companies throughout the study.

In the next section of our study, we have analyzed the CRS efficiency results for Western Medicine (WM) companies, as we have already done for TKBM companies. The analysis has been made on the efficiency score of 49 WM companies for ten years, i.e., from 2009 to 2018. The overall technical efficiency (OTE) result shows that seven companies in 2009, six companies in 2010, seven companies in 2011, five companies in 2012, four companies in 2013, four companies in 2014, six companies in 2015, four companies in 2016, three companies in 2017, and four companies in 2018 have perfect relative efficiency, respectively. In the end, WM companies like Abbott India Ltd., Astrazeneca Pharma India Ltd., Centrient Pharmaceuticals India Pvt. Ltd., and Procter & Gamble Hygiene & Health Care Ltd. have resulted as the most efficient companies throughout the ten years of our study. Abbott India Ltd. is a perfectly efficient company among western medicine companies throughout the study.

5.1.1 Comparison Result of DEA Efficiency Score Across Traditional Knowledge-based Medicine Companies and Modern Allopathic Medicine Companies

From the above two tables, considering the average overall technical efficiency score of the respective companies, we can compare the efficiency across the traditional knowledge-based and western medicine companies. By comparing the average scores of both companies, we can see that Traditional knowledge-based medicine companies are relatively more efficient than western medicine companies, with an average of 78% efficiency score.

5.2. Regression Result Analysis

Table 1

	RANDOM EFFECT		FIXED EFFECT	
Dependent Variable = EFF	Traditional Knowledge-based Medicine Companies		Modern allopathic medicine companies	
Variable	Coefficient	P-value	Coefficient	P-value
EXP	-0.016	0.394	-0.226	0.189
CF	0.031*	0.000	0.007**	0.046
LQ	0.004	0.217	-0.020*	0.010
ATR	0.005	0.157	-0.0005	0.779
PR	-0.0001*	0.000	0.00004***	0.082
MS	0.045*	0.004	0.007	0.855
MC	0.622*	0.000	0.826*	0.000
Constant	0.249*	0.009	0.947	0.154
No. of Obs.	220		490	
Year Effects	Yes		Yes	
Hausman Test (P-value)	7.08 (0.42)		23.17 (0.0007)	
Wald chi^2 (P-value)	330.22 (0.00)		-	
F Test (P-value)	-		15.20 (0.00)	
Within R^2	0.26		0.32	
Between R^2	0.81		0.07	
Overall R^2	0.64		0.12	

Source: Authors' compilation.

The above table shows the random effect results of the traditional knowledge-based medicine companies; we can see in Table 1 that our model supports the random effects model under the Hausman test, where the P-value is 0.42. Considering the results of random effects for traditional knowledge-based medicine companies, we can see that the model has been regarded as the time effect for 220 observations. The Wald chi^2 is 330.22, which means the model is fit for our test. Here EXP is statistically insignificant. PR has negatively significant impacts on EFF at the 1% significance level. This justifies companies are incurring more costs than earning revenue. Comparing other variables, i.e., CF, MS, and MC, shows significant impacts on EFF at the 1% level with positive coefficients. This shows how the traditional knowledge-based medicine companies' efficiency level is certainly affected concerning their management of assets in terms of cash flow and maintaining the position of the companies with potential buyers and market competitiveness in the industry. Lastly, this test shows that LQ and ATR are statistically insignificant.

Traditional knowledge-based medicine companies support the random effects model. In contrast, western medicine companies support the fixed effect model given the Hausman test score of 23.17 with a P-value of 0.0007. So, Table 1 shows the result of the fixed effect model for modern allopathic medicine companies considering the time effect for 490 observations. The F test score is 15.20, which means the model is fit for our test. Here, CF, LQ, PR, and MC, show significant impacts on EFF at 5%, 1%, 10%, and 1%, respectively. But, LQ has a negative impact on EFF. This shows how efficiently modern allopathic medicine companies are utilizing their assets in terms of cash flow. Also, it shows the market competitiveness in the industry impacting their efficiency level. But, we can see that companies' efficiency is affected by negative liquidity, indicating the company's lack of liquidity assets management. Here, EXP, ATR, and MS are statistically insignificant.

6. Findings

This study concludes that the nine most efficient traditional knowledge-based medicine companies are Amrutanjan Health Care Ltd., Dabur India Ltd., Emami Ltd., Patanjali Ayurved Ltd., Sandu Pharmaceuticals Ltd., Shree Baidyanath Ayurved Bhawan Pvt. Ltd., Shree Dhootapapeshwar Ltd., Siddhayu Ayurvedic Research Foundation Pvt. Ltd., and V L C C Personal Care Ltd. throughout the ten years of our study. Similarly, the four most efficient western medicine companies are Abbott India Ltd., Astrazeneca Pharma India Ltd., Centrient Pharmaceuticals India Pvt. Ltd., and Procter & Gamble Hygiene & Health Care Ltd. throughout the ten years of our study. Comparing both types of companies, we concluded that TKBM companies are more efficient than WM companies. It means traditional companies are doing well regarding financial and firm-specific points of view. To know their determinants of efficiency, we have also regressed the efficiency scores of both types of companies with some firm-specific and financial variables. We have used random effects and fixed effects models. We learned from these tests that they are mainly affected by variables like MC, PR, CF, and MS (Market Competition, Profit, Cash Flow, and Marker Size). This means these companies are competitive, utilizing their assets by earning a reasonable profit and adequately managing their cash flow with good market positions. Then we analyzed cross-sectional dependence, heterogeneity, and unit root tests.

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