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Applying Data Envelopment Analysis to Evaluate Financial Leasing Performance of Medical Device Industry in China

Yang LIU¹, Wenyuan LYU²

Abstract

When domestic medical care institutes are increasing and the government enhances the input, medical care institutes need to update and purchase new medical devices to enhance the medical service quality and level. High-end medical devices require a large amount of capital input. High purchase expenses for medical devices do not simply increase a hospital's economic pressure, but would result in expensive costs for patients seeing doctors. How to reduce purchase costs for medical devices becomes a dilemma for medical care institutes. Delphi Method is utilized in this study to make the evaluation indicators of financial leasing performance of medical device industry in China. Based on the data of medical device industry announced in Shanghai, 12 medical device enterprises are sampled as the research objects in this study. Data Envelopment Analysis is further used for calculating individual relative indicator. With linear planning and according to the efficiency frontier constructed with actual observed value, the difference between individual observed value and efficiency boundary is regarded as the relative inefficiency to measure each organization's efficiency. The research results show: (1) the best overall efficiency (1.00) of A Medical Instrument Co., Ltd., followed by L Medical Co., Ltd.0.98), and K Instrument Co., Ltd. the worst (0.70); (2) Malmquist is applied to analyze the efficiency to understand the efficiency change between two phases. Aiming at the financial leasing performance of medical device industry, the financial leasing is analyzed to provide directional thinking and reference for medical device industry.

Keywords: data envelopment analysis, medical device, financial leasing performance, innovation, comprehensive benefits.

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Introduction

Along with the deepening of domestic health care system reform, increasing national medical care institutes, and strengthening government input, medical care institutes have to update and purchase new medical devices to enhance the medical service quality and level. It provides a good development opportunity for domestic medical device manufacturers. Nevertheless, there are plenty of medical care institutes domestically that the government input is limited; besides, advanced medical devices are more expensive than the problem of capital shortage of medical care institutes is highlighted. The introduction of medical reform policy has the development of national medical industry appear clearer development management thinking that 0.85 trillion RMB will be used for medical reform and completing domestic medical infrastructure. It is a major opportunity for the development of medical device manufacturers. To grasp the opportunity and to create the marketing model suitable for the market and the development of an enterprise become the primary problems.

Enterprises in medical device industry are generally classified into production enterprises and circulation enterprises. However, a lot of capitals for equipment is the common problem for the enterprises developing and expanding the businesses to result in tense flow capitals. Being the major hardware for hospitals expanding medical work, medical devices present the critical importance. The acceleration of population aging has people increase the needs for medical services and drive the high-speed development of medical industry. Due to increasing competition in medical related markets, medical device institutes constantly update the medical production equipment, especially the introduction of advanced major instruments, to enhance the comprehensive strength and production innovation ability. Nevertheless, it requires large amount of capital input for high-end equipment. High equipment purchase expenses increases the economic pressure of medical device industry. For this reason, how to reduce equipment purchase costs becomes the dilemma in medical device industry. The financial leasing business therefore emerges. Such a method rapidly offering capitals and equipment for medical device industry is developed. Aiming at the financial leasing performance of medical device industry, this study intends to understand the overall development trend and the economic operation of financial leasing, aiming to provide directional thinking and reference for financial leasing of medical device industry.

Literature Review

Current situation of medical device leasing market

Since the emergence of leasing industry in 1950s, it was rapidly promoted in western advanced countries and permeated to various industries to promote the consumption standard and economic development standard in various countries. Pan & Wang (2013) studied financial leasing industry of medical devices and created new financial leasing businesses. The research results of this study would link the financial leasing of all short-term and hospital emergency centers in the US with deep real meanings. In regard to leasing asset securitization, Chau & Wong (2014) regarded leasing receivable securitization as a part of credit asset securitization and further interpreted the advantage and drawback of asset securitization to conclude that leasing receivable securitization was the financial innovation with real meaning in leasing market and should be largely developed.

Financial leasing was formally introduced to medical device industry in China in 1990s. It is still at the starting stage, is slowly developing, and does not present certain scale and system that it could not be compared with advanced countries. Research revealed low permeability of medical devices leasing in China, not even one-fifth of it in advanced countries in Europe and the US. Among more than thousand million purchase amount of medical devices in China, merely 10%-15% is from leasing. According to the estimate of dun & bradstreet, the medical device leasing input amount in China was about 30 billion RMB in 2010, which was merely 4.3% of the financial leasing transaction of 0.7 trillion RMB in China in 2010, that there was large development space. Since the announcement of new regulations in 2007, the increasing speed of financial leasing industry in China appeared geometric growth with total business amount 24 billion RMB in 2007 growing to 1.55 trillion RMB in 2012, about 54 times. According to China Leasing Blue Book, *2012 China's financial leasing industry development*, national financial leasing contract balance was about 1.55 trillion RMB in 2012, about 0.65 trillion RMB more than the 0.93 trillion RMB by the previous year. The growth range was about 66.7%, and the total industry scale was ranked the second in the world.

When leasing industry is booming in China, medical device financial leasing, as the sub-industry, is constantly developing. According to the statistics, up to a thousand of medical device financial leasing projects were successfully developed and more than one billion financing amount was involved. The geographical range for the business also covered 24 provinces, cities, and autonomous regions that the business coverage was broad. The specialization of domestic financial leasing industry is constantly enhanced and gradually expanding to emerging businesses to reinforce the cultivation and promotion. Medical health, as an important subdivision of financial leasing industry, is rapidly developed. According to *China Financial Leasing Industry Development Report (2016-2017)* of Ministry of Commerce, medical and pharmaceutical devices in domestic financial leasing industry reached

78.3 billion RMB in 2016. Medical health leasing has become a new growth in current financial leasing businesses.

Brief introduction to device financial leasing

Lieser & Groh (2014) mentioned that financial leasing was a new-style leasing developed in 1950s. According to the request of a lessee, a lessor purchased capital goods from a seller assigned by the lessee, according to the contract. Stephany (2015) explained that under the premise when a lessee presented the ownership of capital goods, the lessee paid rents for having and using the capital goods as well as the income right during certain period. In comparison such leasing-assets and financing function with traditional vehicle and house leasing, a lessee could acquire the ownership of leased object after paying corresponding rent and nominal price.

Morse (2015) indicated device financial leasing that an enterprise confirmed the correspondent devices and suppliers (manufacturers) and completed the approval process for introducing relevant devices, and a leasing company purchased selected devices, according to the enterprise's request, for the enterprise. Yang (2014) explained that an enterprise paid certain amount of rent within the valid period for the use and income rights of the device; and, by the end of the lease period, the enterprise could acquire the ownership by paying lower residual value of the device.

Device financial leasing contains following four models.

(1) Simple financial leasing: Simple financial leasing, i.e. financial leasing on the original meaning, involves in device manufacturers, leasing companies, and enterprises. The enterprise is in charge of device repair and daily maintenance as well as possible risks during the leasing period. After the leasing expiry, the enterprise could acquire the device with the contract negotiation price. Such a method shows simple operation and convenient management that most enterprises are willing to adopt such a method.

(2) Manufacture leasing: Manufacturer leasing refers to the financial leasing offered by a manufacturer to enhance the product sales. In such a leasing relationship, the manufacturer is a seller as well as a lessor (playing the role of a leasing company). When introducing devices, a medical care institute could acquire the use right of the device simply by regularly paying correspondent rents. Such a leasing method appears on device manufacturers with high-cost and fast-upgrade device technologies. Such a model is a common leasing method in current China market.

(3) Sale and lease back: An enterprise sells the device to a leasing company with certain price and then rents the device with installment payment. This is a funding method tying financial leasing and sales. In the sale and lease back process, an enterprise could sell the device for an emergent flow capital to revitalize the fixed asset. Furthermore, a leasing company could acquire more stable cash flow

with such a method. Regarding the device as a collateral could effectively reduce risks. Such a method is broadly applied in device financial leasing.

(4) Leveraged leasing: Leveraged leasing is generally applied to large items, such as infrastructure and offshore oil platform. It refers to a leasing company taking the lead to become a major company, uniting other investors (e.g. banks or securities investors) to invest in certain financial leasing project. The major leasing company generally invests in 20%-40% capitals, while the other investors offer 60%-80% non-recourse loan. Such a leasing method allows enjoying net benefits and appears good comprehensive benefits and secure returns. Nonetheless, as more interest groups are involved, such a leasing method is not common in device financial leasing industry, merely in some projects requiring huge capitals.

Performance evaluation

Edelstein and Liu (2016) regarded performance evaluation as a formal and structured system to measure, evaluate, and affect employees' work-related attributes, behaviors, and results so as to understand the employees' productivity and efficiency for employees, organizations, and society making benefits. Ndlovu (2013) defined organizational performance as "the attainment of specific desired end". In other words, performance was the consistency between the actual output and desired output of an organization. However, the setting of "desired end" became an argument for researchers on organization theory (Yoshida, Seko & Kazuto, 2016). Cohen & Sundararajan (2015) further indicated that performance was the result of business outcome, including the creation of operating income, the control of costs and expenses, and the presentation of profits. Emekter *et al.* (2015) stated that a company generally applied financial performance and marketing performance to stand for the business performance; the former contained return on investment, return on sales, income before tax, sales, and sales growth rate, while market share was the representative of the latter. Sherman & Young (2016) divided organizational performance into finance, enterprise, and organization. (1) Financial performance was a common measurement indicator as well as a definite method, e.g. sales growth rate and return. (2) Business performance added operating performance in financial performance and made analyses with other non-financial indicators of market share and product quality. (3) Organizational performance applied broad definition. In addition to above two, various interested parties' goal satisfaction was added to the organizational goal.

Establishment of research indicator

Summing up above performance evaluation indicators, this study intends to draw the financial leasing performance evaluation indicators of medical device industry in China with Delphi Method. Delphi Method, also called expert judgment, is a

group decision-making method with qualitative and quantitative characteristics. Being interdisciplinary and future oriented, it could acquire a commonly accepted answer for a certain issue with inadequate data or unknown situations by using questionnaire survey of experts for several runs of votes and feedback to reduce different opinions down to the lowest (Drabble *et al.*, 2015).

The so-called “expert”, according to research suggestions (Yoshida, Seko & Kazuto, 2016), should present: (1) interests in participating in Delphi Method survey, (2) rich information to share, (3) publically approved knowledge and technology in specific fields, (4) specialty on the surveyed subject, including practical experience and theoretical study, and (5) agreement with the research results containing the special information owned. Kagochi, Al Nasser, & Kebede *et al.* (2013) also indicated that an expert should present knowledge level, reliability, and accuracy as well as deeper understanding of the industry than laymen; expert judgment therefore was closer to the fact. The value of Delphi Method was established based on such answers.

Research method

Research object

With the announced data of medical device industry in Shanghai, 12 medical device enterprises are sampled for this study. Modified Delphi Method is used in this study for enhancing the benefit of the questionnaire survey and having experts focus on the research subject to objectively select inputs/outputs. Total 4 inputs/outputs and 12 DMUs are selected in this study. All variables used in this study are acquired from public profit and loss statement, prospectus, and annual reports of the medical device enterprises.

Data Envelopment Analysis

Data Envelopment Analysis, a math model for efficiency evaluation developed by Charnes *et al.* in 1978, substitutes common default functions with non-default functions to estimate the efficiency and applies mathematical planning model to calculate the efficiency frontier curve for comparing actual outputs with original production functions, as the efficiency. Envelope is the theoretical basis of DEA, with the basic principle based on Pareto Optimality established by Pareto in 1972. It defines that “no one could increase the benefits without damaging others’ benefits”. DEA is a multi-output-to-multi-input efficiency model without considering weight setting. By comparing the quantitative results of all DMUs, DMUs with better performance are gradually selected, and all efficient DMUs are drawn a curve, as the efficiency frontier. The distance between individual DMU’s observed value and efficiency envelope is calculated the relative efficiency level. In sum, DEA is

a relative indicator, through linear planning to construct efficiency boundary with actual observed value, and regards the gap between individual observed value and efficiency boundary as the relative inefficiency to measure the efficiency of organizations.

Definition of input/output

1. Input variable: (1.1) *Investment cost*: Capital costs input the market; (1.2) *Management method*: Marketing plan promotion, equipment turnover rate enhancement, and equipment facility maintenance expenses.
2. Output variable: (2.1) *Net operating revenue*: Gross operating revenue – sales return and allowance; (2.2) *Operating profit*: Expected profits and recovery period.

Empirical analysis

Relative efficiency analysis

Table 1 shows relative efficiency of medical device enterprises. A Medical Instrument Co., Ltd. presents the best overall efficiency (1.00), followed by L Medical Co., Ltd. (0.98), and K Instrument Co., Ltd. the worst (0.70).

A Medical Instrument Co., Ltd. shows the best pure technical efficiency (1.00), followed by L Medical Co., Ltd. (0.99), and K Instrument Co., Ltd. the worst (0.70).

A Medical Instrument Co., Ltd. reveals the best scale efficiency (1.00), followed by L Medical Co., Ltd. (0.98), and K Instrument Co., Ltd. the worst (0.69).

Table 1. Relative efficiency of medical device enterprise

Medical Device Enterprise	Overall Efficiency	Pure Technical Efficiency	Scale Efficiency
A Medical Instrument Co., Ltd.	1.00	1.00	1.00
B Medical Instrument Co., Ltd.	0.93	0.93	0.93
C Medical Instrument Co., Ltd.	0.88	0.89	0.87
D Medical Instrument Co., Ltd.	0.84	0.84	0.83
E Medical Instrument Co., Ltd.	0.95	0.95	0.94
F Medical Supplies Corp.	0.82	0.83	0.81
G Medical Instrument Co., Ltd.	0.90	0.90	0.90
H Scientific Instruments Co., Ltd.	0.78	0.77	0.79
I Electronic Technology Ltd.	0.86	0.87	0.85
J Technology Instrument Co., Ltd.	0.95	0.96	0.95
K Instrument Co., Ltd.	0.70	0.70	0.69
L Medical Co., Ltd.	0.98	0.99	0.98

Malmquist productivity analysis

Table 2 shows various Malmquist efficiency analyses, where A Medical Instrument Co., Ltd. and L Medical Co., Ltd. present the total factor productivity higher than 1, while the rest medical device enterprises appear it smaller than 1, revealing the productivity not reaching the optimal. In terms of pure technical efficiency change, all medical device enterprises have improved the efficiency. Regarding scale efficiency between two phases, A Medical Instrument Co., Ltd. and L Medical Co., Ltd. have moved toward long-term optimal scale, while the rest medical device enterprises appear smaller than 1, showing that the future management would be far away from the optimal scale. Moreover, the medical device enterprises have improved the production technical change between two phases.

Table 2. Malmquist efficiency analysis

Medical Device Enterprise	Two-phase technical change TECHCH	Pure technical efficiency change PECH	Two-phase scale efficiency change SECH	Total factor productivity change TFPCH
A Medical Instrument Co., Ltd.	1.03	1.04	1.06	1.06
B Medical Instrument Co., Ltd.	0.95	0.94	0.96	0.97
C Instrument Co., Ltd.	0.90	0.91	0.89	0.90
D Medical Instrument Co., Ltd.	0.87	0.86	0.85	0.87
E Medical Instrument Co., Ltd.	0.96	0.97	0.96	0.97
F Medical Supplies Corp.	0.85	0.85	0.84	0.84
G Medical Instrument Co., Ltd.	0.93	0.92	0.91	0.93
H Scientific Instruments Co., Ltd.	0.80	0.79	0.81	0.80
I Electronic Technology Ltd.	0.89	0.88	0.87	0.88
J Technology Instrument Co., Ltd.	0.97	0.99	0.98	0.97
K Instrument Co., Ltd.	0.73	0.72	0.71	0.72
L Medical Co., Ltd.	0.99	1.00	1.00	1.00

Conclusion

With survey, total 12 valid medical device enterprises are sampled and evaluated the financial leasing performance with Data Envelope Analysis in this study. The research results reveal that financing limits are the factor in medical device enterprises selecting financial leasing. A medical device enterprise with fewer internal capitals, larger volatility of internal capitals, higher price-book ratio, lower tangible asset ratio, and smaller enterprise size would have higher use of financial leasing. Financial leasing of medical device industry could result in following advantages for medical care institutes.

(1) Capital source: Although different hospitals have distinct capital sources, most hospitals still appear gap on the capitals for purchasing large equipment. Financial leasing could solve the equipment problem as well as provide partial capital support for the development.

(2) Equipment update: When purchasing equipment with one-time large amount of capital, the equipment would become hard to handle after the technology is behind and not practicable. Leasing could save costs and effectively avoid such problems to enhance the equipment update rate.

(3) Reducing technological difference: Different levels of hospitals, at the same period, present distinct requirements for the advance of medical devices. Leasing allows the same advanced medical devices being used at different levels of hospitals to reduce the technological difference.

(4) Optimization of resource allocation: The vast territory in China has continuously existed in the gap of medical devices between developed areas and undeveloped areas. Besides, it is difficult to allocate different medical devices in various areas through administrative tactics. Financial leasing could optimize the resource allocation of medical devices with reduced costs.

Recommendations

Aiming at financial leasing of medical device industry in China, the following suggestions are proposed in this study.

(1) The government should draw healthy leasing regulations to guarantee lessees' rights. Legal restrictions could also enhance market competition to further promote the quality of medical device leasing market. Complete leasing regulations would protect suppliers and medical device enterprises to enlarge the space for financial leasing and effectively encourage medical device enterprises' willingness to engage in financial leasing market.

(2) Financial leasing could effectively separate operating costs and operating assets of medical device enterprises. The higher financial limit has longer repayment period to enhance the capital utilization of medical device enterprises and expand

the utilization of external capitals. Under the situation that medium and small-scale medical device enterprises expanding the scale but short of capitals, it is easier to acquire medical devices than other financing channels. Medium and small-scale medical device enterprises are therefore suggested to take financial leasing into account and then bank loan, shipyard credit, issuance of bonds, and issuing shares, under existing management.

(3) From the research results, medical device enterprises with better corporate information show better financial leasing bargaining. Corporate information reveals influence on financial leasing bargaining of an enterprise that medical device enterprises are suggested to reinforce the financial leasing related information, including soft information variables of financial report reliability, management team, and customer evaluation in the profession, and hard information variables of quick ratio and gross margin. In this case, a medical device enterprise could enhance the financial leasing bargaining ability with the credibility, management ability, competitiveness, profitability, and debt-paying ability.

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