Efficiency Evaluation of China's Investment in Africa under the Background of Constructing 'Silk Road Economic Belt': Application of DEA Model and Malmquist Index Method

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In recent years, with implementation and propulsion of the strategic planning "One Belt and One Road" of China, quality and efficiency of China's foreign direct investment have increasingly become a focused issue. This paper utilizes the DEA model and Malmquist index method to select the data of China's investment in 20 countries of Africa and conducts the empirical research on dynamic evaluation of efficiency of China's direct investment in Africa. The result shows that the general efficiency of China's direct investment in Africa is in a declined fluctuation trend, while the technical efficiency of the investment is in a constant rising trend, and direct investment in most host countries has reached or is reaching the optimal scale. From the perspective of country difference, the efficiency of direct investment in a small number of host countries has been improved while that in most host countries has declined. With improvement of African countries in absorbing and utilizing foreign technologies and management level and effective innovation of China's direct investment in host countries, the efficiency of direct investment in host countries will be constantly improved. The suggestions such as optimizing investment location selection, emphasizing on the linkage between support facilities and industrial chain of the investment project, improving technology spillover efficiency and enhancing infrastructure investment are proposed.

Keywords: Africa, foreign direct investment, efficiency evaluation, DEA, Malmquist index, Silk Road Economic Belt

Africa is the strategic intersection in the planning and construction of " one Belt and One Road" . As a continent with the largest number of developing countries, Africa possesses abundant natural resources, labor resources and giant market potential. China is the largest development country and the second largest economic entity in the world, thus the complementarity between Chinese economy and African economy is good. Both sides possess many common integrating points in economic strategic interests. Economic and

trade cooperation between China and Africa can not only promote industrialization and modernization of Africa, but also has significant impact on economic development of China and the world. Since 2000 when " China-Africa Cooperation Forum" was successfully started, Sino-African trade and investment have entered into a constantly rapid development period. On December 5, 2015, China-Africa Cooperation Forum - Johannesburg Summit was successfully held. This summit upgraded the Sino-African relationship into the comprehensive strategic partnership and approved Summit Declaration and Action Plan (2016-2018). Taking the opportunity of Johannesburg Summit, both parties will comprehensively promote Sino-African cooperation, industrialization and agricultural modernization of Africa and accelerate effective connection between African dream and the Chinese dream. Africa is the strategic highland of " 21st Century Maritime Silk Road" , thus African countries will positively participate in the planning and construction of " One Belt and One Road" so as to improve the connectivity level of Africa. Sino-African cooperation and development will usher a great historical opportunity.

In recent years, China' s direct investment in Africa is increasing rapidly, which has greatly promoted Sino-African trade development and accelerated excessive capacity transfer and industrial upgrading of China. From 2008 to 2014, the annual average growth rate of stock of China' s direct investment in Africa was about 27% and the investment had reached USD 32.35 billion (by the end of 2014). China' s direct investment in Africa has covered 52 countries, and the investment coverage rate exceeds 90%. The investment range is no longer limited to the field of resources and minerals such as petroleum, but has been expanded to the fields such as construction industry, financial industry, manufacturing industry and agriculture. At the time when large-scale increase of China' s direct investment in Africa is achieved, the problems such as frequent investment risks, extensive operation and industrial disperse also appeared. Quality and efficiency of the investment in Africa also aroused people' s attention. For this reason, it is quite necessary to carry out the research on efficiency evaluation of China' s direct investment in Africa.

LITERATURE REVIEW

Research of domestic and foreign scholars on economic growth effect of host countries by absorbing and

utilizing foreign investment. Haskel and Slaughter [1] studied the economic growth effect caused by foreign companies on the host countries respectively by taking Venezuela and England as examples. The result considers that technology spillover effect of foreign investment shows positive correlation. Dupasquier and Osakwe [2] studied the effect of utilizing foreign investment in African countries. The result indicates that the promotion effect of foreign investment is quite obvious. Chunying and Bo [3] utilizes VAR model to study the influence of foreign direct investment absorbed by China on the economic growth of China and the balanced and dynamic relations of influencing factors. The result shows that foreign investment has positive effect on economic growth. Shujie and Genfu [4] verified that foreign investment could promote improvement of production technology efficiency of host countries and pointed out that attracting foreign investment was an important manner for emerging industrial countries in pursuing the developed countries. Research of Hong and Shumie [5] indicates that foreign investment has positive effect on China's economic growth and has obviously promoted employment and economic growth of China which is in a fluctuation trend. Meibo and Dongyan [6] considers that China's investment in African infrastructure construction is beneficial for propelling capacity building of Africa and improving its self-development capacity. Based on the research on evaluation of China's investment in African agriculture, Shaosa [7] considers that China's investment in African agriculture can help solve the food crisis which bothers Africa for a long term.

Researches of domestic and foreign scholars on efficiency evaluation of direct investment in host countries. Most researches are about investment efficiency evaluation carried out mainly by DEA and relevant models. Kravisova [8] utilizes DEA model to evaluate the efficiency of foreign direct investment in host countries. The result shows that the influence of foreign investment on economy of host countries is positive. Badunenko, Henderson and Houssa [9] utilizes DEA method to conduct empirical analysis on the data from 35 countries in Africa. The research considers that human resources and material resources are principal factors in economic growth of Africa. Favorable government management and infrastructure are also beneficial for economic development of Africa. Based on DEA model, Yuechun and Yingzi [10] evaluated the foreign investment efficiency and influencing factors of China's environmental protection industry by taking the panel data of more than 30 provinces and cities nationwide from 2003 to 2009 as samples and proposed relevant suggestions for promoting foreign investment efficiency. Ming'e [11] utilizes

DEA method to construct an environmental technology model and utilizes SBM directional distance function and common boundary ML productivity index to measure the inter-provincial environmental efficiency of China between 1992 and 2012, dynamic evolution and trend of environmental TFP. Bo [12] utilizes DEA method to evaluate the promotion effect of China's direct investment in Africa on economic growth of host countries and suggests that the general development trend of China's investment in Africa shall expand the scale and control the investment in part of the host countries.

In conclusion, existing literatures about evaluation methods, models and empirical researches of foreign direct investment efficiency and research on economic growth effect of host countries by absorbing and utilizing foreign investment have certain reference meaning. However, the researches on efficiency evaluation of China's direct investment in Africa are relatively less. Based on this, this paper utilizes the DEA model and Malmquist index method to select the data from 2008 to 2014, conducts the research on efficiency evaluation of China's direct investment in African host countries from the perspective of the host countries and proposes specific policies and suggestions.

Model Description

-DEA Model

Data envelopment analysis (DEA) is used for evaluating the investment efficiency. It is an efficiency evaluation method developed based on the concept of relative efficiency by determining the production leading surface from the perspective of total factor input. It is for evaluating and sorting the relative efficiency of each decision-making unit of the same type. DEA method does not need to pre-estimate the parameters or assume the weight or make the data being dimensionless, thus it has certain superiority in avoiding subjective factors, simplifying algorithm and reducing errors than other evaluation methods [13].

-Malmquist Index of Productivity and its Decomposition

Malmquist index of productivity was proposed by Malmquist, a Sweden economist, in 1953. Based on DEA, Fare etc. converted the Malmquist index of productivity from theoretical index into empirical evaluation index

and constructed the Malmquist index of productivity $M(x^{t+1}, y^{t+1}, x^t, y^t)$ from t th period to t+1th period as shown in formula (1). In the formula, $D^t(x^{t+1}, y^{t+1})$, $D^t(x^t, y^t)$ respectively refer to the distance function of the evaluation object in the t-th period and t+1th period based on technical reference of the t-th period.

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)} \right]^{1/2}$$

Fare further decomposes the Malmquist variability index of productivity ($tfpch$), into technical efficiency change ($effch$) and technical change ($techch$). Wherein the technical efficiency change ($effch$) is further decomposed into pure technical efficiency change ($pech$) and scale efficiency change ($sech$).

Therefore, formula (1) can be decomposed into formula (2) [14]:

$$M(x^{t+1}, y^{t+1}, x^t, y^t)$$
$$= \frac{D^{t+1}(x^{t+1}, y^{t+1} | VRS)}{D^t(x^t, y^t | VRS)} \cdot \frac{D^{t+1}(x^{t+1}, y^{t+1} | CRS)}{D^{t+1}(x^{t+1}, y^{t+1} | VRS)} \cdot \frac{D^t(x^t, y^t | VRS)}{D^t(x^t, y^t | VRS)} \cdot \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)} \right]^{1/2}$$
$$= effch \times techch$$
$$= pech \times sech \times techch$$
$$= tfpch$$

The relations between $tfpch$, $effch$, $techch$, $pech$ and $sech$ can be obtained according to the decomposition of formula (2), as shown in Figure 1. From t-th period to t+1th period, $tfpch$ refers to change of production efficiency, $tfpch > 1$ refers to improvement of productivity level and on the contrary otherwise; refers to displacement degree of production leading edge which can reflect the change conditions and is also referred to as "leading surface movement effect"; $techch > 1$ refers to technical frontier progress and on the contrary otherwise; $effch$ can reflect technical efficiency changes of the evaluation object, thus it is also referred to as "catching-up effect". $effch > 1$ refers to relative improvement of the evaluation object in technical efficiency and on the contrary otherwise; $pech$ and $sech$ decomposed from $effch$ respectively reflect the change conditions of pure technical efficiency and scale efficiency of the evaluation object, $pech > 1$ refers to efficiency promotion of the evaluation object by improving technology and management and on the contrary otherwise; $sech > 1$ refers that the evaluation object is approaching the optimal scale and on the contrary otherwise. This paper will calculate the Malmquist index of productivity of China's investment in each host country in Africa and each decomposed index analyzes the dynamic efficiency change of

China's direct investment in each host country and proposes suggestions for strategy adjustment and efficiency improvement of China's investment in the host countries in Africa.
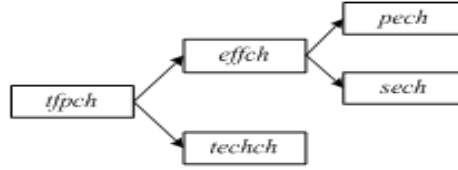

Figure 1. Decomposition of *tfpch*

Evaluation Index and Evaluation Object

-Evaluation Index and Data Source

It is normally considered that effects of foreign direct investment are mainly shown in promoting economic growth, trade development, tax revenue, financial income growth and infrastructure construction of the host countries. This paper takes the stock of China's direct investment in Africa, population in economic activities and labor market efficiency index of the host country as the input factors and takes GDP of the host country, per capita GDP of the host country, export volume of the host country, fiscal revenue of the host country and infrastructure development index of the host country as the output factors. The input factors are expressed by X_1 and X_2, and the output factors are expressed by $Y_1 \sim Y_5$ as shown in Table 1.

-Evaluation Object

To ensure accuracy of the result in utilizing DEA to conduct efficiency evaluation, the evaluation objects in the evaluation process need to be provided with similar characteristics. To ensure that the evaluation result has a reasonable distinction degree, the number of evaluation objects shall not be less than twice of the product multiplying the number of input indexes by the number of output indexes [15]. This paper selects top 20 host countries in the ranking of stock of China's direct investment in Africa by the end of 2014 as the evaluation objects. They are respectively: South Africa, Algeria, Nigeria, Zambia, Congo (Kinshasa), Sudan, Zimbabwe, Angola, Ghana, Congo (Brazzaville), Namibia, Ethiopia, Tanzania, Kenya, Egypt, Mozambique, Mauritius, Uganda, Guinea and Chad. Stock of China's direct investment in the 20 host countries accounts for 88.67% of the total stock of China's direct investment in the entire Africa (as shown in Figure 2). The

number of evaluation objects is twice of the product multiplying the number of input indexes by the number of

the output indexes so as to satisfy the requirements for evaluation objects.

Index Type	Name of Index	S/N	Data Source
Input Index	Stock of China's Direct Investment in the Host Country	X_1	*Statistical Bulletin of China's Outward Foreign Direct Investment*
	Population in Economic Activities of the Host Country	X_2	*African Statistical Yearbook*
	Labor Market Efficiency Index of the Host Country	X_3	*Global Competitiveness Report*
Output Index	GDP of the Host Country	Y_1	World Bank Database
	Per Capita GDP of the Host Country	Y_2	World Bank Database
	Export Volume of the Host Country	Y_3	Database of UNCTAD
	Fiscal Revenue of the Host Country	Y_4	Calculated according to relevant data in *African Statistical Yearbook*
	Infrastructure Development Index of the Host Country	Y_5	*Global Competitiveness Report*

Source: Data of China's direct investment in African countries come from Statistical Bulletin of China's Outward Foreign Direct Investment, population in economic activities, GDP, per capita GDP and export volume of each host country in Africa come from African Statistical Yearbook, world bank database and database of UNCTAD, labor market efficiency index and infrastructure development index of the host country comes from Global Competitiveness Report and fiscal revenue of the host country is calculated according to the data in African Statistical Yearbook (please refer to Table 1).

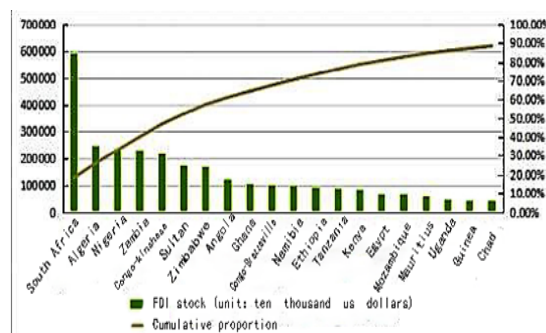*Table 1. Input Index and Output Index*

Figure 2. Stock of China's Investment in Top 20 Countries of Africa and Pareto Diagram (up to the end of 2014)

Evaluation Result and Analysis of China's Direct Investment in African Countries

-Analysis on Overall Efficiency

The overall efficiency of China's direct investment in 20 countries of Africa from 2008 to 2014 is calculated by the Malmquist model and DEA P 2.1, and the evaluation result is as shown in (Table 2). The efficiency tendency chart (as shown in Figure 3) for China's direct investment in host countries of Africa is drawn. Analysis on the evaluation result is as follows:

From the perspective of overall efficiency change ($tfpch$): the overall efficiency of China' s direct investment in host countries of Africa from 2008 to 2014 is in a downtrend, and the average value of $tfpch$ is only 0.803. However, the investment efficiency from 2013 to 2014 is in a rapid rising trend. It indicates that the overall efficiency of China' s direct investment in Africa is in a declined fluctuation trend, but it is turned to a rising trend in recent years.

From the perspective of technical efficiency change ($effch$): technical efficiency of China's direct investment in host countries of Africa from 2008 to 2014 is in a stable trend, and the average value of $effch$ is 1.047. Wherein the technical efficiency from 2010 to 2011 slightly declines, but on the whole, the technical efficiency of China's direct investment in Africa is generally maintained stable.

From the perspective of pure technical efficiency index ($pech$): pure technical efficiency of China's direct investment in Africa from 2008 to 2014 is in a stably rising trend and the average value of $pech$ is 1.047, wherein the efficiency was greatly improved from 2010 to 2013, which was increased by 20.4%. However, the technical and management level of 20 countries of Africa in absorbing China's investment from 2008 to 2014 was generally maintained stable.

From the perspective of scale efficiency ($sech$): scale efficiency of China's direct investment in host countries of Africa from 2008 to 2014 is stable and the average value of $sech$ is 1.000. The scale of China' s direct investment in 20 countries of Africa has generally reached or is close to the optimal scale.

Technical change ($techch$) reflects the advance and retreat change of technical leading surface. Advance of technical leading surface indicates that China's direct investment has obtained effective innovation activities and on the contrary otherwise. The result shows that the technical leading surface of China's direct

investment in 20 countries of Africa from 2008 to 2014 is in a fluctuation trend and the average value is only

0.767. It reflects that whether an enterprise conducts effective innovation activities or not is an important

constraint which influences efficiency improvement of China's direct investment in Africa.

Year	effch	techch	pech	sech	tfpch
2008-2009	1.109	0.563	1.078	1.029	0.625
2009-2010	1.046	0.977	0.984	1.062	1.021
2010-2011	0.986	0.952	0.984	1.002	0.939
2011-2012	1.016	0.818	1.012	1.004	0.831
2012-2013	1.026	0.602	1.188	0.864	0.618
2013-2014	1.108	0.787	1.051	1.054	0.872
Average	1.047	0.767	1.047	1.000	0.803

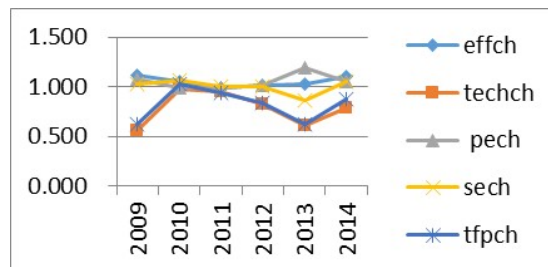*Table 2. Malmquist Efficiency Index of China's Direct Investment in Africa from 2008 to 2014*

Figure 3. Malmquist Efficiency Tendency Chart of China's Direct Investment in Africa

Country Efficiency Analysis

The country efficiency of China's direct investment in 20 host countries of Africa from 2008 to 2014 is

calculated by the Malmquist model and DEA P 2.1, and the result shown in Table 3 can be obtained. The 20

host countries are divided into the following types according to $tfpch$, $effch$, $techch$, $pech$ and $sech$ larger than,

equal to or less than "1", of each host country in Table 3 and based on the classification rules of Figure 4.

Comprehensive Improving Host Countries (Such as Mauritius)

From 2008 to 2014, $tfpch$, $effch$, $techch$, $pech$ and $sech$ of China's direct investment in Mauritius were larger

than "1", wherein the efficiency of China's direct investment in Mauritius was improved by 9.0%. It indicates that China's direct investment in Mauritius is conducting effective innovation activities which
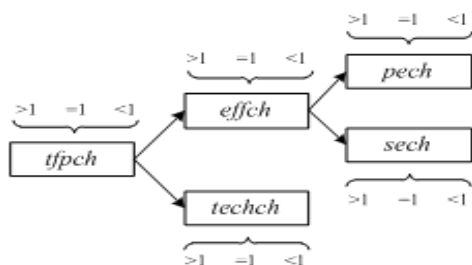

Figure 4. Classification of Dynamic Evaluation on Efficiency of China's Direct Investment in Each Host Country

advances the technical leading surface. Meanwhile, the scale of China's direct investment in Mauritius is reaching to the optimal scale. The level of Mauritius in utilizing the technology and management has also been promoted, which makes the technical efficiency of direct investment promoted. It is thus seen that advance of technical leading surface and improvement of technical efficiency make the overall efficiency of China's direct investment in Mauritius rapidly improved.

Technical efficiency promoting host countries, such as Chad

From 2008 to 2014, *tfpch* and *effch* of China's direct investment in Chad was larger than 1, while *techch* was less than 1. It indicates that the technical leading surface of China's direct investment in the host countries was not propelled. However, the scale of China's investment in this kind of host countries is maintained in the optimal scale, the management level of Chad in absorbing and utilizing investment is constantly improved and the technical efficiency of China's direct investment in the country is improved, thus the overall efficiency of China's direct investment in this kind of countries is improved.

Technical leading surface retreating host countries, such as Zambia, Sudan, Congo (Kinshasa), Angola, Ghana, Tanzania, Kenya, Mozambique and Sudan

tfpch and *techch* of China's direct investment in these host countries are less than "1". It can be seen that retreating of technical leading surface is the main reason for reduction of overall efficiency of China' s direct investment in these host countries. It indicates that China' s direct investment in these host countries is lack

of effective innovation activities.

Technical leading surface retreating and technical efficiency reducing host countries, such as South Africa, Algeria, and Congo (Brazzaville)

$tfpch$, $effch$ and $techch$ of China's direct investment in these host countries are less than "1". It indicates that innovation of China's direct investment in these host countries is not enough and the technical efficiency of the direct investment is also declining. The decline comprises reduction of investment scale efficiency and reduction of the level in utilizing technology and management. The reasons from the two aspects have resulted in the reduction of the general investment efficiency.

In addition to these, it is found by further observing investment scale efficiency of these countries that: $effch$ of China's direct investment in South Africa, Angola, Algeria, Mauritius, Egypt and Namibia is equal to "1", thus the investment scale and the technology utilization level is maintained in the optimal scale; while the $effch$ of China's direct investment in Zambia, Nigeria, Ethiopia, Ghana, Tanzania, Zimbabwe, Mozambique, Guinea and Chad is larger than "1", thus the technical efficiency and investment scale are reaching to the optimal scale.

CONCLUSION

This paper selects top 20 host countries in the ranking of stock of China's direct investment in Africa by the end of 2014 as the evaluation objects from the perspective of the host countries, utilizes DEA model and Malmquist index method to calculate the overall efficiency and country efficiency of China's direct investment in Africa from 2008 to 2014 and analyzes the dynamic efficiency changes of China's direct investment in each host country of Africa. The following conclusions are obtained:

On the whole, the overall efficiency of China's direct investment in Africa is in the declined fluctuation trend, while from 2013 to 2014 it shows a rapidly rising trend. With improvement of technology absorbing and utilization level of the host countries, technical efficiency of China's direct investment has been constantly improved. Direct investment in most African host countries has reached or is reaching the optimal scale. However, lack of effective innovations in the process of China's direct investment has caused retreating of

the technical leading surface. Considering all the above factors, the overall efficiency of China's direct investment in the 20 countries from 2008 to 2014 shows a declined variation trend.

From the level of country difference, the efficiency of China's direct investment in a small number of host countries has been improved, but the efficiency of the direct investment in most host countries is in the declining trend. The reason for efficiency improvement comprises: improvement of the level of the host country in absorbing and utilizing technology and management of China's direct investment, innovation in the process of China's direct investment in the host country and the direct investment scale of the host country has reached or is close to the optimal scale. However, decline of overall efficiency of some host countries is because that China's direct investment is lack of effective innovation activities, the investment scale is improper and the level of absorbing and utilizing foreign investment technology is low.

SUGGESTIONS

According to the above conclusions, the following suggestions are proposed specific to the actual conditions of China's direct investment in each host country of Africa:

It is of necessity to adjust the scale of investment in the host countries and optimize the area selection in direct investment in Africa. Excessive investment scale and improper investment can be avoided by adjusting the investment scale. The direct investment efficiency can be optimized by enhancing agglomeration degree of the invested industries so that the optimal investment scale can be reached. For some of the host countries in Africa, South Africa, Zambia, Sudan, Ethiopia, Congo (Brazzaville), Egypt, Uganda and Guinea shall keep existing investment scale; while Algeria, Nigeria, Congo (Kinshasa), Zimbabwe, Angola, Namibia, Ghana, Tanzania, Kenya and Mozambique shall properly adjust existing investment scale to improve investment agglomeration degree and scale to realize optimal scale of direct investment in the host countries.

We should emphasize on supporting facilities of the invested project and connection with the industrial chain, improve the level of foreign investment utilization and technology spillover efficiency of the host countries. The level of most host countries of Africa in absorbing and utilizing the direct investment is low, which

directly results in reduction of the efficiency of China's direct investment in them. So in the process of investment in Africa, Chinese enterprises shall pay attention to supporting facilities of the invested projects and organic connection between upstream and downstream of the industrial chain. The enterprises are encouraged to enter into Africa "in group" and carry out cluster-type investment so as to enhance the industrial clustering ability and technology spillover effect of the investment in Africa and further promote efficiency level of China's direct investment in Africa. In consideration of the trend that Nigeria, Mauritius, Ghana and Ethiopia have constantly improved their levels of absorbing and utilizing the investment in recent years, China and Africa plan and jointly build the overseas industrial park and economic and trade cooperation areas to strengthen the industrial clustering ability and international competitiveness of enterprise investment.

Innovation of direct investment shall be implemented in Africa. Advance of technical leading surface can be promoted and the direct investment efficiency can be further promoted by innovations in entrance mode, investment industrial pattern and management manner of the direct investment in Africa. Besides, China shall also pay attention to adaption and innovation of technical localization of Chinese enterprises, encourage the Sino-African cooperation enterprises, establish and jointly build Sino-African economic and trade cooperation areas, industrial parks and special economic zones, enhance industry-university-research cooperation and promote industrial clustering ability of the direct investment.

We also need to strengthen infrastructure construction of the host countries and improve investment environment in Africa. Laggard infrastructure becomes the "bottleneck" which restricts economic development of Africa and foreign investment attraction. African countries have taken infrastructure construction as the acting point and important breakthrough point in developing economy and improving investment environment. With implementation of China's "One Belt and One Road" strategy, China and Africa have carried out major cooperation in infrastructure construction and capacity cooperation, which will greatly improve the investment environment of each host country in Africa and promote the overall efficiency of China's investment in Africa.

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Host Countries	effch	techch	pech	sech	tfpch	Host Countries	effch	techch	pech	sech	tfpch
South Africa	0.987	0.920	0.987	1.000	0.908	Ethiopia	1.239	0.766	0.990	1.252	0.949
Zambia	1.068	0.907	0.986	1.083	0.969	Tanzania	1.235	0.766	1.051	1.176	0.946
Nigeria	0.877	1.062	0.871	1.007	0.932	Congo (Brazzaville)	0.998	0.838	1.119	0.892	0.836
Angola	1.166	0.855	1.166	1.000	0.996	Kenya	1.045	0.764	1.057	0.989	0.799
Zimbabwe	1.129	0.713	1.075	1.050	0.805	Egypt	0.861	1.079	0.861	1.000	0.929
Sudan	1.009	0.749	1.066	0.946	0.756	Mozambique	1.196	0.611	1.092	1.095	0.731
Algeria	0.971	0.792	0.971	1.000	0.768	Uganda	1.242	0.515	1.449	0.857	0.639
Congo (Kinshasa)	1.121	0.715	1.143	0.981	0.801	Namibia	1.014	0.837	1.014	1.000	0.849
Mauritius	1.011	1.093	1.011	1.000	1.105	Guinea	1.649	0.603	1.171	1.408	0.994
Ghana	1.077	0.740	1.025	1.050	0.796	Chad	1.556	0.707	1.048	1.485	1.100

Table 3. Malmquist Efficiency Index of China's Direct Investment in Africa from 2008 to 2014