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Investigating operations of industrial parks in Beijing: efficiency at different stages

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ABSTRACT
Industrial parks enjoy significant importance in many countries and regions. This study presents a multi-stage operational process to evaluate the efficiency of parks at each stage using an empirical study of Beijing. The study finds that only three of 22 parks were efficient overall during 2006–2008 and two of 22 were efficient during 2009–2012. The promotion of business, facilitation of production, and rewards of economic returns are highly correlated stages for efficiency performance. The results suggest that Beijing's government should expend more effort developing the potential to generate outputs given current land and investment inputs. In addition, it provides a tool to strengthen the organisational capacity development of industrial parks by emphasising their multi-dimensions in inputs and outputs, selecting the right competitors at the right organisational stage, locating sources of efficiency and inefficiency, and understanding progression and balance of internal stages during operation.

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1. Introduction

Industrial parks are pioneering new economic activities and industrial organisations, and thus, are receiving a lot of attention (Curl & Wilson, 2015; Ramos & Fonseca, 2016; Shen & Tsai, 2016). An industrial park is considered a place in which a group of firms is concentrated to realise the potential of economies of scope and to facilitate both tangible and intangible industrial linkages, knowledge exchange, and technology spillovers to boost local economic growth. This high expectation confers privileges to industrial parks in land provision, infrastructure investment, and fiscal budget. According to the database of the International Labour Organization (ILO), the number of industrial parks worldwide increased from 75 in 1975 to 3500 in 2006 (Boyenge, 2007). By 2007, there were more than 130 countries implementing industrial park schemes (Farole & Akinci, 2011) and the development of various industrial parks has become a strategy to support local economic development,

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especially in Asia (ADB, 2015). Thus, the performance of industrial parks has become an important issue in management and strategic decision processes.

In practice, operating industrial parks presents challenges for policymakers and practitioners. The establishment and operation of industrial parks, as special industrial organisations, involve considerable investment in land construction, infrastructure, and facilities. However, industrial parks are not 'fields of dreams,' that is, initial expectations do not automatically come true after construction of parks (Peddle, 1993; Yang, Song, & Chahine, 2016). Efficiency is an indicator to monitor the establishment and operation of industrial parks. Recently, the efficiency of industrial park operation has received increasing interest, particularly by means of data envelopment analysis (DEA) (Festel & Würmseher, 2014; Hu, Yeh, & Chang, 2009; Izadikhah & Saen, 2015). This type of analysis could be deepened as the operation of industrial parks is a multiple-stage process, embodied by different departments or offices overseeing different issues, including marketing and promotion, production of firms, and reward returns to the park. This study is dedicated to investigating multi-stage operation of industrial parks so as to contribute to enhancing the efficiency of parks' internal organisational structures.

Specifically, using an empirical study of Beijing in China, this study extends the literature about industrial park management in several ways. First, this study provides a framework of multi-stage development of industrial parks inclusive of concepts and ideas widely acknowledged in economic theories and business management. This framework could enable managers and planners to understand the process of industrial operation explicitly and thereby, to adopt more realistic and effective decisions.

Second, in order to investigate the efficiency of multiple stages of the operation of industrial parks, a network D.E.A. method is introduced. The D.E.A. method has received a lot of attention in business operations and project management (Izadikhah & Saen, 2015; Park & Sung, 2016; Xu & Yeh, 2014). This study introduces a slack-based method (S.B.M.) of network D.E.A. as an innovative approach to industrial park management. This method allows for performance evaluation based on multiple inputs and multiple outputs. More importantly, it permits discovery of the black box in D.E.A. and diagnosis of efficiency at each stage, thereby enabling industrial park management from strategic planning to organisational capacity development.

Third, within the fast growth of industrial parks globally over the past decades, China has been one of the most successful countries to employ them as an engine to boost its economy. With successful stories often reported on the economic output of industrial parks, there is growing interest in investigating their performance and efficiency (Hu, Han, Yeh, & Lu, 2010; Khodakarami, Shabani, & Saen, 2014; Shen & Tsai, 2016; Yang, Hao, & Cai, 2015; Yang et al., 2016). This research contributes to the study of industrial parks in China by examining their operational efficiency at different stages. Findings from China are meaningful for practitioners to assess achievements more subjectively, creating a new means of comparison among parks and selection of best performers to encourage management learning processes and particularly, to strengthen internal organisational capacity building. In addition, findings from China have meaningful implications for developing economies especially, as industrial parks in developing countries have become a primary area of investment and construction to facilitate their industrialization and market economy development (Sala-I-Martin et al., 2007; Shen & Tsai, 2016).

The remainder of the paper is organised as follows. Section 2 offers a multi-stage analysis of industrial park operation by drawing on economic, business, and management literature. Section 3 describes the methodology of S.B.M. network D.E.A. for industrial park management. Section 4 presents the results of efficiencies at the main operational stage of 24 industries in Beijing during 2005–2012. The implications of these findings are discussed in Section 5, and Section 6 concludes by recapping the findings and limitations, and suggesting directions for future research.

2. Multiple stages of industrial park operation

As an industrial organisation, the industrial park develops interactions with resources and business environments. From the perspective of business management, it can be divided into the processes of promotion, facilitating production, and generating tax for government. Measuring the efficiencies of these divisions has become critical. Potential can be located effectively in the improvement of overall performance, enabling management in the areas from strategic planning to organisational learning, and eventually improving the competitive advantage of the organisation (Avkiran, 2009; Shen & Tsai, 2016; Yang, Cai, Ottens, & Sliuzas, 2013).

As such, evaluating performance and efficiency of industrial parks is an important issue. Löfsten and Lindelöf (2003) measure the effect of resources, innovation, risk, and strategies on the growth of firms in science parks in Sweden. C. J. Chen and Huang (2004) and Hu et al. (2009) evaluate the performance of high-tech industries in Taiwan's industrial parks. Nosratabadi, Pourdarab, and Abbasian (2011) examine industrial parks' performance in Iran. Rivera, Sheffi, and Knoppen (2016) examine logistics parks in Spain. Gradually, the D.E.A. method has gained popularity in evaluating industrial parks' performance. For example, C.-J. Chen, Wu, and Lin (2006) apply D.E.A. and the Malmquist index to investigate the performance of six industries in a science park in Taiwan. Liu, Tian, Chen, Lu, and Gao (2015) evaluate environmental performance of national eco-industrial parks in China using D.E.A. Izadikhah and Saen (2015) propose a single virtual approach to rank the performance of 17 Iranian industrial parks. Network D.E.A. has also received interest from researchers, such as Khodakarami et al. (2014), who measures the sustainability of industrial parks in Iran by two-stage D.E.A.; and Hu et al. (2010), who analyses science and technology industrial parks in mainland China applying a four-stage D.E.A. approach. Different form Hu et al. (2010) and Khodakarami et al. (2014), who examine both production and environmental efficiency, this research mainly focuses on business management and the economic operation of industrial parks.

From the point of view of business management, it is essential for industrial parks to attract new firms and investment as sources of parks' continuous growth. Marketing and branding have become increasingly important in strategic planning all over the world; these can be regarded as a plurality of efforts to create a corporate image based on firms' and parks' distinctive characteristics, and through this, to attract investments and specialised human resources (Metaxas, 2010; Mudambi, Doyle, & Wong, 1997). This is particularly so for industrial parks in the globalised economy characterised by competition in industrial locations (Bessho & Terai, 2011; Shen & Tsai, 2016; Wilsher, 1994; Yang et al., 2013; Yang, Liang, & Cai, 2014). This constitutes the first stage of industrial park operation, that is, *promotion of business*.

Successfully managed industrial parks never stop innovating operations after attracting firms. At the second stage, the *facilitation of production* includes shaping forward and backward linkages, enhancing business support, developing entrepreneurship, and creating opportunities for improving labour skills. Efforts to achieve these features can be observed in the creation of incubators and science parks for start-ups and technological innovation, local institutional reform, strength cooperation between industries and universities, and stimulating the growth of supporting industries (Phan, Siegel, & Wright, 2005; Salvador, Mariotti, & Conicella, 2013). These efforts aim to leverage the production of firms in the park to reap high industrial outputs and revenues.

Economic returns are the last stage of industrial operation. This represents the rewards for the establishment of industrial parks. In addition, because governments quite often invest significantly in infrastructure and public facilities, fiscal revenue is an important prerequisite for the financial sustainability of the industrial park, including the ability to pay its own operating costs (Geng, Zhang, Côté, & Qi, 2008) and to evolve continuously (Peddle, 1993), especially in a decentralised institutional environment.

These stages constitute a relatively complete process of industrial park operation, although there are still limited studies exploiting the stages of promotion and economic returns. These three stages occur coherently and simultaneously, not in exclusion to each other, in the profit-generating process of the park, from attracting firms to harvesting the fruits of establishing the park. In addition, some factors may work at one or all stages; for example, knowledge milieu can both attract firms and facilitate production. Some factors need balancing, subject to the phase and type of industrial parks; for instance, taxation reduction was a main method used in Chinese industrial parks to lure foreign companies, but hampered the generation of fiscal revenue, causing budgetary problems for industrial construction and maintenance, which was abandoned gradually after 1999 (Kynge, 1999).

Therefore, in order to be successful, industrial park operation needs to monitor each stage's efficiency. This is a crucial step to reveal the strengths and weaknesses of operations, activities, and processes (Maleyeff, 2005). Anand and Kodali (2008) claim that efficiency measurement is a continuous analysis of strategies, functions, processes, products or services, and performances with the intention of assessing an organisation's current standards and, thereby, carrying out self-improvement.

3. Methods and data

3.1. Method

By looking at both inputs and outputs, efficiency evaluation has received a lot of attention, particularly using the D.E.A. method. D.E.A. constructs the best performance 'frontier' and reveals the relative shortcomings of inefficient decision-making units (D.M.U.s) (Xu & Yeh, 2014; Yip, Devinney, & Johnson, 2009). It measures efficiency by generating the maximum outputs obtainable from the given inputs consumed or by minimising inputs for generating the given outputs under the current status of technology available (Song, Yang, & Chahine, 2016). This method shows several merits in practice; for instance, it can evaluate multiple inputs and multiple outputs and thus, can account for multi-dimensionality in management, requires no a priori production function, and distinguishes the best performers for each heterogeneous group rather than against the average of all groups (Kumar Mandal & Madheswaran, 2010; Richard, Devinney, Yip, & Johnson, 2009; Sueyoshi, Goto, & Sugiyama, 2013; Tone, 2001). Despite these merits, standard D.E.A. is denounced as a black box because it provides inadequate information to identify the specific sources of inefficiency (Färe & Grosskopf, 1997). Therefore, network D.E.A. has been developed to open the black box (Avkiran, 2009; Laurens, De Bram, Bart, Filip, & Jeroen, 2013), and has received increasing attention in operational studies (Cook, Liang, & Zhu, 2010; Despotis, Sotiros, & Koronakos, 2015; Park & Sung, 2016). This study attempts to apply a network slack-based network D.E.A. model to investigate the special multi-stage organisational process of industrial parks.

The general idea of applying network D.E.A. is to locate the (in)efficiencies at different stages of the operation of industrial parks. At each stage, the development of industrial parks is featured by multiple inputs (e.g., land and fixed asset investment) and multiple outputs (e.g., to realise economic growth and add fiscal revenues). Moreover, the output in the previous stage could be the input in the next stage, for instance the increase of firms and investment located in the park. Differences in the efficiency of industrial parks at different stages could provide much clearer information on the target of improving an industrial park's operation.

In this study, each industrial park is analogous to a D.M.U., whose efficiency measures multi-dimensional decision problems that can be resolved by D.E.A. Assume a sample that covers n D.M.U.s ($j = 1, 2, \ldots, n$), with m inputs and s outputs on each D.M.U. For the i-th D.M.U., X_{ij} and Y_{rj} are vectors of inputs and outputs. Given that the efficiency of industrial parks can be affected by minimising inputs or maximising outputs, and that inputs and outputs may not change proportionally, an S.B.M. is proposed to solve the non-radial problem in D.E.A. (Tone, 2011). As all industrial parks seek to maximise their outputs under given conditions of inputs, an output-oriented model is selected. In addition, considering the change of scale would affect efficiency, the output-oriented S.B.M. model is chosen under the assumption of variable returns to scale (Tone, 2011).

Following the method proposed by Tone (2011) and Tone and Tsutsui (2009), the S.B.M. network D.E.A. is calculated. Specifically, if input X and output matrix Y are defined as

$$X = (x_1, x_2, \ldots, x_n) \in R^{m\times n} \text{ and } Y = (y_1, y_2, \ldots, y_n) \in R^{s\times n}, \text{ and } X > 0 \text{ and } Y > 0 \quad (1)$$

the production possibility set can be defined by using the combination of D.M.U.s in set J as

$$P = \left\{ \left(x, y\right) | x \geq \sum_{j=1}^{n} \lambda_j x_j, \quad 0 \leq y \leq \sum_{j=1}^{n} \lambda_j y_{j,} \ \lambda \geq 0 \right\} \quad (2)$$

where $\lambda = (\lambda_1, \lambda_2, \ldots, \lambda_n)^T$ is an intensity vector. The output-oriented S.B.M. model is

$$\frac{1}{\rho_o^*} = \max_{\lambda, s^-, s^+} \left(1 + \frac{1}{s} \sum\nolimits_{r=1}^{s} \frac{s^+}{y_{ro}} \right) \quad (3)$$

s.t.

$$x_{io} = \sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- \qquad (i = 1, \ldots, m),$$

$$y_{ro} = \sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ \qquad (r = 1, \ldots, s),$$

$$\sum_{j=1}^{n} \lambda_j = 1,$$

$$\lambda_j \geq 0\left(\forall j\right), s_i^- \geq 0(\forall i), s_r^+ \geq 0(\forall r). \tag{4}$$

where S_i^-, and S_r^+ are slack vectors corresponding to input excesses (input slacks) and output shortfalls (output slacks) in the i-th D.M.U. x_{i0}, y_{r0} represent the input and output, respectively, in the frontier unit 0, and ρ^* is the efficiency of the D.M.U.

In running the D.E.A. model, a problem arises in that all D.M.U.s are non-efficient or efficient with a score of 1. That means the resulting efficiency score is highly skewed, and efficient D.M.U.s cannot be distinguished. To solve this, a super-efficiency (δ_O^*) model of D.M.U.s is calculated (Tone, 2011):

$$\delta_o^* = \min_{\bar{x},\bar{y}.\lambda} \frac{1}{(1/s)\sum_{r=1}^{s}(\bar{y}_r/y_{ro})} \tag{5}$$

s.t.

$$\bar{x}_i \geq \sum_{j=1, j\neq o}^{n} x_{ij}\lambda_j (i = 1, \ldots, m),$$
$$\bar{y}_r \leq \sum_{j=1, j\neq o}^{n} y_{rj}\lambda_j (r = 1, \ldots, s),$$

$$\sum_{j=1}^{n} \lambda_j = 1, \bar{x} \geq x_o, \bar{y} \leq y_o, \bar{y} \geq 0, \lambda \geq 0. \tag{6}$$

The network approach considers the existence of several stages in industrial park operations, each of which consumes its own set of inputs and produces its own set of outputs; intermediate products are defined as inputs for some stages and are the outputs for others, as linking activities in between stages. Specifically, if D.M.U.s ($j = 1, 2, \ldots, n$) can be divided as k stages ($k = 1, 2, \ldots., K$), L is denoted as the link set from stages k to h by (k, h), m_k and r_k are the numbers of inputs and outputs, respectively, to stage k, and the production possibility set is defined as

$$x^k \geq \sum_{j=1}^{n} x_j^k \lambda_j^k \qquad (k = 1, \ldots, K),$$
$$y^k \leq \sum_{j=1}^{n} y_j^k \lambda_j^k \qquad (k = 1, \ldots, K),$$
$$z^{(k,h)} = \sum_{j=1}^{n} z_j^{(k,h)} \lambda_j^k \qquad (\forall (k,h)),$$
$$z^{(k,h)} = \sum_{j=1}^{n} z_j^{(k,h)} \lambda_j^h \qquad (\forall (k,h)),$$

$$\sum_{j=1}^{n} \lambda_j^k = 1(\forall k), \lambda_j^k \geq 0\left(\forall j, k\right) \tag{7}$$

where x_j^k is input resources to DMU_jat stage $k\left\{x_j^k \in R_+^{mk}\right\}(j = 1, 2, \ldots., n; k = 1, 2, \ldots., \mathrm{K})$, y_j^k is output of DMU_jat stage $k\left\{y_j^k \in R_+^{rk}\right\}(j = 1, 2, \ldots., n; k = 1, 2, \ldots., \mathrm{K})$, and $z_j^{(k,h)}$ links intermediate products from stages k to $h\left\{z_j^{(k,h)} \in R_+^{t_{(k,h)}}\right\}\left(j = 1, 2, \ldots, n; (k,h) \in \mathrm{L}\right)$, $t_{(k,h)}$ is the number of items in the link (k, h), and $\lambda^k \in R_+^n$ is the intensity vector corresponding to stage k ($k = 1, 2, \ldots, \mathrm{K}$) (Tone & Tsutsui, 2009).

In the analysis, the linking activities are freely determined and maintain continuity between inputs and outputs. The output-oriented efficiency of DMU_o is solved by the following linear programme:

$$\frac{1}{\tau_o^*} = \max_{\lambda^k, s^{k+}} \sum_{k=1}^{K} w^k \left[1 + \frac{1}{r_k}\left(\sum_{r=1}^{r_k} \frac{s^{k+}}{y_{ro}^k}\right)\right] \tag{8}$$

s.t.

$$\begin{aligned} & x_o^k = \sum_{j=1}^{n} x_j^k \lambda_j^k + s^{k-} \qquad (k = 1, \ldots, K), \\ & y_o^k = \sum_{j=1}^{n} y_j^k \lambda_j^k - s^{k-} \qquad (k = 1, \ldots, K), \\ & \sum_{j=1}^{n} \lambda_j^k = 1 \qquad (k = 1, \ldots, K), \\ & z^{(k,h)} \lambda^h = z^{(k,h)} \lambda^k \qquad (\forall k, h) \\ & \lambda^k \geq 0,\ s^{k-} \geq 0, s^{k+} \geq 0, \qquad (\forall k). \end{aligned} \tag{9}$$

where τ_o^* is the overall output efficiency of DMU_o, w^k is the relative importance of k division, and $\sum_{k=1}^{K} w^k = 1$. The output-oriented efficiency score at each division k is calculated by

$$\tau_k = \frac{1}{1 + \frac{1}{r_k}\left(\sum_{r=1}^{r_k} \frac{s^{k+*}}{y_{ro}^k}\right)} \qquad (k = 1, \ldots, K) \tag{10}$$

In output-oriented S.B.M. network D.E.A., the overall efficiency score is the weighted harmonic mean of the divisional scores

$$\frac{1}{\tau_o^*} = \sum_{k=1}^{K} \frac{w^k}{\tau_k} \tag{11}$$

In order to compare D.M.U.s with efficiency scores of 1, we follow a super-efficiency approach to obtain super-efficiency scores for the overall process and each stage.

3.2. Study area and data

Beijing is the capital city of China, with a population of more than 21 million and a land area of about 16,140 km^2. It is widely reported that industrial parks have become an engine of the Beijing economy (Yang, Sliuzas, Cai, & Ottens, 2012). In 2013, Zhongguancun Science Park (Z.G.C.) made R.M.B. 696 billion in gross domestic product (G.D.P.), accounting for 35% of the total in the city. In 2010, Z.G.C. produced R.M.B. 119 billion, or 17% of the city's G.D.P. It also attracted foreign direct investment (F.D.I.) of U.S.D. 14 billion in 2013, about 16% of Beijing's F.D.I. in 2013 (Beijing Statistical Bureau, 2014; Zhongguancun Management Office, 2014).

At present, there are 24 industrial parks in Beijing, of which 10 are at national level, including eight sub-parks of the Z.G.C., the Beijing Development Area (B.D.A.), and the Tianzhu Bond Area, and 16 are at municipal level. Correspondingly, there is a huge amount of input in establishing and developing the industrial parks. The land size on which parks have been implemented increased from 9849 ha in 2006 to 13,591 ha in 2012, although this accounts for only 37% of the planned area, implying that 63% of the land remains undeveloped (Beijing Statistical Bureau, 2013). Meanwhile, the accumulated fixed asset investment in the parks, spent mainly on road construction and public facilities, was as high as RMB 82.1 billion in 2012, an increase of nearly four times compared to 2006 (Beijing Statistical Bureau, 2006). Therefore, the first empirical question examined in this study is as follows.

Q1: Are Beijing's industrial parks economically efficient so that economic inputs can be used optimally?

As the global financial crisis since 2008 has significantly affected economic development, the second research question this study investigates is as follows.

Q2: Do the relative performances of Beijing's industrial parks change before and after the financial crisis?

Furthermore, as discussed in the literature review, industrial park operation involves different stages. The second empirical question in this study is as follows.

Q3: Do Beijing's parks have different efficiencies at different operational stages?

Answering these questions is expected to generate detailed information for improving the internal processes of industrial park operation.

In light of theoretical analysis, the operational processes of an industrial park can be divided into three key stages: the promotion of business, the facilitation of production, and the rewards of economic returns. The key indicators and the three stages are illustrated in Figure 1. The implemented land area is underdeveloped land or land facilitated for industrial park use, and is assumed as a key input in the whole process. Fixed asset investment is the total accumulated fixed investment since the establishment of the park until the year analysed. As the main output of promotion, investment attracted includes domestic investment and F.D.I. in the park. Registered capital refers to the amount of capital registered at commercial and business bureau when firms are established in the park. This is an important indicator of risk and profit share of firms. Revenue is the total sum of money obtained by firms in the park through services, and industrial output is the value obtained by firms engaged in manufacturing activities. Economic returns are reflected by profits made by the

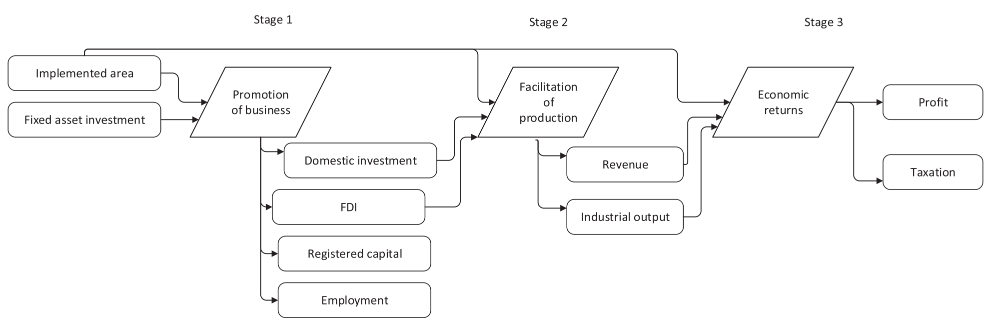

Figure 1. Operational stages and key inputs and outputs of industrial parks. Source: by authors.

park, and tax as the main source of fiscal revenues of the park, collected mainly from land release and taxes on firms.

All the data are collected from a survey of the Z.G.C. management authority and the Beijing Statistical Yearbook 2007–2014. Data are missing for the Z.G.C.-Electronic Yongle economic development zone (E.D.Z.), Xiaotangshan industrial park, and Mafang E.D.Z.; therefore, 22 industrial parks are analysed. Owing to data availability, the period 2006–2012 is analysed, except for missing data from 2007 for Z.G.C.-Yionghe and Badaling E.D.Z. Table 1 presents descriptive statistics of the data-set.

4. Results

The S.B.M. network D.E.A. approach measured the efficiency of each operational stage of industrial parks in Beijing. As the promotion and production stages are more important than the taxation stage, the weight of each of these stages, w^k, is 0.4, 0.4 and 0.2, respectively. Appendix 1 shows the overall network efficiency estimates, and provides a breakdown of each operational score in each year. By considering possible fluctuations and in order to understand long-term effectiveness, the mean of the efficiency score of all periods is calculated by the sum of all scores divided by the number of years observed (Table 2). In addition, the efficiency of industrial parks was compared for the periods 2006–2008 and 2009–2012 to examine differences of their performances before and after the global financial crisis.

5. Discussion

5.1. Comparing relative performances of industrial parks

The findings show that different parks performed quite differently in terms of efficiency – from Z.G.C.-Haidian park with the highest score of 4.302 to Caiyu E.D.Z. with the lowest overall score of 0.004 during 2006–2008, and from Z.G.C.-Haidian park with the highest score of 3.219 to Z.G.C.-Desheng with the lowest overall score of 0.006 during 2009–2012. In general, only three parks were efficient during the period 2006–2008 – Z.G.C.-Haidian, Z.G.C.-Shijingshan, and Z.G.C.-Fengtai – and only two parks were efficient during 2008–2012 – Z.G.C.-Haidian and Z.G.C.-Shijingshan. With regard to the first empirical question, this result suggests that the Beijing government should be careful about the input–output (I–O) relationship during industrial development, and there is still great potential to improve outputs given current land area implemented and fixed asset investment.

The performance of industrial parks is substantially different before and after the global financial crisis, which addresses the second empirical question. Table 2 shows that six parks maintain their ranks before and after the financial crisis, nine parks improve their ranks, and seven parks are downgraded. This reflects that industrial parks, as a connection between local and global economies and an engine of local economic growth, are sensitive to this effect of the financial crisis.

Changes of the performances of industrial parks reflect their ability to compete in the market and to some extent their growth momentum in the future, since industries and firms are intensively engaged in technological innovation and upgrading in order to counteract the effect of the financial crisis. The first science park, Z.G.C.-Haidian park, ranks first before and after 2008 because a handful of high-tech firms, such as Lenovo, IBM, and Microsoft, are located in the park. Z.G.C.-Fengtai maintains its third place mainly due to the

Table 1. Data description of industrial parks in Beijing during 2006–2012.

Industrial parks		Implemented Area (ha)	Fix Asset (R.M.B. million)	Project investment (R.M.B. million)	Domestic Investment (R.M.B. million)	F.D.I. (R.M.B. million)	Employment People	Revenue (R.M.B. million)	Industrial output (R.M.B. million)	Proftofit (R.M.B. million)	Tax (R.M.B. million)
Beijing Development Area	Minimum	3008	9086	112	64,623	2981	114,585	208,800	16,603,000	10,652	9025
	Maximum	3891	33,994	231	163,171	5597	275,219	442,816	22,847,000	33,975	30,130
	Std. Deviation	353	10,462	46	40,297	895	59,443	80,688	2,161,841	8387	8210
Z.G.C.-Haidian	Minimum	1714	344	216	196,484	2680	457,700	318,973	9,582,863	24,001	15,035
	Maximum	1789	8000	356	323,915	7184	776,012	1,066,575	15,175,989	82,236	42,309
	Std. Deviation	28	2680	47	42,647	1688	107,926	266,777	2,088,002	21,393	10,019
Z.G.C.-Fengtai	Minimum	328	562	46	46,007	319	106,827	75,562	1,879,847	5073	1949
	Maximum	328	6400	106	105,701	342	164,716	293,848	3,540,154	12,270	8172
	Std. Deviation	0	2521	22	22,041	7	24,098	82,949	685,551	2932	2230
Z.G.C.-Changping	Minimum	475	188	21	19,758	210	62,145	43,980	2,953,780	2694	1587
	Maximum	863	5064	51	49,346	464	122,726	234,419	12,251,389	12,313	7826
	Std. Deviation	162	1653	11	11,370	81	25,296	69,345	3,436,463	3656	2425
Z.G.C.-Desheng	Minimum	564	86	6	6369	0	13,294	5169	172,485	250	194
	Maximum	564	1176	7	6629	0	55,716	76,488	2,416,205	11,371	3786
	Std. Deviation	0	343	0	108	0	16,104	25,872	830,146	4003	1321
Z.G.C.-Yonghe	Minimum	290	968	0	1084	1	243	175	4761	0	11
	Maximum	290	5022	5	4859	28	24,641	37,948	91,793	1888	1477
	Std. Deviation	0	1760	2	1201	8	8730	13,515	34,425	650	510
Z.G.C.-Shijingshan	Minimum	56	9	2	2293	184	6189	3866	274,869	94	89
	Maximum	56	350	14	15,090	342	57,543	90,948	732,176	4847	2903
	Std. Deviation	0	115	5	5658	67	18,761	34,111	164,065	1895	1041
Z.G.C.-Daxing	Minimum	436	225	2	603	45	507	140	14,422	28	12
	Maximum	518	1654	9	4226	102	9016	6633	611,858	718	503
	Std. Deviation	34	441	2	1170	21	3083	2272	215,594	256	163
Tianzhu Bond Area	Minimum	106	32	1	1132	31	1228	621	62,201	26	6
	Maximum	350	755	11	4722	222	13,865	8167	189,506	3359	447
	Std. Deviation	109	265	4	1364	78	5240	3370	51,085	1206	207

(Continued)

Table 1. (*Continued*).

Industrial parks		Implemented Area (ha)	Fix Asset (R.M.B. million)	Project investment (R.M.B. million)	Domestic Investment (R.M.B. million)	F.D.I. (R.M.B. million)	Employment People	Revenue (R.M.B. million)	Industrial output (R.M.B. million)	Proftofit (R.M.B. million)	Tax (R.M.B. million)
Shilong E.D.Z.	Minimum	110	7	8	4066	63	17,630	2836	142,288	166	616
	Maximum	184	1117	53	15,669	64	60,882	29,374	491,700	2541	2745
	Std. Deviation	29	439	15	4129	0	14,731	10,070	127,833	986	779
Liangxiang E.D.Z.	Minimum	110	18	5	4047	22	16,857	14,060	97,342	278	666
	Maximum	118	300	13	13,249	99	31,469	20,815	458,766	373	1177
	Std. Deviation	3	98	3	3485	26	4940	2313	135,698	33	168
Daxing E.D.Z.	Minimum	183	28	5	3416	95	15,841	4356	242,385	42	168
	Maximum	236	371	5	3554	95	31,221	17,480	1,747,960	591	628
	Std. Deviation	28	108	0	59	0	5692	5277	669,508	196	181
Tongzhou E.D.Z.	Minimum	241	487	8	2797	269	9140	5716	471,537	170	287
	Maximum	402	2012	28	5799	362	11,400	17,734	784,049	616	839
	Std. Deviation	62	611	9	1269	31	982	4449	101,081	174	217
Yanxi E.D.Z.	Minimum	552	1236	10	4518	334	18,530	10,039	990,022	609	678
	Maximum	734	3956	25	8825	2572	27,486	25,541	2,044,441	2245	1764
	Std. Deviation	88	1028	6	1948	1067	3421	5694	409,816	620	425
Xinggu E.D.Z.	Minimum	250	234	7	3568	325	18,063	9503	735,971	542	585
	Maximum	300	1012	9	4201	389	32,962	21,776	1,730,317	1932	1338
	Std. Deviation	24	272	1	189	22	6266	5067	428,834	652	282
Miyun E.D.Z.	Minimum	363	200	5	2366	169	17,827	6601	543,606	64	429
	Maximum	924	2119	22	4522	391	32,968	28,647	1,724,978	1458	1784
	Std. Deviation	203	767	6	803	78	5873	7720	450,469	537	550
Linhe E.D.Z.	Minimum	157	1221	6	3924	72	7871	9126	437,451	423	357
	Maximum	157	3004	15	11,386	924	13,994	38,897	3,223,060	1921	2732
	Std. Deviation	0	525	4	2763	316	2272	11,698	1,298,844	538	1072
Tianzhu Airport E.D.Z.	Minimum	391	1448	38	30,065	631	49,214	52,334	3,328,423	2724	1899
	Maximum	560	6468	56	36,398	1558	63,984	89,179	4,589,045	4980	4147
	Std. Deviation	77	1898	7	2209	343	5016	12,325	447,861	833	795
Badaling E.D.Z.	Minimum	112	19	5	4190	52	9327	6092	98,889	0	306
	Maximum	112	598	12	10,650	65	10,660	12,283	378,357	562	1085
	Std. Deviation	0	205	3	2317	6	474	2431	115,779	202	246

(*Continued*)

Table 1. (*Continued*).

Industrial parks		Implemented Area (ha)	Fix Asset (R.M.B. million)	Project investment (R.M.B. million)	Domestic Investment (R.M.B. million)	F.D.I. (R.M.B. million)	Employment People	Revenue (R.M.B. million)	Industrial output (R.M.B. million)	Proftofit (R.M.B. million)	Tax (R.M.B. million)
Yanqing E.D.Z.	Minimum	130	273	2	269	1	2054	769	85,116	−77	18
	Maximum	306	522	7	1104	8	6595	3227	351,547	63	45
	Std. Deviation	64	80	2	322	3	1497	966	96,730	48	10
Caiyu E.D.Z.	Minimum	142	190	2	930	0	1526	100	10,038	0	2
	Maximum	165	695	4	2709	0	2053	1227	113,545	28	52
	Std. Deviation	9	179	1	808	0	174	375	35,140	11	18
Fangshan E.D.Z.	Minimum	90	575	2	712	25	2935	533	60,513	0	26
	Maximum	155	856	4	997	49	4122	1668	176,785	94	60
	Std. Deviation	29	108	1	118	11	434	456	47,039	31	13
Beijing	Minimum	56	7	0	269	0	243	100	4761	−77	2
	Maximum	3891	33,994	356	323,915	7184	776,012	1,066,575	22,847,000	82,236	42,309
	Std. Deviation	779	4590	65	56,714	1387	128,345	156,952	4,900,275	12,283	7267

Sources of data: Beijing Statistic Yearbooks 2007-2013, Beijing Zhongguancun Management Office.

Table 2. Mean efficiency scores of industrial parks in Beijing before and after the global financial crisis.

	Average performance during 2009–2012					Average performance during 2006–2008					
Industrial parks	Overall	Promotion of business	Facilitation of production	Economic returns	Rank	Overall	Promotion of business	Facilitation of production	Economic returns	Rank	Changes of ranking
Beijing Development Area	0.576	0.485	0.767	0.555	4	0.589	0.409	0.977	0.656	7	3
Z.G.C.-Haidian	3.219	5.096	2.287	3.671	1	4.302	6.471	3.102	5.115	1	0
Z.G.C.-Fengtai	0.884	0.685	1.207	0.957	3	1.096	1.193	1.109	0.936	3	0
Z.G.C.-Changping	0.365	0.270	0.576	0.382	6	0.529	0.460	0.658	0.492	8	2
Z.G.C.-Desheng	0.006	0.002	0.384	0.430	22	0.063	0.130	0.046	0.054	15	−7
Z.G.C.-Yonghe	0.058	0.055	0.055	0.099	16	0.007	0.030	0.005	0.041	20	4
Z.G.C.-Shijingshan	2.776	2.117	3.495	8.944	2	1.256	1.054	2.020	1.417	2	0
Z.G.C.-Daxing	0.039	0.040	0.040	0.037	18	0.015	0.024	0.011	0.017	19	1
Tianzhu Bond Area	0.055	0.133	0.054	0.033	17	0.051	0.153	0.040	0.338	17	0
Shilong E.D.Z.	0.301	0.318	0.311	0.458	8	0.830	0.913	1.024	0.711	5	−3
Liangxiang E.D.Z.	0.272	0.358	0.375	0.137	9	0.335	0.382	0.411	0.636	9	0
Daxing E.D.Z.	0.263	0.431	0.457	0.105	10	0.101	0.300	0.127	0.045	13	3
Tongzhou E.D.Z.	0.079	0.120	0.098	0.039	15	0.111	0.196	0.124	0.055	12	−3
Yanxi E.D.Z.	0.100	0.122	0.098	0.076	13	0.125	0.139	0.131	0.097	11	−2
Xinggu E.D.Z.	0.193	0.174	0.227	0.180	11	0.207	0.260	0.210	0.153	10	−1
Miyun E.D.Z.	0.094	0.097	0.119	0.064	14	0.072	0.127	0.119	0.031	14	0
Linhe E.D.Z.	0.157	0.158	0.196	0.116	12	0.867	0.595	1.526	1.049	4	−8
Tianzhu Airport E.D.Z.	0.346	0.404	0.416	0.227	7	0.708	0.755	0.772	0.559	6	−1
Badaling E.D.Z.	0.371	0.361	0.406	0.579	5	0.005	0.355	0.230	0.001	21	16
Yanqing E.D.Z.	0.014	0.028	0.032	0.005	19	0.017	0.016	0.024	0.014	18	−1
Caiyu E.D.Z.	0.007	0.135	0.021	0.002	21	0.004	0.095	0.006	0.001	22	1
Fangshan E.D.Z.	0.011	0.030	0.015	0.004	20	0.052	0.158	0.045	0.029	16	−4

Sources: by authors.

increasing importance of its firms engaged in environmental protection technology. BDA, the most important manufacturing base in Beijing (Yang et al., 2013), increases its rank by three places compared to other parks, as it has transformed from traditional manufacturing activities to modern ones. Badaling E.D.Z. increases its rank by 16 places as it quickly develops new energy and environmental protection industries. By comparison, traditional manufacturing industrial parks are degraded significantly, including Linhe E.D.Z., which is mainly for auto-parts production, and Fangshan E.D.Z., which is engaged primarily in the oil industry. The lower ranking of Z.G.C.-Desheng by seven places could be because its finance industries (backup offices) were affected during the financial crisis.

The network D.E.A. approach enables a closer analysis of the performance of industrial parks at each operational stage, which allows us to test the third empirical question. Taking the result of 2008–2012 as an example, Z.G.C.-Haidian and Z.G.C.-Shijingshan, were efficient at all stages while Z.G.C.-Fengtai park was efficient at the stage of facilitation of production; the other parks were inefficient at all stages. Nevertheless, the value of efficiency and inefficiency scores varied greatly among the parks.

Furthermore, Kendall's tau coefficient was performed to measure correlation among the rank of overall performance and each stage's performance (Table 3). This showed that the rank correlation coefficients have significance levels of no less than 0.7, except for the coefficients between promotion of business and economic returns, which were 0.58 during 2008–2012 and 0.68 during 2006–2008, implying that the efficiency of the previous stage could significantly affect the next stage.

Detailed analysis could help to detect the main sources of efficiency or inefficiency of parks. If the overall efficiency rank is used as a baseline, the difference of each stage rank from the baseline could be depicted as Figure 1, which could roughly be used to understand the main contributor of efficiency or inefficiency in a relative sense. Take Z.G.C.-Desheng as an example. The key stages to improve its performance were the enhancement of economic returns during 2006–2008, and the facilitation of production and the enhancement of economic returns during 2009–2012. Having a better understanding about the key stages of performance would help industrial parks to improve their operations and become more efficient.

Table 3. Rank correlation among all stages and overall efficiencies of industrial parks.

	2009–2012					2006–2008			
	Overall	Promotion of business	Facilitation of production	Economic returns		Overall	Promotion of business	Facilitation of production	Economic returns
Overall	1	.792**	.792**	.775**	Overall	1	.723**	.870**	.835**
Promotion of business	.792**	1	.706**	.584**	Promotion of business	.723**	1	.818**	.680**
Facilitation of production	.792**	.706**	1	.792**	Facilitation of production	.870**	.818**	1	.740**
Economic returns	.775**	.584**	.792**	1	Economic returns	.835**	.680**	.740**	1

**Correlation is significant at the 0.01 level (2-tailed).
Sources: by authors.

5.2. Operating parks according to divisional efficiency

The stage analysis greatly enhances industrial park management from strategic planning to organisational capacity development. In particular, stage analysis makes four contributions to industrial park operation, especially parks that are government projects.

First, the analysis helps monitor multiple I–O relationships during industrial park development. The D.E.A. method measures efficiency based on multiple inputs and outputs, generating an objective and consistent approach to evaluate park performance, thereby providing information shared by different stakeholders with different interests. As Yip et al. (2009) argue, difficulties in sustaining long-term performance arise not just from the competitive environment but also from subsequent problems in measuring the multi-dimensional characteristics of performance. Depending on data availability, the method can be performed regularly, which helps managers and policymakers to grasp the progress of park operations against their peers or competitors.

Second, by using frontier technology, D.E.A. selects competitors or divides the D.M.U.s as several groups, which share similar inputs or outputs. Therefore, the park can learn from peers that share the same frontier, rather than from the best of the entire group. This enables delivery of information to facilitate the learning process of the organisation. This information is detailed further by examining the operational stages of the industrial parks. For instance, during 2009–2012, B.D.A., and Z.G.C.-Haidian share the same group at all stages; however, Z.G.C.-Fengtai shares the same group with Z.G.C.-Haidian

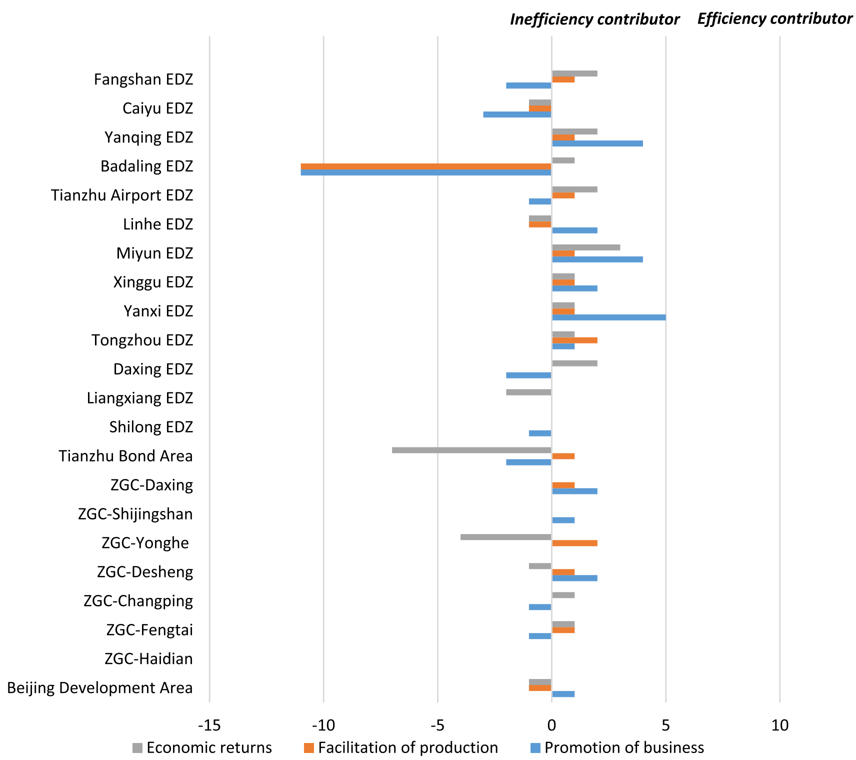

Figure 2. Key factors of efficiency or inefficiency of industrial parks during 2006–2008. Source: by authors.

and Z.G.C.-Shijingshan at the promotion and production stages only, but Z.G.C.-Haidian, Z.G.C.-Shijingshan, and Z.G.C.-Yonghe share only the stage of economic returns.

Third, divisional efficiency locates the source of efficiency performance of the park, which facilitates more target measures. Accordingly, specific efficiency-enhancing strategies can be fostered for the individual components of the production process (Lewis & Sexton, 2004). For example, even though Z.G.C.-Haidian enjoys the highest efficiency score, it could improve its performance at the production stage, as it ranks next to Z.G.C.-Shijingshan during 2008–2012. Z.G.C.-Shijingshan has more problems with the facilitation of production than with the promotion of business and enhancement of economic returns. This internal strengthening process could eventually contribute to overall performance enhancement.

Last but not the least, the divisional analysis helps us to understand the progression of improving performance of industrial parks, and provides a clue to balance the weight of each stage. In this study, focus was given to attracting firms and production of the park, but this by no means indicates that the last stage is not important. As Figure 2 shows, taxation is the main contribution to inefficiency of the Tianzhu Bond Area during 2006–2008. Owing to the special trade policy in this park, taxation is much lower than expected. Although stimulating production and promotion processes, a preferential tax policy needs to be assessed carefully during the development of the Tianzhu Bond Area, as it could affect budgetary issues and the financial sustainability of the park. However, the key issue for the Tianzhu Bond Area changes to the promotion of business due to high marketing competition after 2008 (Figure 3).

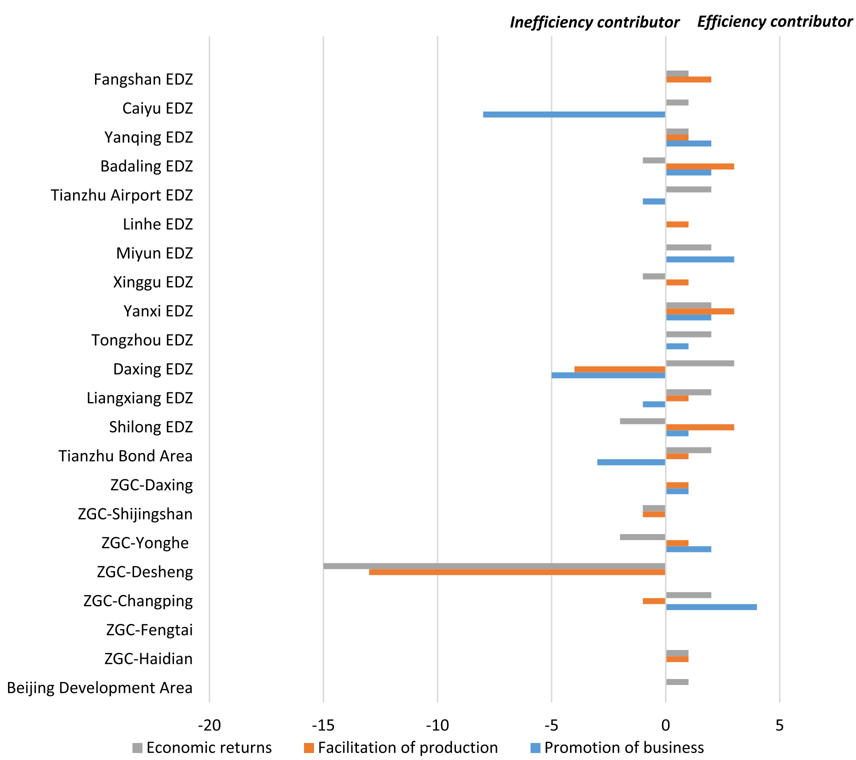

Figure 3. Key factors of efficiency or inefficiency of industrial parks during 2009–2012. Source: by authors.

6. Conclusions

This study presents a multi-stage efficiency analysis of industrial parks in Beijing using S.B.M. network D.E.A. It shows that few parks were efficient overall during the analysis periods, and therefore, the Beijing government should expend more effort developing the potential to generate outputs given current land and investment inputs. Furthermore, the study suggests that the promotion of business, the facilitation of production, and the enhancement of economic returns are successive and highly correlated processes. Inefficiency in one stage may lead to underperformance in the next stage.

This study significantly advances industrial park management from strategic planning to organisational capacity development. Theoretically, by synergizing the literature, the concepts of the promotion of business, the facilitation of production, and the enhancement of economic returns highlight the main stages of industrial park operation, taking academic analysis closer to the reality of management. In addition, this study applies D.E.A. to a sophisticated level. Standard D.E.A. deals with one-stage production processes, in which the operation to a large extent is a black box. On the other hand, this study employs S.B.M. network D.E.A. successfully to reveal that the internal operational structure, by referring to the multi-stage processes and emphasising the flow of the intermediate measures among the stages, plays a key role in the efficiency assessment.

In practice, this study contributes to a performance assessment of industrial parks based on the multi-dimensions of inputs and outputs, selecting the right competitors at the right organisational stage. More importantly, it can help managers and policymakers to locate the stage, and identify the sources of efficiency and inefficiency of industrial park development. Network analysis improves the understanding of the progression and balancing of internal stages during operations and therefore, contributes to improving internal management with clearer evidence to strengthen the performance of different offices responsible for marketing and promotion, production of firms, and reward returns to the park. Given the fast growth of industrial parks, especially in developing regions, this study should have wide applicability.

This study has some limitations. The D.E.A. method measures relative not absolute efficiency. All measures should be in a relative sense, and therefore, it is difficult to compare periodical change of efficiency scores. A trade-off is to compare the ranking orders, which is, however, subject to change of the backdrop. For example, if the overall performances of Beijing industrial parks were to decrease, one park with one order improved would not imply that this park improved its performance. Second, although this network approach to some extent makes us prone to discovering the black box, this is highly dependent on our understanding of the internal operational structure and the analysis is subject to data availability. A more customised structure needs to be proposed according to the particular organisation and economic activity of the park; for example, technological promotion and commercialisation could be the main point of research of a science park. Furthermore, the multi-stage analysis is constrained by data availability: the analysis requires more detailed and internal flows of data in an organisation, which are not easy to obtain. For instance, at our last stage, we confine economic returns to direct outcomes to the park and use tax as an indicator, yet this would be more meaningful if wage data were available. Nevertheless, this study proves that multi-stage analysis and network D.E.A. can be powerful tools for management to investigate internal and coherent operational processes. Balancing and weighing the internal stages would be an interesting topic for future research.

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Appendix 1. S.B.M. network D.E.A. efficiency scores of industrial parks in each year.

Industrial parks	Year	Overall	Promotion of business	Facilitation of production	Economic returns
Beijing Development Area	2012	0.521	0.524	0.645	0.374
Z.G.C.-Haidian	2012	3.153	4.936	2.156	3.959
Z.G.C.-Fengtai	2012	0.773	0.612	1.157	0.680
Z.G.C.-Changping	2012	0.338	0.230	0.682	0.316
Z.G.C.-Desheng	2012	0.012	0.005	1.132	1.180
Z.G.C.-Yonghe	2012	0.049	0.040	0.045	0.146
Z.G.C.-Shijingshan	2012	2.869	1.833	4.314	5.309
Z.G.C.-Daxing	2012	0.037	0.035	0.040	0.037
Tianzhu Bond Area	2012	0.069	0.120	0.066	0.039
Shilong E.D.Z.	2012	0.143	0.200	0.096	0.248
Liangxiang E.D.Z.	2012	0.125	0.144	0.158	0.073
Daxing E.D.Z.	2012	0.152	0.168	0.236	0.080
Tongzhou E.D.Z.	2012	0.077	0.093	0.097	0.044

(*Continued*)

Appendix 1. (*Continued*)

Industrial parks	Year	Overall	Promotion of business	Facilitation of production	Economic returns
Yanxi E.D.Z.	2012	0.095	0.111	0.092	0.077
Xinggu E.D.Z.	2012	0.160	0.151	0.179	0.146
Miyun E.D.Z.	2012	0.117	0.123	0.148	0.078
Linhe E.D.Z.	2012	0.140	0.156	0.160	0.095
Tianzhu Airport E.D.Z.	2012	0.313	0.420	0.405	0.160
Badaling E.D.Z.	2012	0.094	0.189	0.146	0.035
Yanqing E.D.Z.	2012	0.020	0.032	0.042	0.007
Caiyu E.D.Z.	2012	0.014	0.061	0.016	0.005
Fangshan E.D.Z.	2012	0.000	0.010	0.003	0.000
Beijing Development Area	2011	0.598	0.529	0.732	0.543
Z.G.C.-Haidian	2011	3.457	6.406	2.275	3.925
Z.G.C.-Fengtai	2011	0.899	0.644	1.356	1.019
Z.G.C.-Changping	2011	0.352	0.238	0.605	0.402
Z.G.C.-Desheng	2011	0.003	0.001	0.201	0.243
Z.G.C.-Yonghe	2011	0.055	0.069	0.040	0.083
Z.G.C.-Shijingshan	2011	2.553	2.690	2.028	4.364
Z.G.C.-Daxing	2011	0.032	0.030	0.033	0.033
Tianzhu Bond Area	2011	0.055	0.062	0.050	0.052
Shilong E.D.Z.	2011	0.189	0.207	0.138	0.430
Liangxiang E.D.Z.	2011	0.239	0.330	0.283	0.128
Daxing E.D.Z.	2011	0.166	0.208	0.305	0.071
Tongzhou E.D.Z.	2011	0.086	0.122	0.101	0.045
Yanxi E.D.Z.	2011	0.101	0.115	0.100	0.082
Xinggu E.D.Z.	2011	0.167	0.153	0.201	0.144
Miyun E.D.Z.	2011	0.058	0.058	0.077	0.038
Linhe E.D.Z.	2011	0.172	0.164	0.220	0.129
Tianzhu Airport E.D.Z.	2011	0.314	0.398	0.399	0.171
Badaling E.D.Z.	2011	0.785	0.592	0.925	1.202
Yanqing E.D.Z.	2011	0.016	0.025	0.036	0.006
Caiyu E.D.Z.	2011	0.013	0.075	0.018	0.004
Fangshan E.D.Z.	2011	0.023	0.054	0.027	0.009
Beijing Development Area	2010	0.633	0.479	0.831	0.759
Z.G.C.-Haidian	2010	2.969	4.922	2.113	3.019
Z.G.C.-Fengtai	2010	0.925	0.738	1.174	1.008
Z.G.C.-Changping	2010	0.435	0.327	0.602	0.486
Z.G.C.-Desheng	2010	0.005	0.002	0.120	0.189
Z.G.C.-Yonghe	2010	0.063	0.055	0.070	0.067
Z.G.C.-Shijingshan	2010	2.310	2.066	2.304	3.042
Z.G.C.-Daxing	2010	0.052	0.061	0.049	0.045
Tianzhu Bond Area	2010	0.069	0.152	0.067	0.034
Shilong E.D.Z.	2010	0.130	0.307	0.079	0.153
Liangxiang E.D.Z.	2010	0.379	0.562	0.532	0.170
Daxing E.D.Z.	2010	0.528	1.000	1.000	0.183
Tongzhou E.D.Z.	2010	0.082	0.139	0.105	0.036
Yanxi E.D.Z.	2010	0.103	0.133	0.098	0.075
Xinggu E.D.Z.	2010	0.226	0.200	0.272	0.211
Miyun E.D.Z.	2010	0.099	0.098	0.121	0.072
Linhe E.D.Z.	2010	0.147	0.141	0.214	0.096
Tianzhu Airport E.D.Z.	2010	0.375	0.378	0.406	0.323
Badaling E.D.Z.	2010	0.450	0.417	0.377	1.000
Yanqing E.D.Z.	2010	0.004	0.029	0.030	0.001
Caiyu E.D.Z.	2010	0.000	0.375	0.043	0.000
Fangshan E.D.Z.	2010	0.021	0.050	0.028	0.008
Beijing Development Area	2009	0.551	0.408	0.859	0.543
Z.G.C.-Haidian	2009	3.295	4.118	2.605	3.783
Z.G.C.-Fengtai	2009	0.940	0.747	1.142	1.122
Z.G.C.-Changping	2009	0.336	0.286	0.416	0.324

(*Continued*)

Appendix 1. (*Continued*)

Industrial parks	Year	Overall	Promotion of business	Facilitation of production	Economic returns
Z.G.C.-Desheng	2009	0.004	0.002	0.083	0.108
Z.G.C.-Yonghe	2009	0.064	0.055	0.064	0.101
Z.G.C.-Shijingshan	2009	3.375	1.881	5.335	23.061
Z.G.C.-Daxing	2009	0.036	0.037	0.038	0.033
Tianzhu Bond Area	2009	0.027	0.196	0.033	0.009
Shilong E.D.Z.	2009	0.742	0.557	0.931	1.000
Liangxiang E.D.Z.	2009	0.345	0.395	0.527	0.178
Daxing E.D.Z.	2009	0.205	0.345	0.288	0.086
Tongzhou E.D.Z.	2009	0.071	0.127	0.089	0.031
Yanxi E.D.Z.	2009	0.101	0.128	0.099	0.071
Xinggu E.D.Z.	2009	0.218	0.191	0.255	0.218
Miyun E.D.Z.	2009	0.102	0.107	0.130	0.068
Linhe E.D.Z.	2009	0.171	0.171	0.190	0.143
Tianzhu Airport E.D.Z.	2009	0.382	0.419	0.454	0.255
Badaling E.D.Z.	2009	0.155	0.246	0.175	0.079
Yanqing E.D.Z.	2009	0.014	0.024	0.019	0.006
Caiyu E.D.Z.	2009	0.000	0.028	0.006	0.000
Fangshan E.D.Z.	2009	0.000	0.007	0.002	0.000
Beijing Development Area	2008	0.598	0.412	0.965	0.695
Z.G.C.-Haidian	2008	3.311	5.926	2.173	3.968
Z.G.C.-Fengtai	2008	1.169	1.342	1.137	0.973
Z.G.C.-Changping	2008	0.528	0.422	0.711	0.523
Z.G.C.-Desheng	2008	0.086	0.129	0.065	0.087
Z.G.C.-Yonghe	2008	0.013	0.057	0.006	0.082
Z.G.C.-Shijingshan	2008	0.508	0.342	0.586	1.743
Z.G.C.-Daxing	2008	0.023	0.029	0.018	0.026
Tianzhu Bond Area	2008	0.105	0.175	0.057	1.000
Shilong E.D.Z.	2008	1.190	0.911	1.575	1.355
Liangxiang E.D.Z.	2008	0.332	0.523	0.300	0.218
Daxing E.D.Z.	2008	0.077	0.286	0.175	0.021
Tongzhou E.D.Z.	2008	0.106	0.166	0.138	0.049
Yanxi E.D.Z.	2008	0.134	0.132	0.155	0.108
Xinggu E.D.Z.	2008	0.209	0.221	0.261	0.140
Miyun E.D.Z.	2008	0.049	0.117	0.112	0.015
Linhe E.D.Z.	2008	1.029	0.724	1.590	1.192
Tianzhu Airport E.D.Z.	2008	0.797	0.773	0.911	0.671
Badaling E.D.Z.	2008	0.005	0.369	0.271	0.001
Yanqing E.D.Z.	2008	0.012	0.014	0.022	0.005
Caiyu E.D.Z.	2008	0.002	0.014	0.002	0.001
Fangshan E.D.Z.	2008	0.054	0.146	0.059	0.023
Beijing Development Area	2007	0.616	0.410	1.032	0.764
Z.G.C.-Haidian	2007	3.931	6.525	2.706	4.418
Z.G.C.-Fengtai	2007	0.867	1.006	0.838	0.718
Z.G.C.-Changping	2007	0.596	0.550	0.671	0.563
Z.G.C.-Desheng	2007	0.045	0.128	0.034	0.028
Z.G.C.-Shijingshan	2007	0.796	1.000	1.000	0.439
Z.G.C.-Daxing	2007	0.018	0.023	0.014	0.021
Tianzhu Bond Area	2007	0.009	0.055	0.017	0.003
Shilong E.D.Z.	2007	0.420	0.829	0.495	0.184
Liangxiang E.D.Z.	2007	0.213	0.359	0.157	0.193
Daxing E.D.Z.	2007	0.071	0.228	0.079	0.028
Tongzhou E.D.Z.	2007	0.095	0.208	0.106	0.042
Yanxi E.D.Z.	2007	0.110	0.130	0.110	0.085
Xinggu E.D.Z.	2007	0.166	0.245	0.150	0.117
Miyun E.D.Z.	2007	0.101	0.143	0.120	0.054
Linhe E.D.Z.	2007	0.591	0.486	0.811	0.533
Tianzhu Airport E.D.Z.	2007	0.625	0.685	0.640	0.512
Yanqing E.D.Z.	2007	0.010	0.011	0.015	0.006

(*Continued*)

Appendix 1. (*Continued*)

Industrial parks	Year	Overall	Promotion of business	Facilitation of production	Economic returns
Caiyu E.D.Z.	2007	0.005	0.075	0.013	0.001
Fangshan E.D.Z.	2007	0.036	0.126	0.034	0.016
Beijing Development Area	2006	0.554	0.406	0.933	0.510
Z.G.C.-Haidian	2006	5.665	6.963	4.428	6.960
Z.G.C.-Fengtai	2006	1.251	1.232	1.353	1.117
Z.G.C.-Changping	2006	0.462	0.409	0.593	0.389
Z.G.C.-Desheng	2006	0.058	0.134	0.040	0.047
Z.G.C.-Yonghe	2006	0.000	0.004	0.004	0.000
Z.G.C.-Shijingshan	2006	2.464	1.819	4.475	2.069
Z.G.C.-Daxing	2006	0.004	0.019	0.002	0.004
Tianzhu Bond Area	2006	0.037	0.229	0.046	0.012
Shilong E.D.Z.	2006	0.880	1.000	1.000	0.594
Liangxiang E.D.Z.	2006	0.460	0.263	0.775	1.496
Daxing E.D.Z.	2006	0.154	0.385	0.127	0.086
Tongzhou E.D.Z.	2006	0.132	0.215	0.129	0.076
Yanxi E.D.Z.	2006	0.130	0.156	0.128	0.100
Xinggu E.D.Z.	2006	0.245	0.316	0.221	0.201
Miyun E.D.Z.	2006	0.066	0.123	0.124	0.023
Linhe E.D.Z.	2006	0.981	0.575	2.176	1.423
Tianzhu Airport E.D.Z.	2006	0.702	0.807	0.766	0.492
Badaling E.D.Z.	2006	0.005	0.341	0.189	0.001
Yanqing E.D.Z.	2006	0.028	0.022	0.036	0.029
Caiyu E.D.Z.	2006	0.004	0.197	0.004	0.001
Fangshan E.D.Z.	2006	0.064	0.202	0.042	0.048

Source: by author.