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Assessing Business Efficiency in the Use of Social Networking Sites: A DEA Approach

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Abstract. Companies have been increasingly using social networks, showing, at the same time, a growing concern about the assessment of their performance in these platforms. This paper proposes Data Envelopment Analysis (DEA) to evaluate business efficiency in the use of social networks. A model is developed to apply DEA to Facebook. The proposed model is applied to the Facebook pages of 20 hotels.

Keywords: Data Envelopment Analysis, Efficiency, Social Networking Sites, Facebook.

1. Introduction

Digital networking sites have been increasingly used by companies over the last years [1]. Nevertheless, in general companies demonstrate great concern about the measurement of their efficiency in this field [2, 3].

Data Envelopment Analysis (DEA) is one of the main existing methodologies to assess technical efficiency [4]. DEA evaluates the relative efficiency of a set of units, providing an efficiency score for each unit even in situations of multiple inputs and multiple outputs [5].

This paper suggests DEA methodology to evaluate business efficiency in the use of social networks. More specifically, the authors demonstrate how DEA can be applied to Facebook pages.

The paper is organized as follows. Social networks phenomenon is described in Section 2. In Section 3, DEA methodology is explained. A DEA model to evaluate efficiency of companies using Facebook is presented in Section 4. In Section 5, this model is applied to a sample of 20 Facebook pages. Finally, concluding remarks are reported in Section 6.

2. Social Networking Sites

In recent times, the Internet has become increasingly collaborative and user-centric, favouring communication between companies and consumers [6]. Digital networking sites, particularly, have allowed and stimulated this type of company-consumer interaction [7].

With a growing number of users willing to share their preferences and opinions, social networks have become very attractive for companies. In fact, companies are increasingly using social networking sites [1]. Facebook is the most common social media tool used by marketers, followed by Twitter and LinkedIn [2]. In these platforms, engaging with consumers is very important and may affect the success of the companies. Barry, Markey, Almquist and Brahm ([8]) show that, customers that interact with companies over social media are more loyal and spend up to 40% more with those companies than other customers.

Several studies and authors (e.g. [2, 3, 9]) emphasize that a major concern of the companies that use social networks is to know how to measure their efficiency in this environment, and which tools and performance indicators to use. A number of proposed performance indicators are currently used to measure social media activity, such as number of likes, number of fans, and number of comments [10, 11, 12]. However, up to this date a scientific methodology to measure business efficiency in the use of social networking sites, allowing the use of multiple variables and providing a unique and global measure of efficiency did not exist.

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3. Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is a methodology to assess the relative efficiency of a set of DMUs (decision making units) in converting multiple inputs in multiple outputs. The definition of a DMU is generic and flexible. For each unit, DEA provides an efficiency score between 0 and 1. DEA identifies sources and amounts of inefficiency for each DMU. For input-oriented models, if the score is < 1, all inputs should be reduced proportionally; if there are inputs and outputs slacks, then the DMU should make additional input reduction or output production, in order to become efficient. DEA has an empirical orientation and requires very few assumptions. It does not require information about costs and prices or about the formal relations between inputs and outputs [5]. In general, DEA has several features that companies can benefit. It is also a powerful benchmarking technique [13].

The main two DEA models are CCR [14] and BCC [15]. The BCC model is based on CCR model, considering variable returns to scale [5]. Since the first DEA model was presented, there have been several applications of this methodology [5], some being marketing related (e.g. [16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27]). There are also some extensions to the CCR model that allow adapting the methodology to particular aspects of each situation (e.g. [28, 29, 30, 31, 32, 33, 34, 35, 36, 37]). More details about DEA models may be found in [5, 38].

4. Proposed Model

The authors propose DEA methodology to assess the business efficiency in social networks because it allows the consideration of multiple inputs and multiples outputs, which is particularly useful since there are many factors that may influence efficiency in this context. In addition, in social networks the formal relations between inputs and outputs is unknown. Furthermore, often times it is not easy for the companies to estimate what percentage of their revenues is due to social media activities. Being so, one important feature of this methodology is that it does not require any information about costs and revenue. Lastly, by requiring few assumptions DEA can be used to explore a large number of different situations.

To illustrate how DEA may be applied to social networks, the authors propose a BCC model to evaluate business efficiency in the use of Facebook pages. This model is focused on efficiency on the engagement between company and users. In particular, the inputs are related to the type of content published by companies in their Facebook pages, and the outputs consider comments and likes made by Fans on these posts (Fig. 1):

Inputs	Outputs
• Number of posts “photo” • Number of posts “link” • Number of posts “status” • Number of posts “video”	• *Comments* = Σ (Number of comments /Number of fans) $_p$ • *Likes* = Σ (Number of likes / Number of fans) $_p$ p = 1,…, total number of posts in the considered period.

Fig. 1: Model inputs and outputs.

The outputs *Comments* and *Likes* are variables that express the number of comments and likes taking into account the number of fans, for each post. These variables are used instead of the number of comments and likes because the number of fans of different Facebook pages is, generally, not the same.

5. Case Study

The proposed model was applied to the Facebook pages of 20 hotels. The authors collected the input and output data for each Facebook page during the course of 4 months. This study includes information about 1321 posts, 1814 comments and 21085 likes. BCC model was used and the DEA results are presented in Table 1:

Table 1: DEA results

DMU	Efficiency Score	Slacks						Benchmarks
		“Photo”	“Link”	“Status”	“Video”	Comments (10^{-2})	Likes (10^{-2})	
1	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--
2	0,60	4,62	0,00	0,00	0,00	0,00	2,29	5; 6; 7; 13
3	0,85	0,00	0,00	0,00	1,70	0,00	1,79	6; 7; 8; 18
4	0,56	0,00	0,00	2,76	0,00	0,54	0,00	5; 6; 7; 13
5	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--
6	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--
7	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--
8	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--
9	0,55	0,00	0,00	6,37	1,37	0,75	0,00	6; 8; 14
10	1,00	7,82	53,55	25,27	0,00	0,28	0,00	6; 7; 14
11	0,90	0,00	0,00	4,25	0,26	0,00	0,59	6; 7; 8
12	0,54	0,00	30,43	0,00	1,57	0,13	0,00	7; 18, 20
13	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--
14	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--
15	0,61	0,00	0,00	2,50	1,03	0,03	0,00	7; 8; 13
16	0,73	3,36	19,80	0,00	0,00	0,52	0,00	6; 7; 20
17	0,62	18,89	0,46	0,00	0,00	0,02	0,00	6; 7; 20
18	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--
19	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--
20	1,00	0,00	0,00	0,00	0,00	0,00	0,00	--

DEA identifies the most efficient units and the inefficient units of the set. DMU 1, 5, 6, 7, 8, 13, 14, 18, 19 and 20 are effective because they have an efficient score of 1 and all slacks are zero. The remaining units are inefficient because there are non-zero slacks.

For each unit, DEA identifies what is the amount and source of inefficiency, showing managers how they can improve performance. For example, DMU 2 should reduce proportionally all posts to 60% of its current quantities, and, additionally, reduce about 5 “photo” posts, while obtaining the same level of comments and a higher level of likes. Using this kind of information, it is possible to set inputs and output targets for an equivalent period of time. DEA also provides information about the set of corresponding efficient units that can be used as benchmarks to achieve this improvement. The benchmarks for DMU 2 are DMUs 5, 6, 7 and 13.

Using this particular model, it is also possible to explore what media type is more appealing in each page. For example, DMU 2 should strongly reduce “photo” posts, which may suggest that this page’s fans do not engage so easily when the hotel posts photos on Facebook as they do when the hotel posts links, status information or videos.

6. Conclusions and Limitations

This paper presents a DEA model to evaluate the efficiency of the companies that use Facebook, focusing on their engagement with the Page’s fans. However useful, this model has necessarily some limitations. The model assumes that a higher number of comments is preferable to a lesser number, and this might not be the case when the sentiment of the comments is negative. Furthermore, the model does not evaluate any qualitative characteristics of the posts besides the media type, which may also influence the way the fans respond to the posts (e.g. originality and humor of the posts). Nevertheless, the model illustrates how DEA may be used to assess business efficiency in the use of social networks. In fact, this model may be extended, with some adaptations, to other social networks such as Twitter and Google+. The authors believe that DEA is a powerful tool to evaluate the business efficiency in social networks because it allows the consideration of multiple variables, and it does not require the formal relations between inputs and outputs to be specified. Furthermore, this methodology may be used in situations were no information about costs and revenue is available.

For future research, the authors suggest applying DEA to Facebook using other inputs and outputs, and focusing on other efficiency levels. For example, inputs such as social networks expenses and outputs such as sales increment due to social media activities may be used if that information is available. DEA may also be used to evaluate other aspects on Facebook, such as advertising. Furthermore, the authors propose applying DEA to other social networks, and to use DEA extensions to adapt the model to particular circumstances of each situation.

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