Performance Evaluation of Mobile Phone Producers

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INTRODUCTION

Since the introduction of first mobile phone prototype by Motorola in 1973, the global mobile communication industry has faced tremendous changes. Mobile phones evolved from brick-sized devices to today's smart phones and their infrastructures have been through vast improvements. Historically, the use and spread of mobile phones as consumer item have accelerated from early 1990s, when a move away from the very large sized devices to everyday items emerged. Introduction of the text messaging and functions like calculators, e-mail devices, pagers and address books etc. as other features, in 1993, initiated the process of movement towards today's smart phone technology. In mid-1990s, Research in Motion (RIM) took its place in the market by introducing the innovative changes that led to a path for development of smartphones (Farley, 2005). Apple's emergence in the market in 2005 increased the competition even more and also sped up the transformation from the classic mobile phones to the smartphones. Today, mobile phone industry and its smartphone segment are one of the fastest growing sectors due to the rapid improvements and increasing demand, especially, from the emerging markets.

Considering extremely competitive and rapidly changing business environment of our era, in the high technology global business sectors such as mobile phone industry, management, marketing and development activities of competitors have a great effect on the position of the companies in the market. Therefore, measuring the performance of the businesses depends not only on the evaluation of internal practices but also on the success of the business relative to the performance of the other businesses in the market. One of the key objectives of performance measurement is to evaluate how efficiently the businesses or specific business units perform in terms of various practices. Employment of a relative standpoint in evaluating those practices plays a crucial role in deriving useful information to understand the current state of the market and to identify the opportunities for improvement in efficiency.

In this study, we focus on performance evaluation of major mobile phone producing companies in terms of marketing and R&D practices. We establish a basic segmentation in the market between 'classic mobile phones' and 'smartphones'. We apply Data Envelopment Analysis to measure relative performance efficiency of those global companies within each segment in terms of marketing perspective (including selling and R&D activities) during a period of 2007-2011. Hence, we identify the best and worst efficient mobile phone producer at each year. The impact of various marketing efforts and R&D practices may be realised in the following years. In order to investigate how the relative performance of mobile phone companies changes overtime in the global market, we apply Malmquist Productivity Index approach.

DATA ENVELOPMENT ANALYSIS

Data Envelopment Analysis (DEA) is a non-parametric approach for identifying relative efficiency of Decision Making Units (DMUs) that are producing multiple outputs using multiple inputs. DEA does not require any assumption about the functional form. The efficiency of a DMU is measured relative to all other units with the simple restriction that all DMUs lie on or below an efficient frontier (Cooper et al., 2006). A production possibility set, containing 'all input-output correspondences which are feasible in principle including those observed units being assessed', is constructed (Thanassoulis, 2001). Hence, DEA determines the efficiently performing units in relation to each other and benchmark the other units relative to the efficient units in the defined production possibility set through the calculation of efficiency scores. Therefore, the efficiency scores for the units performing efficiently relative to other units are obtained as one and those units take place on the efficient frontier. The DMUs scoring less than one are identified as inefficient with respect to all other units in terms of input and output variables and remain outside the efficient frontier. The efficiency score of each decision unit is obtained by solving a pair of mutually dual linear programs that are based on either the *envelopment* or the *multiplier* DEA model. The linear programming model *maximises* (or *minimizes)* the objective function that is formulated as *output-oriented* (or *input-oriented*) form. For further information and various DEA modelling issues, the reader is referred to Thanassoulis (2001) and Cooper et al. (2006).

DEA is a well-established method that was built upon the seminal work by Farrell (1957) and presented to the operations research literature by Charnes et al. (1978). Since the introduction of the method, many researchers in operational research and management science, economists, and experts from various application areas have contributed in improving the various DEA models and developed new approaches (Liu et al., 2013).

DEA is used to measure relative efficiency of organisations or organisational units producing multiple outputs through the use of multiple inputs. The DEA approach has been widely applied for the performance evaluation of different aspects of business practices in various industries such as public sectors (Panta et al., 2013), agriculture (Zhu & Lansink, 2010), banking (Staub et al. 2010), education (Kao & Hung, 2008), energy and environment (Sueyoshi & Goto, 2013), health care (Amado & Dyson, 2009), marketing research (Noorizadeh et al., 2013) and telecommunication (Cooper et al., 2001).

DEA has been recognised as a powerful tool to investigate relatively the worst and the best performers within a market by taking into account different perspectives. For instance, Brown and Ragsdale (2002) consider the branding perspective of tourism sector. They investigate the brand efficiency of hotels clustered into different segments depending on the comparability among each other and measure the relative efficiency of each segment in terms of customer satisfaction and value created by the hotels. Similarly, Haugland et al. (2007) evaluate performance efficiency, effectiveness and productivity of services within a hotel chain. Donthu et al. (2005) measure benchmarking potentials in terms of sales and customer satisfaction created by the branches through manager experience and number of employees in fast food chain. The DEA-based models have also been developed for measuring performance of Research and Development (R&D) practices of computer firms in context of firm-level evaluation (Chen et al., 2004) and project evaluation (Eilat et al., 2008).

In the mobile telecommunication sector, the DEA approach is applied to measure the efficiency of different aspects of the mobile service providers. Cooper et al. (2001) introduce an imprecise DEA model through an evaluation in a Korean mobile telecommunication company. Tsai et al. (2006) consider global telecom operators and Debnath and Shankar (2008) evaluate telecommunication service providers in India. Bayraktar et al. (2012) measure the efficiency of customer satisfaction

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