Chapter 36
On the Efficiency of Grey Modeling in Early-Stage Technological Diffusion Forecasting

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ABSTRACT

The issue of how to obtain an accurate short-term forecast in the beginning stage of the technological diffusion is of great importance for policy makers, researchers and managers. Time-series forecasting has been noticeably neglected in the specific research area due to the prerequisite of having enough data in order to create a time-series. In this paper, Grey modeling is examined as an alternative tool for technology diffusion forecasting in the early diffusion process, where the commonly used aggregate diffusion models usually fail to deliver accurate forecasts. Grey modeling is a unique time-series methodology that requires only a few data points in order to make a forecast. The GM(1,1) model is tested against a classic aggregate diffusion model, the Gompertz model, using only the first four data of mobile broadband diffusion to make an one-step-ahead prediction. The results in the EU15 countries reveal that the Grey model outperforms the Gompertz model in every case, thus stimulating new research guidelines in terms of combinations of the two approaches and further investigation of the value of Grey modeling in the specific area.

DOI: 10.4018/978-1-5225-5201-7.ch036

INTRODUCTION

One of the key objectives of technology management is accurate diffusion forecasting, even at the beginning of the diffusion process, where the available data are not sufficient for application of well-known models. As the rapid pace of technological innovation allows heterogeneous technologies to coexist and converge, emerging innovations have been introduced to overcome the limitations of existing ones and to meet consumers' requirements. Accurate early forecasting allows policy makers, researchers and managers to control the changeable market and enhance competition. This research topic is always up-to-date, and recent research papers in the area stimulate the scientific interest (Goodwin et al, 2014, Nguimkeu, 2014, Shi et al, 2014, Lin 2013). It is obvious that an accurate and easily applicable method for forecasting the diffusion of innovations would be an extremely beneficial tool for companies, especially when they need to estimate the diffusion of new-to-the-market products. It is crucial for a company seeking sustainable competitive advantage to anticipate future developments on its markets. The usual techniques used for this purpose are divided into two categories: Qualitative and Quantitative techniques (Fildes & Kumar, 2002, Gruber and Verboven, 2001). In the world of research, there are two general approaches to gathering and reporting information: qualitative and quantitative approaches. The qualitative approach to research is focused on understanding a phenomenon from a closer perspective. The quantitative approach tends to approximate phenomena from a larger number of individuals using survey methods.

Qualitative techniques in the specific research area include:

- Delphi method converges answers from a panel of experts
- Scenario planning envisions multiple possible futures and their implications
- Qualitative diffusion models describe a bell curve of innovators, early adopters, early majority, late majority, and laggards and the process of how innovations diffuse from one group to the next.

Quantitative techniques in the specific research area include:

- "S-curves," such as the Bass model which provides a mathematical model based on a population of innovators and imitators, the Logistic model and the Gompertz model, based on biological population dynamics.
- Causal techniques use regression testing to identify key variables that determine a specific technology's penetration.

When studying the relevant bibliography on the issue of very early technological diffusion forecasting, one can easily discover that it is monopolised by applications of the well-known aggregate diffusion models, which cannot guaranty accurate forecasts due to the limited amount of available data. These models are based on the anticipation that the new technology will have a sigmoid diffusion pattern based on the experience gained from similar cases (Fourt and Woodlock (1960), Mansfield (1961), Floyd (1962), Rogers (1962), Chow (1967) and Bass (1969)). In other cases, the forecasting is realised using the other qualitative and quantitative methods that were mentioned earlier in the text. One can easily identify the lack of time-series forecasting methods in the specific area. Even though some studies have been realized in later stages of the diffusion process investigating the use of such methods opposite the commonly used aggregate diffusion models (Gottarsky and Skarso 1994, Christodoulos et al 2010, Christodoulos et al 2011), the early-stage predictions do not involve the use of time-series models, as