

## **Mathematical modelling of the value of technology brands**

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### **Abstract**

In recent years, especially in the last half century, a change of business paradigm has been experienced due to the growth in the value of intangible assets held by companies. More specifically the brands have taken a significant relevance in the creation of value of the companies (Bonet, 2003). This change has been accelerated from the 1990s onwards with the technological revolution affecting the whole society, and leading to the creation of numerous companies in the technological sector over the years (Timoteo & et, 2015).

According to the American Marketing Association, the brand is usually associated with a name, a term, a signal, a symbol, a design, or a combination of some of them, which identifies a company's products and services and differentiates them from its competitors. A similar definition uses Keller (2007), who says that whenever a marketer creates a new name, logo or symbol for a new product, he or she has created a brand. Due to a brand's contribution of immateriality and subjectivity, there is no consensus on the valuation method to be used nowadays and numerous valuation methods have been developed. These methods can be classified into two broad groups: methods based on economic-financial information (Simon & Sullivan, 1993; Fernández, 2005; Aaker, 1991; Damodaran, 1994, 2007), and methods based on consumer perception (Kapferer, 1992, 2004; Keller, 1993, 2007; Ratnatunga & Ewings, 2009).

While methods based on marketing perspective or consumer perception provide an index of value of the brand and they use qualitative variables, methods based on economic-financial perspective provides a quantitative value of the brand through economic-financial variables.

At the same time, within the economic-financial approach to brand valuation are distinguished three methods, based on: costs, market and results. The cost-based method has been scarcely used due to its difficult calculation (Abratt & Bick, 2003). However, through the study of the literature (Majerova & Kliestik, 2015; Salinas & Ambler, 2009) it is observed that the vast majority of them do not use a pure method, but a combination of them, such as the results approach with the market approach.

On the other hand, some international organizations with world-wide recognition have developed rankings of the quantitative value of brands, but with divergent results, which raises doubts about the methodology used and the variables or factors considered as influential in the value of a brand. These rankings group the brands by sectors. In addition, the technology sector is the most incipient in the economy, is revolutionizing markets and

society around the world, and is the fastest growing both in terms of turnover and number of companies.

The objective of this study is to build mathematical models that explain the value of brand rankings in the sector of new technologies based on economic-financial and stock market information.

For this purpose, we build a database composed by technology companies that are listed on the main world stock exchanges and are ranked in the Top 100 of at least two international brand valuation rankings, throughout the period from 2005 to 2016. These rankings are composed by reputed consultant companies such as Interbrand, Brand Finance, and Millwarbrown. Following these criteria thirteen brands have been selected: Accenture, Apple, Cisco, Facebook, Google, HP, IBM, Intel, Microsoft, Oracle, Samsung, SAP, and Sony. The 85% of companies selected were included in the three rankings while 15% just in two of them.

For each of the selected companies the brand value was collected, as well as the economic-financial and stock market information for each year of the period of study (2005-2016). The economic-financial and stock market information was compiled mostly from AnnualReports.com, but it was completed with the annual reports published by the companies themselves on their websites and through other web directories of the stock markets.

The methodology used has been primarily the analysis of multiple regression by ordinary least squares (OLS). Two regression models were built to explain the value of the brand in the ranking (VR) and the market capitalization value (VC) respectively for the period of study (2005-2016). The explanatory variables were a set of economic-financial variables and stock market ones, such as the value according to books (VB), results (R), the size measured with revenues (S), the ranking used through dummy variables (RD), R & D expenditures (E), return on assets (ROA), return on equity (ROE), and the ratio value in stock / book value (RV). In order to capture a possible lagged effect, each variable was introduced in the model also as a lagged variable.

Once the regression models were obtained, in which the cause-effect relationship is unidirectional, simultaneous equation models were employed (Gujarati, 2003; Guadalajara & Barrachina, 2013).

These types of methods have been widely used in the construction of econometric models (Chu & Keh, 2006; Schendel & Patton, 1978), and they determine a set of variables simultaneously through a remaining set of variables. In this way, model parameters are estimated considering the rest of equations.

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