



A study of the method using search traffic to analyze new technology adoption

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ABSTRACT

Various types of indices have been developed and applied for the purpose of identifying emergent technologies and forecasting their adoption. Recently, researchers have proposed search traffic analysis as a new method for tracking changes among consumers and utilizing this information to conduct further market research. Now with the onset of big data era, various attempts are being made to analyze the immense body of information made available by hidden traces left behind by consumers. In the same vein, our present study seeks to draw attention to the analytical advantages of utilizing search traffic. In this study, we use search traffic to analyze the adoption process of a new technology, in this case the technology of hybrid cars, for the purpose of verifying the potential value of conducting adoption analysis based on search traffic and we also propose a more refined method of analysis. First, we undertook to examine the keyword unit used in the searches, in order to refine our analysis of search traffic and thereby obtain greater practical utility. This was accomplished by comparing technology searches that specified the technology name with searches that specified the brand name. For each respective case, we also performed comparative analyses examining instances in which consumers simultaneously included the representative attributes of a product in their search.

Our research found that the traffic of searches that specify a product's brand name was significant for explaining sales. Therefore, in the conclusion of this paper we argue that if the unit of search is properly refined, search traffic can indeed serve as an extremely useful method for analyzing or forecasting sales volume. Notably, brand-focused search traffic exhibited a superior ability to forecast sales volume compared to macro-indicators such as GDP growth or WTI prices that had been used to forecast car demand in preceding studies. Forecasting based on search traffic was even superior to forecasts using other bibliometric indices such as patent applications or news coverage.

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1. Introduction

Market competition among companies, accelerated launchings of new products, and the competition for technological development have all resulted in shortening the life span of technologies. For these reasons, it has become increasingly important to analyze the adoption of technologies and products as part of the effort to forecast technologies and demand. One leading method used for conducting such analyses

of technology adoption, particularly those focusing on new technologies, is the technology life cycle method. The life cycle method is a macroscopic approach that is frequently used in bibliometrics or business administration studies. However, this life cycle approach can be problematic because it is narrowly focused on the producers' perspective. This limits our ability to use the life cycle to forecast the current market, since this market is now often characterized by the leadership of consumers [1].

To overcome the limitations of such analyses based on the producers' perspective and to enhance the accuracy and explanatory power of technology and demand forecasting,

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researchers have also deployed various approaches from a microscopic perspective. Some representative examples of such approaches include marketing research, which targets consumers, or the business survey index, which targets producers. Such research is dependent on the use of a survey-based method, a method that requires a large amount of financial cost and time investment. These approaches are also hampered by the inherent limitations of such sample-based research and by psychological complications such as cognitive dissonance.

This study adopts a macroscopic approach that overcomes the limitations of such microscopic, survey-based approaches, while also moving beyond the conventional focus on producers, instead analyzing the market from the consumers' perspective. For this purpose, our study focuses on search traffic, which we argue to be a new index that will better equip us to analyze the adoption of new technologies. Search traffic gives a direct indication of consumers' behavior while also providing macroscopic information close to the total population. Above all, search traffic is a method worthy of our attention because it is economically advantageous in terms of expense and time and it enables us to analyze hidden consumer intentions [2].

With the arrival of the big data era, various attempts are being made to analyze the wealth of data that is unconsciously left behind by consumers, and this study explores a method of utilizing search traffic to understand the adoption of new technologies. Our study examines search units in order to secure a more practical method of applying the search traffic data. In this study, we regard new technology as an embedded product.

2. Theoretical context and preceding research

2.1. Theoretical context

Marketing theory defines adoption as the decision of an individual to become a regular user of a certain product [1]. In innovation theory, adoption is regarded as the most advanced step of the process, since it represents the decision to utilize the innovation without any reservation [3]. Our present study shares this concept in as far as we regard adoption as essentially the final step of selection, consisting of the sale of a product applying new technology, but our conceptual framework is also broader in scope, since we regard the adoption process as the entirety of the process encompassing awareness, interest, evaluation, use and adoption. The major theoretical backgrounds to this study are briefly outlined in the following.

2.1.1. Consumer behavior model

The study of consumer behavior refers to the study of the methods used by individuals, groups and organizations to select, purchase, use and process products, services, ideas or experiences for the purpose of satisfying their primary and secondary needs. Such consumer behavior is impacted by cultural, social and personal factors, and numerous types of consumer behavior models have been proposed to better understand such consumer behavior. According to the stimulus-response model of buyer behavior, first, marketing stimuli and environmental stimuli enter the consciousness of the consumer. The psychological process combines with special consumer characteristics to influence the decision making process and ultimately induce the decision to purchase. In other

words, the consumer behavior model addresses the process that occurs within the consumer's consciousness in between the input of the external marketing stimuli and the final buying decision.

When the purchase decision making process is examined based on this consumer behavior model, it can be broadly distinguished into five stages, consisting of 1) problem awareness, 2) information search, 3) evaluation of alternatives, 4) decision to purchase, and 5) actions following purchase. This model emphasizes that the process leading to the purchase is initiated long before the actual act of purchase, and that its results linger long after the purchase. However, consumers do not undergo all five stages in all cases when they purchase a product. In other words, some consumers sometimes simply skip over a certain stage, and some even move through some of the stages in inverse sequence. As in the consumer behavior model, the differences in cultural, social and personal factors inevitably result in diversifying the forms of adoption exhibited by consumers in their consumption of new products in particular [1].

In regards to search traffic, which is the object of this study, the dynamic nature of information searches must be emphasized. Consumers collect information to learn about competing brands and their characteristics. The first stage presented in Fig. 1 indicates the total set of brands available for use by the consumer. In this stage, consumers have knowledge of only a few of the brands, and these known brands constitute the "awareness set." Even among the brands within the awareness set, only several of them fulfill the criteria that will determine the consumer's initial purchase, and these brands constitute the "consideration set." Consumers collect further information regarding these brands and winnow out a few brands that are strong candidates for selection, and these then constitute the "choice set." All brands within the choice set are acceptable, and the consumer selects the optimal choice from within this choice set [1].

2.1.2. Consumer adoption model

In technology innovation theory, the consumer adoption model is the key theoretical component for explaining consumer behavior. In this context, innovation pertains to goods, services or ideas that people perceive as new, regardless of how long they have existed. The above definition of innovation is based on the work of Rogers [3], who defined the innovation diffusion process as the "the dissemination of a new idea generated by invention or creation among the final users or adopters." In other words, the consumer adoption process scrutinizes the mental experiences that the individual undergoes from the moment he or she first hears of the innovation up to the stage of final adoption. The adopters of new products proceed through five stages in the adoption process, namely the stages of Awareness, Interest, Evaluation, Trial and Adoption [1]. The approach to the adoption process outlined by Rogers highlights the mental process experienced by the individual. It is therefore qualifies as an approach from the point of view of the user (or consumer), in contrast to the life cycle, which is a conventional approach that focuses on the producers. Among the five stages listed above, the Interest stage is the one most deeply related to search traffic, which is the subject of our attention in this study.

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