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Network effects in technology acceptance: Laboratory experimental evidence☆

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ABSTRACT

This research analyzes network effects in technology acceptance. The hypothesis is that the size of the user network affects technology acceptance. Even today, empirical measurement of network effects is challenging and there is a lack of experimental evidence. In order to investigate and measure the relationship between network size (number of adopters) and user acceptance, technology acceptance research needs to broaden its scope and approaches. To overcome this limitation we reproduce a particular type of technology acceptance process in a laboratory experiment, controlling for user network size and testing its influence on user perceptions and, ultimately, on acceptance decisions. We measured user perceptions and analyzed the data using consolidated and tested technology acceptance models. The results confirm our hypothesis, showing a significant effect of user network size on user perceptions. Finally, we discuss the theoretical and managerial implications of our approach and findings.

1. Introduction

This empirical study investigates the influence of network effects on technology acceptance. Network effects (or network externalities[1]) occur when users are directly or indirectly connected in a network of relationships, experiencing growing benefits as the number of connections in the network increases.

Technology acceptance is basically a choice among different alternative technologies/tools (such as software applications or computer systems) to accomplish user tasks. Many studies focus on this fundamental choice. The most tested theoretical approach is the so-called "Technology Acceptance Model" (TAM: Davis, Bagozzi, & Warshaw, 1989). Many different versions of the original model have since been developed in an attempt to explain user decisions and acceptance behaviour (Venkatesh, Morris, Davis, & Davis, 2003).

Our present research study is based on the expectation that the candidate technology with a larger user network could be favoured in comparison with the candidate technology with a smaller user network, because users may experience greater benefits with an increasing user network size, as predicted by economic studies on network effects. To our knowledge, this issue has never been directly addressed within technology acceptance models. Different reasons may have determined this lack of theory testing: first, network effects have been mainly investigated in Economics, at the macro-economic level; whereas technology acceptance processes have been investigated by behavioural studies in Information Systems, at the individual level; second, the empirical measurement of network effects is difficult to accomplish on the field; third, technology acceptance models were first proposed in the late 1980s, when network technologies (and their effects) were much less developed and recognized.

This study aims at covering this empirical gap, proposing for the first time a direct measurement of the influence of user network size on technology acceptance processes using TAM.

In particular, the following research issues will be discussed:

- Which types of technology acceptance processes may be expected to show network effects, and why?
- How can network effects be operationalized and measured?
- How can the influence of network effects on the selected type of technology acceptance processes be empirically tested?

The intended contribution of this study is theory testing more than theory building, with no explicit focus on proposing new theoretical explanations. The main objective is to verify whether user network size may affect certain technology acceptance processes, showing a need to explain and theorize the underlying reasons.

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[1] Network externalities are a particular type of network effect. The differences between network externalities and network effects, and their implications, are discussed in (Liebowitz & Margolis, 1994). We are taking into account all types of network effects, not just network externalities; an explicit discussion of the distinction is irrelevant to our purposes.

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Nevertheless, directions for theoretical development are advanced both in the literature analysis and in the discussion of the outcomes.

The investigation described here is based on data from laboratory experiments, reproducing the technology acceptance process under network effects of different intensity. The methodological choice of the laboratory experiment is not only a way to overcome the well known difficulties in detecting and measuring different user network sizes; it is also useful to introduce a clear empirical distinction between network effects and other relational factors well known in technology acceptance, such as social norms, normative pressures, and social influence. The results confirm the role of network effects in user choice and show some unexpected outcomes.

This empirical study rests on two main theoretical pillars: the theory of technology acceptance, and the studies on network effects/externalities. These contributions are discussed in the following section. The subsequent sections describe the experimental setting, the data collection process, and the empirical analysis, with a discussion and interpretation of the outcomes. Final remarks on the theoretical and managerial implications conclude the paper.

2. Relevant literature and theoretical focus

2.1. The Technology Acceptance Model (TAM)

Understanding why people accept or reject technologies has proven to be one of the most challenging issues in Information Systems (IS) research: in the last 20 years technology acceptance has been among the most investigated topics in Information Systems. The theory of technology acceptance goes back to 1989, with the introduction of the Technology Acceptance Model (Davis, 1989; Davis et al., 1989), which soon emerged as one of the most widely cited and replicated studies in Information Systems as a whole. The numerous TAM-based empirical studies have been the subject of several critical reviews and meta-analyses, including (Lee, Kozar, & Larsen, 2003; Legris, Ingham, & Collerette, 2003; Hirschheim, 2007; King & He, 2006).

Two aspects of the TAM-related theories and models are probably at the origin of their success in the academic world: their simplicity and their potential (King & He, 2006).

TAM is simple: TAM sheds some light on a complex phenomenon (technology acceptance) on the basis of just two fundamental factors: the perceived "ease of use" and "usefulness" of the system. A TAM investigation is natural and immediate: through standard questionnaires and statistical analysis tools, researchers can easily make rigorous measurements of individual perceptions to build standard structural equation models.

TAM has a wide potential for application: a good model of technology acceptance may result in an invaluable aid for making better systems, which would be more promptly and easily accepted by potential users. To recall the words of Davis' group, "computer systems cannot improve organizational performance if they aren't used" (Davis et al., 1989, p. 982).

In (Lee et al., 2003) a simple graphical map of the original TAM and its extensions is depicted, with four main groups of additional factors, visualized here in Fig. 1. Besides the original TAM core (in the center), it is possible to distinguish (1) prior factors; (2) factors suggested by other theories; (3) contextual factors; and (4) consequent factors.

TAM research has covered quite a lot of ground since it was first introduced. TAM is often taken as a solid empirical and methodological base for studies on user perceptions about technology (e.g. Ghorab (1997) and Lin (2006)), with applications to various technological domains, including Web systems (e.g. Chuan-Chuan Lin & Lu, 2000). The most significant contributions were recently integrated in a unified theory of acceptance, including constructs such as "attitude towards technology", "social influence", "facilitating conditions", "self-efficacy", and "anxiety" (cf. Venkatesh et al., 2003, and references therein).

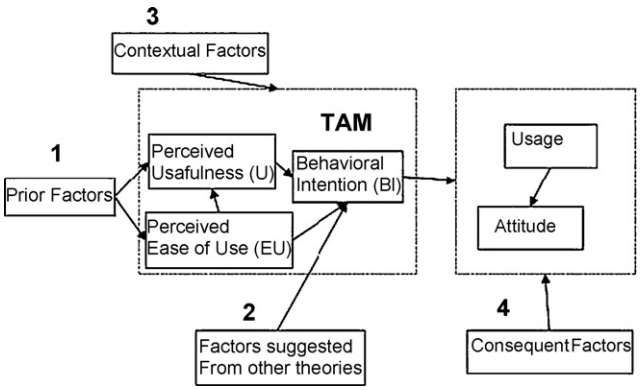

Fig. 1. The original TAM model and four categories of modifications. *Source*: King and He (2006, p. 741).

To our knowledge, TAM research has not yet investigated whether bigger user networks may actually push potential new users toward acceptance. Conversely, a similar phenomenon has been extensively studied in Economics. In what follows, some of the main contributions of this research path are briefly recalled.

2.2. Economic studies on network effects

Network effects and network externalities have been widely debated and investigated. The most cited and comprehensive literature reviews published in the last 20 years in this area include (David & Greenstein, 1990; Economides, 1996; Farrell & Klemperer, 2007; Stango, 2004). As an indication of the wealth of studies in this area, Farrell and Klemperer (2007) alone take into account over 470 different contributions. One of the most influential early studies on network externalities is Katz and Shapiro (1985). Their opening sentence is often quoted as a definition of network externality: "There are many products for which the utility that a user derives from consumption of the good increases with the number of other agents consuming the good" (p. 424). Katz and Shapiro propose a formal economic model of oligopolistic markets in presence of network externalities, showing two main results: first, the role of consumer expectations for the selection of the dominant seller "if consumers expect a seller to be dominant, then consumers will be willing to pay more for the firm's product, and it will, in fact, be dominant" (p. 425); second, the need for social incentives in order to achieve product compatibility "we find that in our model the firms' joint incentives for product compatibility are lower than the social incentives" (p. 425).

Another well known account of the economic issues related to network externalities is given in Farrell and Saloner (1985). Many studies followed these two seminal papers. Network effects theories and related issues were popularized by Brian Arthur's widely-cited account in *Scientific American* (Arthur, 1990). More recently, Katz and Shapiro (1994) took into account the so-called "systems markets", involving products intimately related and working together, such as hardware and software within a standard system architecture (e.g. PC versus Mac software). The success of a new product is actually bound to the success of the entire system/architecture, with network effects playing an important role. In particular, three orders of decision are influenced by network effects: technology adoption decisions, product selection decisions and compatibility decisions. Again, the analysis is purely theoretical, based on existing studies and findings, but with no direct empirical support.