



Contents lists available at ScienceDirect

Technological Forecasting & Social Change

journal homepage: www.elsevier.com/locate/techfore

The coupling relationship between standard development and technology advancement: A game theoretical perspective[☆]

Hong Jiang^a, Shukuan Zhao^{a,*}, Yue Yuan^a, Li Zhang^b, Lian Duan^c, Weiyong Zhang^d

^a School of Management, Jilin University, Changchun, Jilin 130022, China

^b College of Economics and Management, Beijing Jiao Tong University, Beijing 100044, China

^c Department of Information Systems and Business Analytics, Hofstra University, Hempstead, NY 11549, USA

^d Department of Information Technology and Decision Sciences, Strome College of Business, Old Dominion University, 2028 Constant Hall, Norfolk, VA 23529, USA

ARTICLE INFO

Keywords:

Technology advancement
Standard development
Game theory

ABSTRACT

Technology advancement has profound implications to almost every aspect of human life and society progress. It leads to better quality of life and a higher level of human intelligence. Accelerating technology advancement is of interest to all societies. It is an even more critical issue in emerging economies because technology application is generally lagging behind there than established economies. The literature has indicated that technology advancement is deeply coupled with standard development. However, this coupling relationship has not been sufficiently elaborated. In this paper, we draw upon the literature to clearly define the concepts of technology advancement and standard development, and how contexts affect the inter-relationship between the two. Adopting a game theoretical perspective, we analyzed the coupling relationship between the two in four different scenarios. Our findings potentially contribute to a more in-depth understanding, and practically, can offer guidance to policy makers.

1. Introduction

Technology advancement has significant impact to all aspects of human life and society progress. The history of human and society development is also the history of technology advancement. For example, in ancient times, harnessing the power of fire started a new stage of human civilization. In the last century, the invention of airplane made globalization a reality. The list of such examples is endless. Since technology advancement has such huge impacts, it is natural for both academic researchers and practitioners to be keenly interested in the topic.

Technology advancement is deeply coupled with standard development. Standards are crucial because technology advancement can be in different directions and eventually standards must be established to determine which directions are the right one. For example, in ancient times, the invention of currency is major technology advancement, yet it is a standard that determined which form of currency would prevail. The significance of standards is even stronger in modern society, particularly when we think about technologies such as computer and telecommunications. But on the other side, standards do not emerge out of nowhere. Their development is also affected by technology advancement. They have a deeply coupled relationship. Studying the coupling

relationship can potentially make significant contributions to both the literature and practices. Insights on the coupling relationship help achieve an in-depth understanding on how technology advancement and standard development work together and affect each other. Technology advancement takes place in numerous fields in modern societies, for example, renewable energy, bio-tech, Internet, and telecommunications, to name a few (Fan, 2017; Levy et al., 2016; Nikander, 2017). The progress of standard development essentially determines whether one specific technology has potential or not. In certain fields such as telecommunication, standard development is vital in deciding which direction the whole industry is going. But the development of standards cannot be done without advancement of technology. To the world economy, standardized technologies facilitate a highly efficient world trade network. To many countries, standardization of technologies is crucial to sustain economy growth, optimize industrial structure, and improve competitiveness of businesses. To emerging economies, technology advancement is even more important, without which it is inconceivable for them to catch up with established economies.

To date, standards have become precious resources and national assets. Many countries worked hard to develop their national policy of standardization. They all seek to have a larger share in the world-wide

[☆] Not to be reproduced or quoted without written permission from the authors.

* Corresponding author.

E-mail address: zhaosk@jlu.edu.cn (S. Zhao).

<https://doi.org/10.1016/j.techfore.2017.11.018>

Received 23 February 2017; Received in revised form 6 November 2017; Accepted 12 November 2017
0040-1625/ © 2017 Elsevier Inc. All rights reserved.

competition of standardization. A favorable standard is undoubtedly beneficial to economy development. To that end, policy makers are inherently interested in how their countries can promote technology advancement while participating in standard development. To emerging economies, it is an interesting question whether standard development provides an opportunity for them to accelerate technology advancement, and become more competitive in the global market. This research aims to provide insights for these important questions.

This paper is organized as follows. In Section 2, we review the extant literature on the coupling relationship between technology advancement and standard development. Section 3 focuses on the coupling relationship from a game theoretical perspective. We develop a game model in which technology advancement interacts with standard development. The model is composed of a two by two matrix. Section 4 evaluates the four scenarios of the proposed model using case data. We conclude the paper with a discussion of findings and potential contributions. The limit of this study and future research directions are also addressed.

2. Literature review

The significance of technology advancement and standard development has long been recognized in the literature due to their impact on all aspects of human life and societies (Gorkhali and Xu, 2017; Li, 2012, 2013, 2017; Liu et al., 2017; Lu, 2017; Peruzzini and Stjepandic, 2017; Tao et al., 2016; Verma and Singh, 2017; Wang, 2017; Xu, 2011, 2016; Xu et al., 2014, 2016). Standards affect R&D, production, and market penetration stages of economic activities, thus having a significant effect on innovation, productivity, and market structure (Tassey, 2000). Standardization, localization, and flexible technology together form an optimal method for penetrating foreign markets (Kwon, 2013). In the fields of information and communications technology, standards are converging and they can largely dictate technology advancement (Han and Sohn, 2016; Li et al., 2015; Whitmore et al., 2015; Xu and Viriyasitavat, 2014). The significance of standard development is unprecedented when one looks at the latest mobile communication technologies, casually referred to as 4G LTE (Yuan, 2012).

Standards affect the level of technology advancement. Whenever a core technology standard is formulated, it has profound implications. It determines the roadmap of technology evolution for an extended time period into the future. The establishment of such standards also sets the entry barriers for an industry, which affects trade efficiency, and even social welfare (Wu and Mu, 2005). Further, a standard may be developed even before technologies themselves are invented. Such a standard, named by Byrne and Golder (2002) as an anticipatory standard, can be an effective way to achieve consistency in new technology development speed. Given the strong impact of standards, it has become a mainstream practice for leading companies to form a coalition of technology standards based on patents on hand. Such standards can then lead to price premium for these companies (Economides, 1996). Generally, for emerging economies, the impact of standard is even stronger because of the lower level of technology advancement.

Standard development can be a double-edged sword. On one side, standardization helps ensure consistency in technology advancement, minimizing potential waste on developing incompatible technologies. To emerging economies, it presents a shortcut for them to participate in global competition. On the other side, standardization can lead to monopoly, which is detrimental to technology advancement in the long run. Standardization may also suffocate the development effort of new technologies, which may be prematurely judged as being incompatible with existing standards. To emerging economies, such risks can be extremely high to the extent that new technology advancement in those countries may completely halt.

According to Acemoglu et al. (2012), innovation is often followed by a lengthy and costly process of standardization. Standardization may

both be a barrier or an engine to growth. Similarly, while intellectual property rights offer protection to a technology's original developer, abusing this protection can effectively stifle technology development (Maskus, 2000). In practice, leading companies have attempted to set compatibility requirements in standards development, which has effectively become their competitive strategy in deterring others (Katz and Shapiro, 1985, 1986). Clearly, such practices present a difficult challenge to emerging economies.

A major goal of standards development is to provide a common platform for different parties such as users and manufacturers to ensure compatibility between various parts of a technical system. By adhering to standards, performance and consistency is ensured. Standards also provide an evolving path for technology advancement, hence leading to long-term stability. Meanwhile, technology advancement may also prompt standards to change. The interaction between the two is the key issue addressed in this paper. The goal of this study is to analyze how the interactions should be managed so that issues can be minimized and benefits can be maximized.

3. Coupling between standard development and technology advancement

3.1. Coupling

The concept of coupling originates in physics. It refers to a device that connects two shafts for power transmission. Disconnection of shafts is generally not allowed during operations, with the exception of torque-limited coupling. Later, the concept of coupling has been applied in a variety of fields such as software engineering, medical sciences, and mechanical engineering. In a cognitive science study, Hasson et al. (2012) examined brain-to-brain coupling to identify the mechanism for creating and sharing a social world. In software engineering, coupling is the manner and degree of interdependence between software modules. It is a measure of how closely two routines or modules are connected, and the strength of relationships between the two (Pressman, 2005).

According to Orton and Weick (1990), in any system, coupling means a rather certain and stable relationship between two parts. When a system is viewed as one unit, the whole is emphasized but elements are de-emphasized. The reversed situation is that the importance of each element is over-emphasized. To that end, the study of coupling relationship is about a balance.

Applying the coupling concept, it is possible for us to identify how standard development and technology advancement interact with each other. To any policy makers, the goal is always to find the optimal point – how much standardization should be carried out so that it encourages technology advancement but not stifles it, and similarly, how much effort should be put into technology advancement so that it not only can help standards development but also avoid issues such as incompatibility and fragmentation. In the emerging economies context, the policy implications are likely even stronger as there is a strong desire to promote technology advancement.

In this paper, we define the coupling relationship between standard development and technology advancement as: Within a certain technical system, each technology and standard actively seek to determine the growth roadmap, patent development and licensing, system integration and inter-operability in a systematic manner. The purpose is to form a unified technical coordination between various network technologies so that collaborative innovation can be achieved.

3.2. Game theoretical perspective

We adopt a game theoretical perspective to study the coupling relationship between standard development and technology advancement. Nash (1950) developed game theory to study strategic decision making. Specifically, it is the study of mathematical models of conflict

Download English Version:

<https://daneshyari.com/en/article/9952896>

Download Persian Version:

<https://daneshyari.com/article/9952896>

[Daneshyari.com](https://daneshyari.com)