Technological Forecasting & Social Change xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

# Keystone effect on entry into two-sided markets: An analysis of the market entry of WiMAX

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ARTICLE INFO

*Article history:*
Received 12 February 2014
Received in revised form 26 July 2014
Accepted 14 September 2014
Available online xxxx

*Keywords:*
Keystone effect
WiMAX
3G
Two-sided markets
Market entry
Indirect network effect

ABSTRACT

We investigate a market entry scenario where a technologically-superior new platform may overcome its installed base disadvantage with the backing of a strong keystone species advantage within the business ecosystem, called keystone effect in this study, over an incumbent in a market that exhibits indirect network effects. The strength of the keystone species impacts the availability of complementary goods, which is a key factor for a platform to increase its installed base. This study proposes a dynamic economic model to map a market landscape that shows the internal condition (entrant's keystone effect) and external conditions (incumbent's keystone effect and indirect network effects) under which a new platform can successfully enter (i.e., maintain oligopoly or monopoly share) or fail to enter a two-sided market in a winner-take-all scenario. We then illustrate the model's applicability by examining the entry of Worldwide Interoperability for Microwave Access (WiMAX) into the global mobile telecommunications market, employing recent market data from 2009 to 2012 as well as forecast scenario data from 2010 to 2014. In both the historical data and hypothetical forecast scenario we find that WiMAX's keystone effect disadvantage and the market's indirect network effects were cumulatively strong enough to prevent the new technology standard from successfully competing with the incumbent (cellular 3G and Long Term Evolution) for oligopoly or monopoly share in the long run.



## 1. Introduction

One type of market which has been the subject of extensive study because of its contextual factors, namely the presence of network externalities, is the two-sided, or platform-based, market. Increasingly many industries are organizing around such platforms (Boudreau, 2010; Eisenmann et al., 2006; Iansiti and Levien, 2004a,b), which heightens the need for firms to tailor their business models to take advantage of the benefits and plan for the substantial impact of network effects (Rochet and Tirole, 2003). In a market that exhibits network externalities, a technology's installed base and the availability of complementary goods, called direct and indirect network effects respectively, both play major roles in user adoption (Brynjolfsson and Kemerer, 1996; Choi, 1994; Katz and Shapiro, 1986; Khazam and Mowery, 1996; Kristiansen, 1998; Schilling, 1999, 2003; Wade, 1995). While much of the extant literature regards technology adoption as an evolutionary process determined by consumers, this study discerns an invisible force driving suppliers' business networks, especially when two rival technologies are sponsored by a group of suppliers with shared interests (i.e. market monopolization) and consumers have little power or interest in the technology adoption process.

For this purpose, we employ an ecological perspective to explore the dynamic, interconnected forces of the business network impacting the standards battle. Adapting Moore's popular definition, a *business ecosystem* refers to an "intentional community of economic actors whose individual business activities share in some large measure the fate of the whole community" (Moore, 2006). As a corollary of this notion, the health of the ecosystem directly impacts its members' chances for survival. Therefore the keystone organizations, those crucial

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http://dx.doi.org/10.1016/j.techfore.2014.09.008
0040-1625/

hubs within the business ecosystem that provide a stable and predictable set of common assets (e.g. Microsoft's Windows operating system and tools) that other organizations use to build their own offerings, are of paramount importance for the ecosystem's health and survival (Iansiti and Levien, 2004b). Specifically, in modern standards battles, business ecosystems are often formed to ensure de facto standardization, and victory predominantly goes to the ecosystem with stronger keystones, a process termed the *keystone effect* in this study.

Two noteworthy anecdotal examples of the impact of the keystone effect in standards competitions were, first, the battle for the videocassette recorder (VCR) standard between Sony's Betamax and Matsushita's (Panasonic) video home system (VHS), and second, the battle for the high-definition video format standard between Sony's Blu-ray and Toshiba's high definition digital versatile disk (HD-DVD). In the former case from 1975 through the late 1980s, the VHS format eventually dominated not from technological advantage but due to Matsushita's superior collaborative strategy of licensing and OEM arrangements that made the VHS ecosystem superior to that of Betamax (Wonglimpiyarat, 2005). In the latter case during 2003–2008, the two technologies were again both sponsored as Sony squared off against Toshiba. A substantial technological advantage was not the deciding factor since each format was similar in terms of performance, components, and availability of complementary goods, which could be either hardware or software depending upon the platform (Church and Gandal, 1992). HD-DVD had a legacy advantage because it, unlike Blu-ray, was compatible with the previous generation's standard, DVD, and it even entered the market at a lower price point than Blu-ray. Yet despite these disadvantages, Sony secured Blu-ray's eventual dominance by courting more significant content providers, in particular Warner Bros, one of the largest Hollywood studios which made an impactful switch to Blu-ray from HD-DVD. Sony leveraged its experience from the previous format war to focus on collaborative advantage attracting strong keystones of the home video industry, namely the major movie studios. Contrary to the traditional notion of pricing decisions and entry timing as the deciding factors for standardization among sponsored technologies (Katz and Shapiro, 1986), these examples of technology standards determined by the ecosystem's stronger keystone species demonstrate scenarios in which neither cost advantage nor technological superiority was sufficient to determine the outcome.

A more recent example can be found in the battle for the 4th generation (4G) mobile communication technology standard between Worldwide Interoperability for Microwave Access (WiMAX) and the third generation (3G) mobile technology standards, along with the mobile 4G standard, Long Term Evolution (LTE), which entered the market over two years later than WiMAX. As the first commercially available 4G option, WiMAX had a technologically superior position for the start of the data-led era of mobile computing that allowed it to capture some of the worldwide mobile broadband user base from the incumbent 3G standards group (hereafter referred to as "3G/LTE" to signify the consortium of manufacturers and network operators supporting the previous and subsequent generations of the incumbent technology standards). This quality advantage and user base momentum, with backing from some large names (e.g., Intel and Google) (Anon, 2008), seemingly should have given WiMAX a fighting chance at contending with the 3G/LTE. Nevertheless, the ecosystem of WiMAX built around weak keystones, namely relatively smaller or startup mobile network operators (MNOs), could not overcome the significant barriers to entry of a mobile telecom market that was nearly monopolized by the 3G/LTE ecosystem with dominant MNOs (Kang et al., 2011). Although, this "ecosystem war" viewpoint has been the subject of ongoing industry and media discussion (Anon, 2004, 2007, 2010b; Conti, 2010), it has received only limited attention from academic researchers regarding its implications for technology strategy and market entry decisions (Kang et al., 2011; Shin et al., 2011).

The research on business ecosystem theory as a strategy formulation tool is still in its early phase of development (Zhang and Liang, 2011). Most studies are qualitative analyses (Kang et al., 2011; Zhang and Liang, 2011) with little empirical support. More attention is paid to particular industries such as IT and biological technologies (Iansiti and Levien, 2004b; Gunasekaran and Harmantzis, 2008), Iansiti and Richards, 2006). The quantitative studies that have attempted modeling technology adoption with network externalities have generally neglected considering an ecosystem, which is crucial for accurately modeling modern standards battles (e.g., Church and Gandal, 1992; Farrell and Klemperer, 2007; Gandal et al., 2000; Park, 2004; Zhu and Iansiti, 2012).

Motivated by this gap, we aim to explore the importance of the keystone effect for platform competition in the presence of indirect network effects. Furthermore, this study intends to contribute to the ongoing discussion of market entry in the literature, and extend the discussion of platform competition by examining the conditions under which a new platform can successfully enter a two-sided market. For empirical analysis, we examine the failed entry attempt (i.e. failure in terms of market dominance) by WiMAX against 3G/LTE and evaluate it according to a dynamic model that incorporates indirect network effects, relative quality advantage, and a third factor that we introduce here, the keystone effect.

The paper proceeds as follows: The next section presents a brief review of the literature on keystone species in business ecosystems and telecommunications market externalities. Section 3 then formulates theoretical foundations into a dynamic market entry model, which we adapt from Zhu and Iansiti (2012) to fit this market context and allow for quantification of the keystone effect. We explain the equilibrium outcome conditions for the entrant platform, WiMAX, vis-à-vis 3G/LTE within the mobile telecom ecosystem. Section 4 presents the empirical analysis of WiMAX's entry into the global market by adapting regression equations from the theoretical model. Section 5 presents the method and results of the regression analysis. Finally, Section 6 offers the conclusions drawn from these results and their implications for management.

## 2. Literature review and industry overview

### 2.1. Keystone effect and the mobile telecommunications ecosystem

The concept of a keystone species that disproportionately impacts its ecosystems was borrowed from its biological origins and, like the ecosystem concept before it (Moore, 1993), applied to the realm of business. In a business ecosystem, the keystone

Please cite this article as: Kang, J.-S., Downing, S., Keystone effect on entry into two-sided markets: An analysis of the market entry of WiMAX, Technol. Forecast. Soc. Change (2014), http://dx.doi.org/10.1016/j.techfore.2014.09.008