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Standards, consortia, and innovation☆

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ABSTRACT

The development of formal ICT standards is a challenging form of collaborative innovation, combining consensus decision making and R&D rivalry. To supplement this formal standard setting process, it has thus become frequent that part of the involved firms creates ad hoc consortia to better align positions on a common technology roadmap. This paper aims to assess whether such consortia can effectively mitigate R&D coordination failure through enhanced cooperation. We first develop a theoretical model showing that depending on the nature of firms' incentives to contribute proprietary technology, different types of R&D coordination failure – namely a *Public Good* or *Rent Seeking* problem – may occur in equilibrium. Using a large panel of standards, we then confirm empirically the prediction that consortia have different effects on innovation under a *Public Good* or *Rent Seeking* regime. Overall, we observe an increase in innovation after a firm joined a consortium. However, this effect is significantly weakened or even reversed for standards characterized by a strong *Rent Seeking* regime.

1. Introduction

In a few decades, standardization in Information and Communication Technologies (ICT) has evolved from the definition of simple specifications to the joint development of large technology platforms including numerous patented components (Simcoe, 2007).[1] While the conditions for licensing these standard essential patents have been widely discussed (see e.g., Layne-Farrar and Lerner, 2011; Lerner and Tirole, 2004; Shapiro, 2001), the peculiar type of R&D collaboration they proceed from has received less attention so far.

Formal standards are developed and updated in standard setting organizations (SSOs) – such as the European Telecommunications Standards Institute (ETSI) and the Institute of Electrical and Electronics Engineers (IEEE) – that are open to a broad range of stakeholders. Unlike e.g. R&D joint ventures, the main originality of this process is that it does not involve any ex ante contracting between the participants. Firms develop proprietary innovations ahead of the standardization meetings, and SSO members then decide on a consensus basis which candidate technology shall be included the standard. As a result, formal standardization may entail R&D duplications and delays due to vested interests (Farrell and Simcoe, 2012; Simcoe, 2012).

Against this background, it has become frequent that part of the companies contributing to the standard forms an ad hoc consortium to supplement the formal standard setting process. Some consortia substitute for more formal SSOs and issue their own standards (Lerner and Tirole, 2006), including the Blu-Ray alliance or the W3C for web protocols. But most of them actually accompany formal standardization[2]

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[1] As an example, the number of functionalities and formats (e.g., email, video, internet) supported by the late wireless communication standards (3rd and 4th generation) considerably exceeds those of the second generation (GSM, CDMA) that are limited to voice communication.

[2] Formal SSOs indeed have policies of active cooperation with informal consortia (cf. David and Shurmer, 1996; Hawkins, 1999). The International Standards Organization (ISO) cooperates with Partner Standard Development Organizations (PSDO) through liaison agreements regarding specific standard projects. ISO also provides for a formal fast track agreement, the PAS (Publicly Available Specifications), which allows sponsoring organizations to receive formal accreditation of their specification. ISO's Joint Technical Committee 1 (JTC1) has a similar policy of featuring Approved References Specifications (ARS).

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(Cargill and Weiss, 1992). Important examples are the WiMAX Forum, providing a collaboration forum for companies contributing to wireless communication standards developed at the IEEE, and the UMTS Forum, representing the interests of its members regarding 3rd Generation mobile phone standards in SSOs such as ETSI and the 3rd Generation Partnership Project (3GPP). Such consortia are not a means for members to contractualize R&D. However, they make it easier for a smaller group of firms to align positions on a common technology roadmap (Delcamp and Leiponen, 2012), thereby enhancing R&D coordination while improving their chances to influence the standard setting process (Leiponen, 2008) and to obtain essential patents (Pohlmann and Blind, 2012).

The purpose of this paper is to assess whether such standards consortia can effectively address R&D coordination failures in formal SSOs. To do so, we develop first a theoretical framework accounting for firms' incentives to develop innovations for a standard in a context of loose R&D cooperation. We use this framework to derive predictions on the effect of enhanced cooperation between a subgroup of companies contributing to a standard, and then test our predictions empirically on a large panel of ICT standards. Our results suggest that consortia can not only unlock innovation in the standard setting process but also, in some cases, mitigate intensive patenting around the standard when it is wasteful for the firms.

The model indeed highlights two possible coordination failures depending on the share of the standard's value that accrues to owners of essential patents. A *Public Good* regime involving R&D free-riding prevails in equilibrium when firms' incentives to innovate are primarily driven by expected sales of standard-compliant products. Conversely, a wasteful *Rent Seeking* regime prevails when licensing revenues are sufficient to cover R&D costs. Against this background, we introduce consortia as a means to enhance cooperation between a subgroup of member firms. We show that consortium members then tend to increase (reduce) their R&D efforts when a strong *Public Good* (*Rent Seeking*) regime prevails in equilibrium, and can thus mitigate coordination failure at the SSO level.

We use a panel of 167 ICT standards observed over 9 years to test these predictions empirically. For this purpose, we have developed an original dataset of standard-related, citation-weighted patent applications to measure innovation at firm level, and matched these observations with information on firms' participation in 21 closely related consortia. Drawing on our theoretical framework, we use the participation of pure R&D firms in the standard setting process as a proxy to identify standards that are subject to a *Rent Seeking* regime. Our results are consistent with the prediction that joining a consortium is positively correlated with firm-level patenting under a *Public Good* regime, and negatively correlated with patenting under a *Rent Seeking regime*. Overall, we indeed observe an increase in patent output after a firm joined a consortium. However, this effect diminishes and eventually reverses as the participation of pure R&D firms in standard setting increases.

While a large strand of papers discuss optimal rules for licensing essential patents (Lerner and Tirole, 2004; Lerner et al., 2007; Shapiro, 2010; Swanson and Baumol, 2005), we take the reverse approach by highlighting how the prospect of licensing essential patents actually drives innovation in standards. In this respect, this paper is more closely related to recent empirical work on standard essential patents. Rysman and Simcoe (2008) find that SSOs not only select the most valuable patents in standards, but also enhance the value of these patents (through e.g. network effects), thereby providing incentives for firms to contribute patented inventions. Our definition of pure R&D firms also partly recoups that of Simcoe et al. (2009) who show that entrepreneurs use standards to enter an industry as stand-alone suppliers of proprietary technology.

Our theoretical framework follows the literature on R&D joint ventures (Amir et al., 2003; d'Aspremont and Jacquemin, 1988; Kamien et al., 1992) to capture firms' ability to (imperfectly) cooperate in a simple way. However, the type of interactions we aim to account for has been analyzed in more details in the literature on standard setting. Farrell and Saloner (1988), Farrell and Simcoe (2012) and Ganglmair and Tarentino (2012) model standard setting as a bargaining process entailing a discrepancy between the fully cooperative and actual outcomes. Simcoe (2012) also produces empirical evidence of a slowdown in standards production by IETF (an SSO which issues many of the Internet standards) due to distributional conflicts induced by the rapid commercialization of the Internet after 1993.

A few papers finally explore the articulation between consortia and standard setting. Lerner and Tirole (2004) and Chiao et al. (2007) respectively develop and test a model of forum shopping where firms can choose between different SSOs or consortia to develop a standard. Our approach differs in that we consider consortia as complements rather than substitutes to formal SSOs. Although more restrictive, this definition is consistent with a large subset of existing consortia that submit standard specifications to formal SSOs. Leiponen (2008) studies a number of consortia contributing to 3GPP. She shows empirically that connections with peers in related consortia enabled members to better influence the selection of standard components at 3GPP. Delcamp and Leiponen (2012) also find that joining a consortium connected with 3GPP increases cross-citations between the members' patents. These results are consistent with our approach of analyzing consortia as a means to improve R&D cooperation between members.

The remainder of this article is organized as follows. We present the theoretical model and its implications in Section 2. Section 3 discusses the empirical strategy, the database and econometric results. We conclude in Section 4.

2. Theoretical framework

We consider a standard which generates aggregate profits $v(x)$ in the industry. These profits increase with the quantity $x \geq 0$ of patented inventions embodied in the standard, but with decreasing return: $v_x \geq 0$ and $v_{xx} \geq 0$. The industry consists of n firms who can take part in the standard development and implement it in their products. Firm $i = 1, n$ is defined by (c_i, s_i), denoting respectively its unit cost of invention and its market share in the market for standard-compliant products. The number of inventions originating from firm i is noted x_i, with $x = \Sigma x_i$.

We denote by $r \in [0,1]$ the share of aggregate profits accruing to essential patents owners, and posit that these aggregate licensing revenues $rv(x)$ are split between the firms according to their respective shares of essential patents (that is x_i/x). In the sequel, we will consider r as an exogenous parameter. The share of profits accruing to patent owners is partly endogenous to the strategies of the firms, but is in large parts driven by policy parameters such as the licensing policy of the standard setting organization and the courts' varying interpretations of these policies. By positing r as exogenous, our main purpose is to account for the wide variety of observed licensing practices across standard related industries ($r = 0$ denoting for instance royalty free licensing) while keeping the model tractable enough to analyze firms' innovation and cooperation strategies. This simple approach moreover allows us to capture the role of patent portfolio sizes in firms' ability to collect royalties, or to save royalty payment by striking cross-licensing agreements.[3]

The remaining part of aggregate profits – that is $(1 - r)v$ – is split between manufacturers in proportion of their weight s_i in the

[3] As far as we know, the available literature does not provide us yet with a model of price formation that would be consistent and general enough to account for the variety of actual licensing practices for standard essential patents across different industries, and for the role of patent portfolio size in this context. There are several normative discussions in the literature how to implement efficient royalty rates through public policy (e.g. Swanson and Baumol, 2005). Our contribution is to study how coordination among firms can result in more efficient innovation investment decisions even for an exogenously determined, non-optimal royalty rate.