



Intellectual Property Bundle (IPB) theory: Managing transaction costs in technology development through network governance

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ABSTRACT

Technology is a bundle of inventions, which are increasingly protected by intellectual property rights. Typically, these rights are owned by multiple different entities, operating in different industries and countries. Moreover, once an invention protected by intellectual property right is incorporated in a product, it becomes very difficult to substitute it with an alternative technology, especially when the product has been widely adopted. Thus, technology creators must coordinate the disparate interests of various intellectual property owners in order to create useful technology. In this paper we introduce a new theory as an extension of transaction cost economics to explain the relative merits of different governance forms vis-à-vis the creation of technology that is a bundle of inventions. From this theoretical extension, we derive a number of testable hypotheses.

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1. Introduction

Technology development is an inventive process. To create a useful technology, developers must invent the solutions to a variety of interrelated problems. In fact, this is the dominant paradigm behind the object-oriented approach which holds that a useful technology is developed in components that perform a specific task and are reusable. However, what is little appreciated is the fact that many of these inventions can be and are protected and owned separately by way of intellectual property rights (IPR). For example, an Intel microprocessor is a complex combination of around 10,000 different patents bundled as a single product [25]. This view of technology as a bundle of intellectual property is new but important in the sense that it will fundamentally alter our perceptions about the nature of technology ownership. Table 1, below illustrates the numbers of entities and patents in some common technologies.

There is a growing trend toward development of technology by multiple entities [13,33]. As of 2008, more than 450 such alliances, like the smart card and the Wi-Fi alliance, are listed on Consortiuminfo.org. Yet there is a widely held belief that development by groups results in slower development, greater setup costs, and even inferior technologies [15,26]. Even with such beliefs, which suggest that alliances have sub-par outcomes, we observe a large number of alliances and new ones being formed regularly. We theorize that the primary reason for this is the need to transact for intellectual property

rights associated with the development of the technology. Beyond technical considerations, organizing technology development as an alliance helps developers locate and procure IPR and protects the technology from frivolous litigations. We introduce an Intellectual Property Bundle (IPB) theory as an extension of transaction cost theory [42] to understand how IPR give rise to transaction costs in the technology development area and how governance moderates those transaction costs.

In the next section we present a literature review on transaction cost economics and intellectual property rights. Following that we discuss the assumptions and constructs of our theory. Then we describe the causal mechanism linking the constructs and propose testable hypotheses based on those constructs. We conclude with a discussion and directions for future research and implications.

2. Discussion of related literature

The theoretical extension that we develop in the present paper fits into an area of scholarship termed *New Institutional Economics*. This field of inquiry studies the rules by which economic activity takes place. In this case, the economic activity is the creation of a technology product.

There are two main institutions in which we are interested. The first is the property rights regime as it relates to technology. Williamson [44] notes that this institution changes on the order of decades or centuries. Thus, we take this institution as fixed. Specifically, we take it as fixed to the United States today. As we move away from the US laws and from current time, this institution can change. The second institution of interest is the governance of the

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Table 1
Number of patents and owners for some well known technologies (approximate numbers).

Technology	No. of patents	No. of countries	No. of patent holders
DVD Media	500	28	9
MPEG 4 (Motion Pictures)	196	21	22
802.3 Ethernet	70	4	65
802.11 wireless	100	7	91

development process. Roughly speaking, we compare development by a single entity to group development. We strive to answer the question of how the governance structure can moderate the causes of transaction costs in the development of technology.

A few studies have directly addressed the role of IP in technology development. For example, Farrell and Katz study the effects of intellectual property and antitrust on innovation in the technology arena [10]. Shapiro describes the emergence of patent thickets and discusses the role of patent pools in mitigating the risks [35]. Farrell and Shurmer, separately, discuss the merits of the IP protection in network industries [9,36], and Lemley focuses on existing practices of IP treatment in various standard-setting organizations [24]. Gandal et al. analyze the IP holding patterns of firms participating in standardization [11]. However, these views are restricted to either single institutional form or a discussion of the intellectual property issues in a specific technology. Though these studies cover a substantial ground, none of them examines the implications of technology as a bundle of IP.

The work in this paper is probably most closely related to the theory of the anti-commons [17]. This theory was formulated to explain the dysfunctional outcomes of property rights regimes in post-communist Russia. The anti-commons existed in Russian real estate because a variety of different entities held effective rights of exclusion over the use of real estate. For example, the right to lease, the right to receive sales revenue, and the right to occupy real estate were held by different entities. Thus, for a retailer to effectively use the building, it must collect lease rights from one entity, revenue collection rights from another entity, and the occupation rights of the building from yet another entity. Thus, the retail situation observed in Russia, until quite recently, was big deserted malls and small shabby kiosks by the roadside. It was simply too difficult to secure all of the permissions to have a retail establishment in a building designed for that purpose, so instead retailers constructed their own portable buildings. Similar arguments about anti-commons have been used to illustrate the detrimental effects of privatization of biomedical research [18]. From the anti-commons literature we borrow the idea that legal regimes in which property rights are distributed have consequences.

While our work is related to the anti-commons literature in that it concerns property rights and acquiring permissions from multiple entities, it also differs in several important aspects. Our work is focused on *intellectual* assets which are fundamentally different from physical assets such as real estate [40]. Hence, the rights associated with intellectual assets are also different from those associated with physical assets. In particular, real estate is highly observable. Inventions, on the other hand, are invisible and intangible, so it is not always obvious that they exist (more on this later). Furthermore, many inventions are “un-owned”, so they may or may not have rights attached to them. The other important distinction is the institution of interest. The anti-commons literature is interested in comparisons of legal institutions. Our work holds legal institutions constant and instead focuses on governance of the development process. We propose specific antecedents and specific transaction costs that arise in technology development and address how governance moderates those relationships.

In examining the governance structures, we rely on transaction cost economics, particularly Williamson [41,42]. Williamson proposes that different governance structures have different setup costs and

different abilities to moderate transaction costs. The best known work in this area proposes that asset specificity, frequency of transactions, and uncertainty cause transaction costs, and governing transactions in a hierarchy moderates these effects [41]. We extend this basic setup to examine how governance moderates the antecedents of transaction costs. We have different antecedents due to our focus on intellectual property (or inventions) instead of physical property, and we consider a bundle of assets rather than just one.

In this sense, this work is similar to Joskow's [20] which looks specifically at coal mines and power generation, and hence uses antecedents like region of the country – because coal from different regions of the country require different types of power plants. Our work is also similar to Saussier [34] who looks at the rivers on which goods are shipped on. On some rivers boats need to be specialized, while on others they can be the same as those used at sea. The point is that we look at the characteristics specific to the domain of technology as bundles of intellectual property.

The binary choice of markets or hierarchies has given way to a variety of other governance forms. One that applies in our context is network forms [29]. Network forms of organization are groups of firms that are interdependent. They govern transactions by consensus and make use of both formal and informal rules of exchange and reciprocity. They share knowledge and other resources and operate, at least to some degree, for the collective good rather than just the individual good.

From transaction cost economics, we borrow the idea that governance moderates the antecedents of transaction costs. We also borrow two basic forms of governance—hierarchies and networks. To transaction cost economics we add considerations for intellectual property rather than physical property, antecedents specific to technology development, and transaction cost specific to technology development. We also go into some specific detail about the causal mechanisms for this specific domain rather than keeping everything at an abstract level.

Another major stream of work from which we borrow ideas is the literature on the impact of IT on institutions. Several authors have examined how IT may change the transaction costs associated with different forms of governance. The first idea in this stream was that information technology would reduce the costs of coordinating market transactions more than it would reduce the cost of coordinating internal (hierarchical) transactions, which would result in more market transactions and vertical disintegration [27]. More advanced theory was proposed in the move to the middle hypothesis [7], which suggested that IT would reduce the dimensions of transaction costs that lead to vertical integration, but it would also reduce the dimensions of transaction costs that lead to using a large number of suppliers. Thus, we would expect to see more outsourcing, but to fewer suppliers.

From this stream of literature, we borrow the notion that governance structures moderate transaction costs in particular ways. It is the moderation of those transaction costs that is the main concern of this paper. However, our focus is slightly different than in this literature. Our paper focuses on how governance can moderate the transaction cost effects of the legal regime that currently dominates technology development. Thus, we explicitly assume a fixed technological regime; specifically the current regime. This is a limitation of the work, and we certainly recognize that there are interesting questions about how technology (like Google patents search) might change the situation.

Finally, from the incomplete contracts literature [14], we borrow the notion that property rights help determine optimal governance form. In particular, we borrow the idea that intellectual property rights are not necessarily subject to the same rules as physical property rights because inventions are not subject to the same rules as physical assets such as real estate [40]. However, our theoretical perspective is different from the property rights literature, which is concerned with ownership as a

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