OPEN E-BUSINESS STANDARD DEVELOPMENT AND ADOPTION: AN INTEGRATED PERSPECTIVE

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ABSTRACT

The recent growth of e-Business has called for open standards for inter-organizational electronic information sharing. Many firms form consortia to facilitate the development and adoption of open e-Business standards (OEBS). In this paper we study the consortium-based open e-Business standard development and adoption from an integrated perspective that recognizes the fact that firms have the choice of 1) joining the development of the standards; 2) being an adopter only and 3) not adopting at all. We consider the network effects and the interaction between the developer network and the adopter network. We find that the size of both the developer network and the adopter network is positively related to the network effect of the standards. The developer network's size is also positively related to the “insider” effect of being in the development. Furthermore, by increasing developer firms' “insider” effect and reducing the myopia for developers, the total value of the standards can be increased.

Keywords: Consortium-based standard development, standard adoption, network effects, economics of standardization.

INTORDUCTION

Standard development and adoption has critical implications on e-Business. Fuelled by penetration of the Internet in business operations, the growth of e-Business has transformed the way business is done between trading partners. Thanks to the highly dynamic formation of business relationships made possible by e-Business, firms have shifted their partnerships from a linear fashion, such as a supply chain, to value webs (Mathias and Kapur 2002) and enterprise networks (Zhao et al. 2002). The proliferation of e-Business technologies, especially the eXtended Markup Language (XML), has laid the foundation for firms to share information electronically with partners in the enterprise network. Such information sharing is the key to better interoperability, inter-firm coordination and collaboration, all of which are among the most important factors of e-Business. Yet, the lack of common open e-Business standards (OEBS), a specific set of IT standards for e-Business, has greatly hindered electronic information sharing among companies. The high developing cost due to the enormous scope of such standards, together with the uncertainty of adoption, has made it economically infeasible for the

development to be done by any single firm. When multiple firms are involved in the development of any standard such as OEBS, the incentives have to be set carefully to induce optimal effort from participating firms, which is a necessary condition of wide adoption and the eventual success of the OEBS.

We refer to OEBS as the type of IT standards that facilitate Web-based business information sharing in an enterprise network, such as ebXML (the E-Business eXtensible Markup Language) (Marchal 2003) and RosettaNet standards (Greenemeier 2002). OEBS has some special characteristics that set it apart from traditional standards, which call for a different approach when it comes to developing the standards. First, firms involved in the development of the standards are the actual future adopters[1], in addition to the firms that adopt after the standards are developed. This is the case because adoption of e-Business is embraced by many firms as a strategy to survive and succeed in today's extremely competitive market, therefore the potential users of a set of e-Business standards have strong incentives to develop it themselves. By contrast, existing research on the economics of standards typically treat the creator and users of a standard as separate entities. In this setting, the standard developer first create a standard, then has to win the standard war (Shapiro and Varian 1999), i.e. to convince potential adopters why it is worth the cost and risk to adopt it, when other competing standards are also available. Second, the development and adoption of OEBS are extremely interactive. Yet to our knowledge, the previous economics of standards literature all take standards as exogenously developed (David 1985, Farrell 1996, Shapiro and Varian 1999). Third, as argued above, OEBS cannot be developed by a single firm. Thus it is not an option, but a requirement, that multiple firms collaborate in the development. Furthermore, the standard development process has to be perceived fair and neutral by the consortium's member firms and does not favor any firm(s) (Berners-Lee 2003)[2].

The e-Business standards of concern in this paper also differ from EDI, the Electronic Data Interchange. EDI mainly facilitates business-to-business communication on transactional data. By contrast, a set of e-Business standards cover many aspects of the business partnership, including shared business processes such as product development or joint inventory management between trading partners. Business process sharing requires that partnering firms maintain a close and active relationship with one another. It opens up new opportunities for firms to jointly improve their overall operations efficiency and even create new business opportunities. Furthermore, open e-Business standards that are adopted by a sufficient number of firms will enable them to establish business relationships on a real time basis in the highly dynamic enterprise network.

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[1] For example, Intel is a board member of RosettaNet, a non-profit consortium to develop a set of XML-based e-Business standards. Intel and all 90 of its trading partners in 17 countries use RosettaNet e-business standards (Greenemeier 2002). The Interactive Financial eXchange (ifxforum.org), a consortium to develop financial web services standard, is made up of banks, mortgage companies, financial services companies, etc. who want to use the standard in their business. The Open Travel Alliance (opentravel.org), a consortium for web services standards in the travel industry, has 124 member companies such as airlines (AA, United), car rental companies (Thrifty, Dollar) and hotel chains (Hyatt), who will be using the standards to share information between them.

2 It is not coincidental that standard-developing consortia, such as RosettaNet and OASIS (http://www.oasis-open.org), are the leading forces to define and promote OEBS. Farrell and Saloner (1996) show that committee-based standard setting, as is the case in these consortia, is more likely to achieve coordination than under a pure market mechanism.

In this paper, we propose an integrated framework to study OEBS by capturing both the development stage and the adoption stage, as well as the interactions between the two. We endogenize the formation of the two networks, i.e. firms choice of which network to join is modeled. Therefore, the size of the two networks is not known ex ante, but is an outcome of the model. Firms' decision of which network to join is determined by the reciprocity between the standard development and adoption. Through analyzing the equilibrium of an economic model, our goal is to answer the question: *in an open, neutral standard-setting consortium where participation in development and adoption is voluntary, what are the factors that drive the development and adoption?*

In the next section, we use RosettaNet as an example to highlight the issues in consortium-based standard development and adoption.

ROSETTANET: A CASE FOR CONSORTIUM-BASED E-BUSINESS STANDARD DEVELOPMENT

As mentioned earlier, RosettaNet is a non-profit standard setting organization in the hi-tech industry. Set up by 40 companies in1998 as a consortium to facilitate e-Business standard development and adoption, RosettaNet has grown rapidly to have more than 400 companies as its members. The hi-tech industry, known for its high growth rate, fast depreciation and complexity of products, was in dire need of efficient inter-firm communication and information sharing. The founding companies, recognizing the inefficiency, determined that an open e-Business standards, based on XML, would be the first step in removing the barriers of seamless communication between firms.

The e-Business standards developed by RosettaNet encompass many aspects of an e-Business trading partnership. It covers operations ranging from pre-sale inquiry to ordering to post-sale services. Semantically, the RosettaNet standards are made up of three major components: data dictionaries that provide common set of properties in business transactions much as words in a language, the RosettaNet Implementation Framework (RNIF) much as the grammar, and the Partner Interface Processes (PIPs) as the dialog. Each part is further decomposed into many modules. For example, there are seven clusters within PIPs: partner profile management, product information, order management, inventory management, marketing and support, service and support and manufacturing (RosettaNet 2003a). The standards not only apply to firms' internal operations but also inter-firm communications, such as PIPs, specifications for shared business processes in the relationship between two partners. Therefore, its development as well as adoption entails a high level of collaboration among the trading partners.

The enormous scope of the standards also calls for cooperation of multiple firms in the development. It is the collective effort of member firms that determines the quality of the resulting standards.

In RosettaNet, member firms can choose to participate in two levels, as a board member or a partner[3]. Being a board member entitles, and requires, the firm to devote personnel and financial resources to actively participate in the development of the standards, as well as implementing the standards within the company and with its trading partners (RosettaNet 2003b). A partner does not directly get involved in the standard development but can adopt the draft submitted by developers before it becomes part of the standards (RosettaNet 2003c).

[3] Although one can choose to participate as an Alliance partner, it is mainly for governmental, academic and non-profit organizations (RosettaNet 2003d).

Obviously a board member has more involvement thus more impact on the forthcoming standards. Nevertheless, the highly interactive development process, with communications within the developers (the board members) and the adopters (the board members and the partners) ensures a high quality for the resulting standards.

This bi-level membership structure also differs from traditional standard setting consortia that treat all members homogeneously. In the latter, the resulting equality of members' rights cannot address the different aspects and levels of interests, which typically leads to a much elongated development process. By contrast, the idea of the RosettaNet approach is to provide differentiated incentives to parties with various levels of valuation of the standards. Its goal is to induce maximal incentives from firms that place a high value on the upcoming standards by giving them more influence in shaping it, while giving the firms with a relatively lower but still significant value an opportunity of early adoption before a draft is incorporated into the standards.

ISSUES CONCERNING STANDARDIZATION PROCESSES OF OEBS

The above observations on RosettaNet highlight the research issues of OEBS development and adoption in a consortium context. The endogenous formation of the developer and adopter networks, as well as the interdependence between the standard development and adoption, are two critical and unique features of OEBS and they will influence firms' decisions as to how to participate in the consortium. In this paper, to analyze the dynamics of this process, we adopt the concept of enterprise networks (Zhao et al. 2002). In this setting, two enterprise networks form sequentially: the developer network and the adopter network. In the RosettaNet case, the board members form the developer network and the partners including all board members compose the adopter network. Both networks are a special case of the enterprise networks proposed by Zhao et al. (2002). Firms have to first decide which network to join. By joining a network, a firm becomes a part of a network and can have a “link” with any other firm in the same network, in the form of collaborating in the development or sharing the same standards in the adoption stage. If a firm chooses to join the developer network, it also needs to select a level of participation, i.e. how much effort to exert in the development.

On the one hand, the size of the adopter network and the resulting network externalities will affect the developer firms' business value of the standards. Previous research on network externalities (Katz and Shapiro 1985, Liebowitz and Margolis 1994) has shown that network externalities have critical strategic implications for standard adoption (Shapiro and Varian 1999, Kauffman et al. 2000). As a typical network technology, OEBS had positive and indirect network externalities among adopters. That is, the business value for an OEBS adopter increases with the number of firms within the adopter network. With more firms adopting the same OEBS, the fears of being locked in from small companies will be eased and with reduced switching costs, it is easier to locate new trading partners and collaborate dynamically. In addition, network externalities intensify the interdependence between the developer network and the adopter network. The size of the adopter network will determine the developers' payoff, which serves as a determining factor for firms' decision to join the developer network.

On the other hand, the developer network also has impacts on the adopter network formed later. The quality of the standards is an increasing function of the overall effort level in the developer network. It will influence firms' adoption decisions, which in turn determines the size of the adopter network. The collaborative development of OEBS requires coordination of efforts by multiple individual firms. This can be viewed as a collective action problem (Sandler 1992) as the outcome is a function of the collective action. Therefore, the resulting quality of OEBS will be determined by the aggregate effort of all developers. For an individual firm, its utility is

dependent on the other firms' efforts. It is the standard setting consortium's task to coordinate and promote the collective actions between firms involved in establishing OEBS.

In the following section, we create a game theoretical model to analyze the standardization process of OEBS in a consortium setting. The model reflect our observations drawn from the RosettaNet case and incorporate the unique characteristics of OEBS we identify before. We take into account the network externalities among adopters and collective action problem within the developer network. Specifically, our model aims to answer the following research questions:
(1) What kind of companies will be likely candidates of leading developers and which are expected to be following adopters in an OEBS setting process?
(2) For firms that choose to be developers, how much effort will each firm invest in the process of standard development?
(3) How to induce firms' incentive to participate the standardization process of OEBS to maximize the total value of the standards?

THE MODEL

In this model, we assume there are *N* firms and a consortium is proposed to develop a new OEBS. Firms have three choices. They can voluntarily participate in the development of the standards, adopt them after they are developed or not adopt at all. A firm's participation in development will be viewed as a commitment of human and financial resources for development as well as a promise for future adoption.

The Model Description

The players in the game theoretical model are the *N* firms. The game is made up of three stages.

Stage 1: (Developer Network Formation) Firms simultaneously determine whether to participate in a joint standard setting effort. A developer network is formed by those determined to join.

Stage 2: (Standard Development) Firms in the developer network determine the optimal individual effort level to invest in the development. The standards are developed jointly, with the quality determined by the aggregated effort of all firms.

Stage 3: (Adoption) The remaining firms outside the developer network make their individual decision as to whether to adopt the new IT standards. The adopters enjoy the value of OEBS.

Note that by our definition, a developer always adopt the standards in Stage 3.

The business value of the standards for an adopter is the sum of the direct benefit from adopting OEBS, the network effect as a function of the number of total adopters and the quality of the standards as a function of the collective efforts from all developers.

In this model, the *N* players are all interested in a forthcoming OEBS. However, the players are heterogeneous in that the benefits they can derive from the standards, i.e. their valuation, are not the same. Without loss of generality, we assume that firm i's valuation of OEBS, q_i, has a uniform distribution between 0 and 1. The assumption of the uniform distribution is not critical in the model, which we will prove in the following section. The difference can result from firms' heterogeneity in size, sophistication in technology and product category. In general, firms with high valuation have incentives to participate the developer network because: (1) they can speed

up the development/adoption process; (2) they can become insiders in shaping up the standards, which will further increase their payoff in the future. Firms with higher valuation on the standards tend to be more sophisticated e-Business wise and have stronger preference on the content of the standards as they are more likely to have a related practice in place.

In the developer network, firms determine their individual effort level e_i with cost $C(e_i)$. We assume that $C(e_i)$ is a convex function of e_i. Developers' direct benefit from the standards, once they are adopted, is dq_i, where $d > 1$ represents the benefit of being an "insider". As we indicate before, the quality of OEBS is a function of the collective effort $Q(\sum e_i)$, which is a strictly concave function of e_i. All adopters will incur the same adoption cost C_a. We use a linear function "$a * \text{proportion of adopters}$" to represent the benefit from positive network externalities, where $0 < a < 1$.

The Equilibria and Their Implications

We use backward induction to compute the equilibria of the game and derive the following implications.

Recall that a firm's payoff function is:

1. If firm i is a non-adopter, $U_i = 0$.

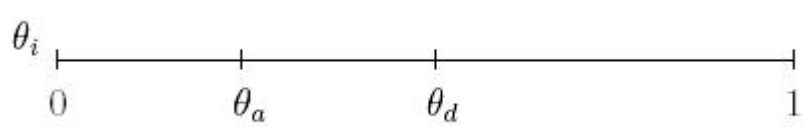
2. If firm i is a following adopter:

$$U_i = q_i + a * \text{proportion of adopters} + Q(\sum e_i) - C_a \qquad (1)$$

3. If firm i is a leading developer:

$$U_i = dq_i + a * \text{proportion of adopters} + Q(\sum e_i) - C(e_i) - C_a \qquad (2)$$

The utility function we use in the paper is a natural extension of the one proposed by Katz and Shapiro (1985). To simplify the computation, the externality function is a linear function of the proportion of adopters among the total *N* firms. From the payoff function, we can see that the firms with higher q_i tend to be more active in the OEBS setting game. In addition, we use q_i to represent individual firms and visualize the two enterprise networks in the following figure.



In the figure, q_d is the firm that is indifferent between being a developer or not, and q_a is the firm that is indifference between adopting and rejecting the new OEBS. Under the assumption of the uniform distribution, $1-q_d$ is the proportion of firms within the developer network, which is

the line between q_d and 1 in the figure. Analogously, $1-q_a$ is the proportion of firms that belong to the adopter network. Moreover, we can easily relax the assumption of the uniform distribution based on the same approach. For any type of distributions, the size of the developer network is $1-F(q_d)$ and the size of the adopter network is $1-F(q_a)$, where $F(q_i)$ is the cumulative distribution function of q_i.

Step 1: The size of the adopter network

To calculate the size of the adopter network, we only need to find the value of the marginal adopter, q_a. Because he is indifferent between adopting and non-adopting, we have:

$$q_a + a*(1-q_a) + Q(\sum e_i) - C_a = 0$$

$$q_a = \frac{C_a - a - Q(\sum e_i)}{1-a} \qquad (3)$$

Therefore, the size of the adopter network is:

$$1-q_a = \frac{1+Q(\sum e_i) - C_a}{1-a} \qquad (4)$$

For OEBS to be successfully developed in such a joint setting, it must satisfy the condition that $1+Q(\sum e_i) - C_a \geq 0$. Otherwise, even the firm with highest valuation is not willing to develop the standards.

Proposition 1: The size of the adopter network is positively related with the network effect and the quality of the standards; however, it is negatively related with the adoption cost.

The size of the adopter network increases when the marginal adopter q_a can realize higher utility from the network effect and improved OEBS quality. The higher network effect means the larger value an additional user brings to the other adopters as well as to itself. Similarly, lower adoption costs encourage more lower end firms to implement OEBS, since they are relatively smaller in size and firm resources.

While this result may not be surprising, it is not entirely obvious. The model assumes simultaneous move of the potential adopters in the third stage. Intuitively, without possibility of coordination, non-participation could be an equilibrium outcome, if the potential adopters fear that adoption benefits from the network effect will not materialize without coordination.

Step 2: The optimal investment level in the developer network

Each firm in the adopter network determines their optimal effort level to maximize its payoff:

$$\max_{e_i} \; dq_{\mathrm{i}} + a(1-q_a) + Q(\sum\nolimits_{-i} e_j + e_i) - C_a - C(e_i)$$
$$= dq_{\mathrm{i}} + a\,\frac{1+Q(\sum\nolimits_{-i} e_j + e_i) - C_a}{1-a} + Q(\sum\nolimits_{-i} e_j + e_i) - C_a - C(e_i)$$
$$= dq_{\mathrm{i}} + \frac{a}{1-a} - \frac{1}{1-a}C_a + \frac{1}{1-a}Q(\sum\nolimits_{-i} e_j + e_i) - C(e_i)$$

Note: $\sum_{-i} e_j = \sum_1^{N_d} e_i - e_i$, which is the sum of all the other developers' efforts.

From the first-order condition, we find that:

$$\frac{1}{1-a}Q'(\sum\nolimits_{-i} e_j + e_i) - C'(e_i) = 0 \qquad (5)$$

Under our assumption of the homogeneous cost function, i.e. the function form of $Q(.)$ and $C(.)$ are the same for all firms, the above equation represents the symmetry among firms. In equilibrium, all firms in the developer network will have the same optimal investment level. So we can further simplify the equation as $\sum_{-i} e_j + e_i = N(1-q_d)e_i$ to the following:

$$\frac{Q'(N(1-q_d)e^*)}{C'(e^*)} = \frac{1-a}{N(1-q_d)} \qquad (6)$$

The second order condition $\frac{1}{1-a}(N(1-q_d))^2 Q''(N(1-q_d)e) - C''(e) < 0$ ensures the maximization of the equation (6). Notice that the left hand side of equation (6) is a decreasing function of *e*.

Proposition 2.a: The optimal individual effort level of a developer firm is positively related with the network effect and the total number of firms interested in the forthcoming OEBS.

Higher network effect means that the size of the adopter network is more valuable for developer. In that case, developers are willing to increase the quality of OEBS so as to attract more adopters at the final stage. *Q* is an increasing function of the collective effort level. A large N implies more firms in the developer network and even slight change of the individual effort level will trigger a significant change in *Q*. So the total number of firms is aligned with firms' investment incentive.

Proposition 2.b: The individual valuation of the standards will not influence the optimal individual effort level.

We obtain a slightly counterintuitive result. Firms' heterogeneous valuation will determine their participation choices. However, once firms join the developer network, their objective is to maximize their business value, which is the same across firms under the symmetric assumption.

Step 3: The size of the developer network

We assume that *N* is large enough that any one firm dropping from the developer network does not influence its size. To find the size of the the developer network, we need to find the type of the firm that is indifferent between being an active developer and being a passive adopter.

$$dq_d + a*(1-q_a) + Q(N(1-q_d)e^*) - C_a - C(e^*) = q_d + a*(1-q_a) + Q(N(1-q_d)e^*) - C_a$$

which is equivalent of:

$$1-q_d = 1-\frac{1}{d-1}C(e^*) \qquad (7)$$

Because $C(e^*)$ is an increasing function of a , we obtain the following proposition:

Proposition 3.a: The size of the developer network is positively related with the insider effect and the network effect.

The developer's utility is an increasing function of the network effect and the insider effect. Under the higher a and d , the marginal developer's valuation q_d can be lower. The impacts of the network effect have been discussed before. And the insider effect is a key incentive component for developers. If firms can influence the developer process and let the forthcoming OEBS match their individual interests, they will have incentive to participate the developer network despite the costs incurred. In addition, from equation (6) we obtain that the increased insider effect will not only increase the size of the developer network, but also will increase the optimal investment level at stage 2.

Let e^{**} denote the myopic optimal investment level, when firms only consider the network effect within the developer network at step 2.

$$\begin{aligned}
&\max_{e_i} \; dq_{\mathrm{i}} + a(1-q_d) + Q(N(1-q_d)e) - C_a - C(e) \\
&\quad = dq_{\mathrm{i}} + a(1-\frac{1}{d-1}C(e)) + Q(N(1-q_d)e) - C_a - C(e) \\
&\quad = dq_{\mathrm{i}} + a - C_a + Q(N(1-q_d)e) - \frac{a+d-1}{d-1}C(e)
\end{aligned}$$

The first order condition is:

$$\frac{Q'(N(1-q_d)e^{**})}{C'(e^{**})} = \frac{a+d-1}{d-1}\frac{1}{N(1-q_d)} \qquad (8)$$

Because that $\frac{a+d-1}{d-1} > 1-a$, we obtain that $e^{**} < e^*$.

Proposition 3.b: If the firms in the developer network are myopic, the optimal effort level will be lower.

If developers myopically expect that the potential adopters are just current members of the developer network, they will underestimate the value from positive network externalities realized at the final stage. That impact parallels a lower network effect. So similar to Proposition 2.a, firms' incentive to invest will be lower. To increase firms' motivation, the consortiums should educate the firms on the long-term value of standards, so they do not act myopically.

DISCUSSION AND CONTRIBUTION OF THE MODEL

The standard-developing consortium, founded by multiple firms, is an entity with its own agenda and policies. Its goal is to maximize the total value of the standards to be developed brought to its member firms, which is the sum of all the firms' payoffs. Note that each firm has the freedom to choose which network to participate in, or not to join the consortium at all, before the development starts, therefore the formation of the networks is endogenous in our setup. Suppose we denote the developer network as *D* and the pure adopter network as *A*, the consortium's objective function can be derived as follows:

$$\max \sum_{j\in A} U_a(j) + \sum_{j\in D} U_d(j)$$

$$= \max \int_{q_a}^{q_d} [q_j + a(1-q_a) - Q(\sum e) - C_a]dq_j + \int_{q_d}^{1} [dq_j + a(1-q_a) - Q(\sum e) - C_a - C(e)]dq_j$$

$$= \frac{q_d^2 - q_a^2}{2} + \frac{d(1-q_d^2)}{2} + a(1-q_a^2) + (1-q_a)Q(\sum e) - (1-q_a)C_a - (1-q_d)C(e) \qquad (9)$$

If we know the value of the ”insider effect”, d , the network externalities, a , the functional form of $Q(.)$ and $C(.)$, the objective is a quadruple function of firms' efforts, e, as both q_a and q_d are functions of e. One can solve for the optimal e_c^* that maximizes the consortium's objective.

The same can be applied to any individual developer firm, as we have done. The individual developer i's objective function is:

$$U_d(i) = dq_i + a * (1-q_a) + Q(\sum e) - C_a - C(e) \qquad (10)$$

Again, if the value of the “insider effect”,d , the network externalities, a and the functional form of $Q(.)$ and $C(.)$ are known, through backward induction, we can find the optimal e_I^* that maximizes this individual firm's payoff. It is usually not the e that the consortium prefers most, i.e. it might be that $e_C^* \neq e_I^*$. The reason is that the overall benefits are closely related with the size of the adopter network and the developer network, and the consortium wants to induce the investment level that trigger the right network size, which is not an issue considered by individual developers. Since the effort is either non-observable by the consortium or non-contractible, the consortium cannot force a firm to exert any given effort level if that does not coincide with the firm's preference. The consortium's problem, then, is how to change the conditions it can control so as to reduce the gap between overall value resulting from firms' optimal effort and the optimal overall value. The consortium, for example, can change the “insider effect”, d , by giving developing firms more freedom and control in shaping the standards.

Based upon our model, we can conceptually show the difference between the individual optimal investment level and the consortium optimal investment level.

Our setup assumes that there are two networks in the consortium, the developer network and the adopter network. Since we also assume that developers will always adopt, the former is a subset of the latter[4]. This assumption reflects the fact that a company is willing to become a leading developer by incurring addition costs only if, ex ante, its expected payoff is higher than being a following adopter. Furthermore, adopting at the adoption stage is a sub-game perfect strategy for the developer firm, as it will always find adopting a dominant strategy when it comes to the adoption stage--otherwise its payoff is negative.

The most unique and desirable characteristic of our setup is the endogenous formation of the two networks. Without it, the problem can be viewed as a classic agency problem, with the consortium being the principal and firms in the two sub networks being agents. The firms maximize their own objectives, which may result in a solution different from the overall optimal from the consortium's perspective. In reality, however, the agency approach is inapplicable as the networks are not fixed ex ante but formed voluntarily by the firms. The coupling of the payoffs of the two groups, due to the quality of the standards as a function of developer efforts, complicates firms' decision as to which network to join. Our model, by incorporating the endogenous strategic formation of the two networks, better captures the reality as firms have to weigh the tradeoff and choose an action before the development begins. This phenomenon is very important in consortium-based IT standard setting efforts as firms always look to find the best form of engagement in these initiatives[5].

SUMMARY AND FUTURE EXTENSION

OEBS, being important emerging IT standards, have strong interaction between the development process and the adoption process. The unique characteristics of OEBS make previous research frameworks inapplicable. Our three-stage game theoretic model provides an integrated perspective to study the new IS phenomenon.

During the standardization process of OEBS, three types of firms will emerge in a market: active developers, following adopters, and non-adopters. Heterogeneous valuation of individual firms, which can be a function of their size, sophistication in IT and scale of suppliers/business clients, determines firms' participation decisions. The marginal adopter and the marginal developer are identified so that we can predict the category each firm belongs to. Firms with a valuation higher than the marginal developer value the benefits of being an “insider” more than others and find it worthwhile to devote financial and human capital to participate in the development. Firms with a relatively lower valuation of the standards, which is between that of the marginal developer and the marginal adopter, will choose to be adopters only. Firms with yet lower valuation than the marginal adopter stay out of the adopter network altogether. In addition, our propositions analyze the critical factors, such as the network effect, that will influence the number of firms within each category.

[4] The pure adopter network, as appeared before, is the set of adopters that are not developers. The adopter network, therefore, is made up of the developer network and the pure adopter network.

[5] Chen (2003) reports that at GM, “four people work full-time deciding what standards are important to the company and what kind of participation in standards groups is appropriate.”

Through backward induction, the optimal investment level that maximizes individual developers' business value is calculated. Under the symmetric assumption, the optimal investment levels within the developer network are homogenous and are not affected by individual valuations.

Successful OEBS should be able to maximize the collective benefits of all adopters. Our model indicates that the increased optimal investment level at the second stage will improve the quality of OEBS as well as enlarge the size of the adopter network. So the incentive mechanism is a critical issue during the voluntary collective development. Our research have strategic implications are generated to achieve successful consortia formed in the OEBS setting, such as RosettaNet. The first is to clarify and increase the “insider” effect. When the firms are convinced about their privilege as insiders in the developer network, they are more willing to put effort in the collective action. This addresses the issue of coordination failure often encountered in a setting with high network externalities. To attract more firms to the consortium, the organizers of the consortium should ex ante clarify the rights and potential benefits that members can enjoy. In the RosettaNet case, board members have more power to design standards that are consistent with their business need. This is done by dividing the standards into fine, easier-to-manage and relatively independent modules so the number of developers on each module is very small so as to give firms more freedom thus more “insider” benefits. The second is trying to avoid “myopia” of the developers. When firms realize that the benefits will come from future adopters other than existing members in the current developer network, firms will have a higher optimal effort level at the development stage, which is socially beneficial. The appropriate estimation of the future network impacts should be shared by all members within the developer network, which is part of the responsibilities of the consortium.

Our framework highlights several interesting properties of OEBS and offers managerial implications to better manage strategies in the standard setting. Future study can be extended to the asymmetric and private information game.

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