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### Abstract

This research examines the participants in the de jure standard setting in Japan, so as to understand the benefits and costs that corporations receive from participation. In particular, the research and development (R&D) expenditure to sales (R/S) ratio is used to examine corporations' relative R&D position in their industry sector, in the following four sectors: (1) production machinery, (2) transportation machinery, (3) non-ferrous metals, and (4) information and communications technology. In addition, an analytical framework for the cost and benefit structure of corporate participation in standard development organizations is described. We have found that in R&D-intensive industries, there is less participation from high R/S corporations. This result is in accordance with previous research into European Union (EU) de jure standardization, but not with the case of the United States.

*Keywords:* Standardization, De jure standard, De facto standard, R&D

*JEL classification:* O30

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## **1. Introduction**

This research examines who participates in the de jure standard setting in Japan, so as to understand the benefit and the cost that corporations receive from participation in the Japan Industrial Standard Committee (JISC). In particular, the R&D expenditure to sales (R/S) ratio is used for examining the company's relative R&D position in its industrial sector, in the following four sectors: (1) production machinery, (2) transportation machinery, (3) non-ferrous metals, and (4) information and communications technology (ICT). In the formation of Japan Industrial Standards (JIS), agreement among relevant parties is viewed as essential. The draft standard is crafted in a group whose members consist of producers, neutral parties, and users, with an equal share of each, according to the rules. After a draft is agreed upon by the drafting group, it is sent to the JISC, which is in charge of establishing JIS. In the JISC, the draft is investigated and authorized to become a JIS. In the authorization process, equal treatment of the three member groups—producers, neutral parties, and users—is necessary.

In the JIS authorization process, members from corporations are meant to behave in the public interest rather than for the profit of the corporation. However, there is no incentive for the corporation to participate in the JISC if the cost of participation is greater than the benefit. In that case, corporations would not serve as committee members even if nominated. Such a

situation is not appropriate from the viewpoint of industrial policy. Hence, the cost and benefit structure of participation in JISC committees is worth studying for the corporate side as well as the JISC.

What kinds of benefits can a corporation obtain through JISC membership? What kinds of costs does a corporation incur through participation in the JISC? While answering these fundamental questions is beyond the scope of this research, this paper presents original data shedding light on a cost-benefit model for participation and this will be useful for corporations when they decide whether to participate in the committee. Such decisions are assumed to be made using the inside knowledge of individual corporations unknown to the outsiders. Consequently, the administration side of the JISC is not aware of the merits and demerits from the corporations' perspective. It is useful for the JISC to be aware of them in the policy design for the JISC so as to strengthen the JIS system as part of national industrial policy. To this end, this study focuses on the research activities of corporations, since technology standards are the result of R&D activities. The R/S ratio is used to gauge the R&D intensity of corporations participating in the JISC. Comparative analysis is conducted across four industrial areas and corporation members in terms of R&D. Through the comparison, the costs and benefits of participation in the JISC committee for corporations are elucidated.

The organizational format of de jure standardization committees has been found to have a great influence on the standard creation process, and thus is a key focus of standardization policy (West 2007). It is generally understood that standards are substantively affected by the framework of decision making in which they are developed. In a sense, the results or outcomes of a committee are ultimately controlled by the process by which the committee was formed. Thus, the study of the process is as important as the study of the end result itself. In the case of standards, the process of creating standards through standard development organizations (SDOs) is as important as the actual drafting of standards themselves.

Standardization by committees or SDOs has not adequately been examined from a research perspective (Steinfeld et al. 2007). Generally, research conducted to date has focused on two areas: how standard committees operate in practice (the structure of decision making) and how strategic behavior of the participants influences the nature of agreed upon standards. In the previous research on standardization activities, the role and effect of the standard formation body or committee of each nation, generally referred to as SDOs, have been the primary focus. For example, the effect of standardization activities by manufacturers in SDOs has been the subject of research and analysis in regards to the American National Standard Institute (ANSI)

(Gandal et al. 2007).

The de jure standard-setting body in Japan is the JISC. In the JISC, there are technical committees, which are in charge of deliberating on the original draft of a JIS. The draft of a JIS is usually prepared by the relevant parties and submitted to the JISC for formal deliberation. During the drafting process, consensus among the relevant parties is essential. When the draft standard is submitted to the JISC technical committees, necessary modifications are made according to the opinions of JISC committee members. The JISC is in charge of authorization and confirmation, but the role is limited since a substantial part of the original draft is made by the relevant parties. In sum, it could be said that the role of the JISC technical committee is to authorize submitted draft proposals rather than substantial discussion (Figure 1). As for modifications, it is not generally observed that committee members from a specific group are more active in revisions. It seems that opinions are based on the personal knowledge of committee members rather than their belonging to a particular group. The JISC's equivalent in the United States is ANSI. The roles of the two organizations are generally similar in that they are both responsible for setting de jure standards, which are used as national standards. On the other hand, de facto standards and consortium standards are typically formulated by interested producers, typically private corporations. De jure standards are public standards, usually set by

governmental or quasi-governmental agencies such as the JISC and ANSI, whereas de facto standards, including consortium standards, are set through market mechanisms. Needless to say, the latter types of standards are strongly production-oriented and the objective is promoting corporate innovativeness and increasing profitability. De jure standards, however, have a broader perspective than production, and may also aim to maintain public safety and promote social welfare.

[Figure 1]

Nevertheless, the general understanding that de facto standards are innovation-oriented and de jure standards are focused primarily on social infrastructure is changing rapidly and dramatically. It is recognized in academic circles that developed nations such as Germany, France, the United Kingdom, and Japan have begun to strengthen national SDOs to pursue standards as part of national industrial policy (Cargill and Bolin 2007). Considering this policy transition, the question arises as to what happens in these SDO activities. The membership and participants of de jure standard bodies most certainly influences the setting of de jure standards.

A notable difference between Japan and the United States in de jure standard setting is that SDO membership is not necessarily allocated evenly among producers, users, and neutral parties in ANSI; hence, US corporations are thought to participate in SDO activities for pursuing their

own profit, whereas in the JISC representation is supposed to be equally allocated among these parties under the Industrial Standardization Act of Japan. Gandal et al. (2007) note that, in the case of standard setting in ANSI for communication modems, participants were mainly companies from the electronics industry in the United States. Participating corporations in ANSI standard development receive the benefit of increased numbers of patents obtained pertaining to new standards. This means that the process of de jure standard formation in the United States provides participants on the committee with information that is beneficial for corporate innovation.

However, in the case of the Japan, the membership of de jure standard committees has not been reviewed to date. Especially in terms of R&D and corporate participation, numerical analysis of the actual situation in JISC technical committee activities has not been studied, unlike the previous study of ANSI. In particular, the degree of R&D-intensiveness and composition breakdown between leading members and follower members by industry sector has not been shown. In addition, the corporate size of JISC members has not been discussed before. Unlike for ANSI, basic analysis and data on the actual situation and participation in JSIC have not been developed.



JIS are the de jure standards formulated by the JISC, primarily concerning industrial products and management systems. The JISC is part of the Japanese government. In other countries such as the United States and in the European Union, the standard committee is typically set up not within a governmental agency, but within a quasi-public agency such as ANSI. Therefore, de jure standards are formulated by committees apart from the market mechanisms and competition of corporations. De facto and de jure standards differ both in the nature of the standards and in the formation process.

De facto standards change according to the power and influence of each corporation, and changes are usually related to product innovation. Therefore, de facto standards are often viewed as being important because they are decided in the market. Needless to say, however, de jure standards provided by ANIS, JISC, ISO, and the International Telecommunication Union are as important as de facto standards. Particularly in the field of ICT, product innovation is impossible without the de jure standard, as shown in the case of ANSI modem standards. Indeed, in the case of Finland, growth in national innovation is attributable to the development of the mobile telecommunication industry (Tokumasu and Watanabe 2008). Standardization plays an important role in this industry because communication between new mobile telecommunication devices requires a standardized communication protocol.

De facto standards are inevitably influenced by corporations' behavior in the market, so it likewise should be asked how de jure standards activities affect corporations. This question ties back to the fundamental research interest of this paper: What is the corporate benefit of JISC participation?

JIS standards are formulated by the JISC, a governmental committee in the Japanese Ministry of Economy, Trade and Industry (METI). Its activities are publicly oriented. The stated goal of the JISC is to improve economic activities through the formation of standards that improve product interoperability, that make production more efficient by reducing the use of different parts, and that benefit users in terms of safety and health.

In this research, a literature review is conducted from a theoretical perspective, the results of which are interpreted in the model equations to identify the costs and benefits of committee participation for corporations in terms of R&D level. In addition, participating members are categorized as either leading corporations or following corporations. Where the R/S ratio of a corporation is above the average R/S ratio of its industry, it is categorized as a leading corporation and when the R/S ratio is lower than the industry average, the corporation is

categorized as a following corporation. Policies are then examined to identify methodologies to improve participation by industry sectors on de jure standard committees and make committee activities more oriented toward corporate innovation. In addition, especially for high-technology industries, it is noted that establishing guidelines for the protection of R&D trade secrets promotes participation by corporations. Because product innovation in the ICT industry has made standardization an essential activity, a safety system for corporations to protect trade secrets while pursuing the formation of standards is a necessary component of the corporate intellectual property (IP) management system.

In sum, the objectives of this study are as follows:

*To examine who participates in the de jure standard setting in Japan, so as to understand what benefits corporations receive through participation in the de jure standard formation.*

This research is of an introductory nature and aims to facilitate future inquiry. The results will be an initial step toward further development and, as a basic reference, will be beneficial to academic scholars. The results will also be useful for the improvement of the de jure standard formation process. Ultimately, the knowledge and information obtained through this study will be valuable to countries around the world, as de jure standards are prepared in both developed

and developing countries, although de facto standards are generated primarily from market competitive corporations in developed countries.

## **2. Literature Review**

In the past research, standardization organizations have been the target of investigation because information on SDOs is more easily obtainable. One research topic on SDOs is the coordination cost among participants. Delays in standard setting may result in the loss of market opportunity. Large membership of SDOs is associated with longer standard development time, as having more members on SDO committees can result in delays in the processing time for new standards (Simcoe 2007). According to Farrell (1996), the average duration to formulate a standard is five to seven years in the case of de jure standards setting developed by the ISO and the International Electrotechnical Commission.

Changes in membership may occur according to the benefit that each corporation receives since the standards are formed through the agreement of the participating members. A membership change was observed in the Internet Engineering Task Force (IETF), which is a consortium standard-setting organization. On the IETF, corporate members increased from 20% to 60% from 1986 to 2002, while representatives from the governmental sector decreased dramatically

from 80% to 10% (Simcoe 2007). This finding may suggest that the benefit of participation in SDO is increasing rapidly. Further, membership issues are certainly associated with standard formation efficiency.

#### i) De jure standard formation in Japan and the United States

In the case of Japan, the de jure standard-setting organization is the JISC and participants on technical committees of the JISC are appointed by affiliation, with members from industry, academia, and consumer groups. Participants represent three affiliation types on the committee:

(1) neutral parties, (2) producers or manufacturer, and (3) users. In the process, the role of producers is mainly in authorization and deliberation, but when technology intensity is high, these corporations will benefit from making their own technology into technology standards.

This situation is different from the case of ANSI in the United States, for which membership quotas seem not to have been adopted. The important parts of the general guidelines for ANSI membership are as follows:

- participation is open to all affected parties; and
- decisions are reached through consensus among those affected (Cargill and Bolin 2007).

These differences suggest that standard setting can be affected by the formation process in different ways in Japan and the United States.

ii) R&D orientation and participation

As for the motivation to participate in SDO activities, it is reported that R&D-oriented corporations and organizations are less likely to participate in the activities because of the fear that the technology information of the corporation will unintentionally spillover. Instead, R&D-oriented corporations are more likely to use their energy on patent applications to protect their intellectual property assets and the results of their technological developments (Blind & Jungmittag 2008). In particular, high-technology industries are often unwilling to participate in SDO activities. In contrast, corporations and manufacturers that are not R&D-oriented may view SDO meeting attendance as useful for the collection of technology information (Blind 2006).

In addition, research of the standardization effect on economic growth has also been conducted. For industry sectors with a low and medium R&D level, investment in standard development has an impact on economic growth, whereas in industry sectors with a high R&D level, investment in patents has more impact (Blind and Jungmittag 2008). That research result implies that, for corporations in low- and medium-technology industry sectors, the activities in the SDOs are viewed more favorably and that the participation from such industry sectors on the

standard formation committee will be higher.

Unlike the previous research on the ANSI modem case, research on the relationship between the JISC committee member affiliation and industry sector in terms of R&D level has not been examined in past research. In the case of ANSI, the industry sector of the participant is not necessarily decided from the viewpoint of affiliation diversity; indeed, committee construction seems to have nothing to do with affiliation. However, in the case of the Japan, the structure of the committee seeks balance between producers, users, and neutral parties. This difference may affect the nature of the standards developed.

As for the role of government and the public, they are essential members in de jure standard setting, as the formed standards are often used as part of the regulatory structure. De jure standards are also used sometimes for governmental procurement since, from a technological and industrial policy perspective, governmental authority is highly influential in the de jure standard setting. These authorities are sometimes particularly influential in high-technology R&D areas (Hemenway 1975). For example, the National Bureau of Standards in the United States (now renamed the National Institute of Standards and Technology; NIST) asked the industry not to create computer interface standards. In this case, the standard authority feared

the lock-in effect of the standard and that an interface standard could become an obstacle to technological development.

### **3. Hypothesis**

Corporations participating in the JISC responded to a request for participation, and the decision to participate is considered to be made rationally. In the study, corporations are assumed to decide participation by calculating the benefits and costs of participation comprehensively and rationally. If the cost is very high and the benefit is low, a corporation will avoid becoming a member. Hence, in the model, members are those corporations which will profit from participation. In the case of participation of leading corporations with high R/S ratios, it is assumed they receive a benefit by participating in the activities.

By considering Blind's (2006) perspective, high-technology industry sectors would have a negative attitude towards participating in de jure standards formation processes, since they would be concerned about unintentional technology spillovers. However, considering the increasing influence of standards on R&D and innovation, the relationship between industrial participants and standard formation might be different in the United States as seen in the research results of Gandal et al. (2007), where participation in ANSI activities is beneficial in regard to corporate patents. In particular, in the United States, the incentive for a corporation to



incorporate its own technology into standards from participating industries is high, since the standards organizations are more willing to develop standards which use patented technologies, as long as the firms commit to RAND licensing.

Hence, the hypothesis examined is as follows.

*Hypothesis: For the de jure standard formation committee in Japan, the profit that corporations receive from their participations is not necessarily high in technology-oriented industry sectors.*

If the hypothesis is correct, the case of de jure standard setting in the JISC will be in line with what happens in the European Union rather than the United States.

## **4. Methodology**

### 4.1 Data preparation

In this research, four large technology business sectors are selected since the participant list of corporations is publicly available (JISC 2012). These industry areas are (1) production machinery, (2) transportation machinery, (3) non-ferrous metals, and (4) ICT. The average R/S ratio of each sector is calculated, as well as the R/S ratio of participating corporations, the mean R/S ratio of participating corporations, and the number of leading corporations. Here, a leading

corporation is one which has a higher R/S ratio than the average for its industry sector. In addition, to examine corporate size, the number of small- and medium-sized enterprises (SMEs) is counted in each industry area.

#### 4.2 Data sources

In Table 1, the data were obtained from the Basic Survey of Japanese Business Structures and Activities (METI 2012) and the securities reports of individual firm. For the “Average R/S in each technology area” and the “Sales growth in each technology area” in Table 1, data from the “Basic Survey of Japanese Business Structures and Activities” are used. For the preparation of the R/S of participating corporations, the numbers of “R&D expenditure” and “Sales” in the firm’s securities report are used and calculated unless the R/S ratio is directly noted in the section on the R&D activities in the firm’s securities report. When R&D expenditure is not noted in the securities report, these corporations are not counted in the category “Number of corporations reporting R&D expenditure”.

### 5. Analytical framework

On the basis of the literature review above the following cost equation can be formulated:

$$\text{Cost} = (\text{risk of unintentional spillover}) = f(\text{R\&D orientation})$$

$$= g(\textit{kind of industry}) \times h(\textit{corporate size}),$$

where  $g(\textit{kind of industry})$  is positive when the industry is R&D-oriented and  $f(\textit{corporate size})$  is positive when the corporate size becomes larger.

The benefit equation is expressed as

$$\textit{Benefit} = \textit{information of R\&D} + \textit{benefit of standardization of own (or complementary) technology}.$$

(In “benefit of standardization of own technology”, “technology” includes the main technology and complementary technology)

Thus, utility of participation can be shown by subtracting the costs from the benefits, for which the equation becomes

$$\textit{Utility of participation} = \textit{benefit} - \textit{cost} = \textit{information of R\&D} + \textit{benefit of standardization of own(or complementary) technology} - g(\textit{kind of industry}) \times h(\textit{corporate size}).$$

(In the benefit of standardization, the expectation to set own technology as the next-generation standards is included.)

Here, if  $\textit{utility of participation} > 0$ , then participation in the SDOs will be beneficial for the corporation. In that case, there will be corporate members if the membership is formed without any external intervention from the SDO governing body. In the case of ANSI, there seems to

have been no such intervention. On the other hand, for the JISC, there is intervention and coordination in membership formation.

The cost of becoming a committee member needs to be considered. Initially there is a transaction cost for participants (*Transaction cost of membership*) to become a member. This cost, which is a sunk cost if membership is not obtained, can be expressed as

*Transaction cost of membership = information gathering of SDOs + transaction cost of nomination.*

In the case of free membership without intervention from the governmental authority, entrance and exit incur no cost. Thus, the equation is reduced to

*Transaction cost of membership = information gathering of SDOs.*

In the case of restricted membership such as in JISC, where entrance and exit are coordinated and there is intervention from the governmental authority, the cost becomes

*Transaction cost of membership = information gathering of SDOs + transaction cost of nomination.*

Thus, by substituting the transaction cost of membership into the original utility of participation equation, the following can be written:

Utility of participation = *benefit - cost = information of R&D+ benefit of standardization of own (or complementary) technology - risk of knowledge spillover - transaction cost of membership*

=*information of R&D+ benefit of standardization of own(or complementary) technology - g(kind of industry) × h(corporate size) - (information gathering of SDOs + transaction cost of nomination).*

However, for corporate participants there is incomplete current information, which results in the benefits of participation (e.g., information on R&D) being undervalued or neglected by corporations. Hence, in the participation decision, the determinative factor would be entrance cost (*transaction cost of membership*) and *risk of knowledge spillover*. Thus, low entrance cost is estimated to be more important than the information benefit of R&D. Therefore, to promote participation of a specific sector, the government can choose to decrease the transaction cost of membership to corporations administratively.

## **6. Results and Discussion**

### 6.1 Hypothesis validation

The R/S ratios of the four industry sectors are presented in Table 1. Among these sectors, ICT shows the highest value of 7; however, the average R/S ratio of the ICT corporations

participating in the JISC technical committees is about 4. In addition, no participants have an R/S ratio above the sector average of 7. This result suggests that in the ICT sector, no leading corporation is a member of the JISC. In other words, all participants are following corporations. This seems to reflect a typical characteristic of this industry's standardization activities. A review of the literature suggests this result is in line with the case of EU de jure standard formation (Blind 2006). Thus, the hypothesis is almost supported.

[Table1]

In the production machinery sector, the R/S ratio is about 3.19 and the average for the participating corporations is 4.00; the participant average is above the sector average. In addition, four leading companies participate in the technical committees. This means that in this industry sector the JISC member corporations are leading corporations. This result shows the same tendency as SDOs in the European Union. In the industrial sector where the leading corporations participate, the participants can benefit from activities such as amending standards and technology information gathering. This group is centered on leading corporations (Table 2).

[Table 2]

The other industry sectors can be said to be between the previous two. The sector of non-ferrous metals has an R/S ratio of about 1.67 and the average R/S ratio of participating corporations is 1.12. There are two leading corporations. The transportation machinery sector has a

sector-average R/S ratio of 5.9 and participants' R/S ratio is below the sector average. However, among the participants, there is one corporation that has a higher R/S ratio than the sector average; that is, there is one leading corporation in the sector. In these groups, the participating corporations are a mixture of leading corporations and following corporations.

## 6.2 Corporate size

The participants are mainly from large corporations. The result is different from the literature review showing that low-technology industries are more oriented toward standardization since the technology level of SMEs is low. Almost no SMEs are found among the members of JISC.

The only example is in the ICT sector; however, that corporation is a consulting services provider for ubiquitous information technology, not a vendor. So, SMEs are not involved in the JISC de jure formation process. One reason why SMEs are passive with regard to standardization formation is that they are in the position of using the formed standards.

Because compliance with JIS is used to promote products quality, SMEs are, at the least, expected to play the role of standards users. In addition, from the technology level argument, the low-technology SMEs will benefit from participation in SDOs (Blind 2006). The obstacle hindering participation seems to be the cost accompanying participation. For example, corporate employees are required to attend the JISC meetings; if there are no employees able to attend, it

is difficult for the corporation to participate. This is a human resource problem.

### 6. 3 Policy perspective

#### i) R&D perspective

For high-intensity R&D sectors, the committees where high R/S corporations participate are less oriented toward standard setting. In such technology-oriented industry sectors, there are few leading corporations that participate. This could be interpreted to mean that there is competition between de jure standards and de facto standards and that market-oriented standards are prepared and maintained in consortium standard forums. For consideration of the situation, the utility of participation is described as below.

*Utility of participation = information of R&D + benefit of standardization of own (or complementary) technology - risk of knowledge spillover - transaction cost of membership.*

Then, to increase the utility of participation, what policy options are there for reducing the cost of R&D information spillover and increasing the possibility of making corporations' own technology into standards? To increase the chances of making companies' own technology into standards, the role of the JISC committee needs to be reviewed. Currently, the role is thought to be a passive one of authorization and deliberation. One improvement would entail that the



opinions of the corporations themselves are positively expressed in the JISC for the purpose of making their own (or complementary) technology standards.

ii) Intellectual property management perspective

In JIS there are standards that use proprietary technologies (essential patents). This means that the development of the standards may involve disclosure of information which can influence patentability and who gets patents. Hence, for corporate participants, special attention to the management of such R&D proprietary information is essential. So far, this point has not been considered from the corporate policy perspective, but seen more as personal issues for participants. However, information leaks often happen during the informal occasions accompanying the official meetings. Corporate participants know the standards that involve patentable knowledge, so there is the risk of R&D information spillover. Such risk cannot be denied just because standardization of technology is not directly related to patenting. In this regard, the JISC can send signals to private corporations and consortium standards forums to attract attention to such issues by developing guidelines for JISC participants as well as JIS draft committees for protection of such information. This is an issue which is not discussed in current JISC activities. For this purpose, internal guidelines for SDO participants may help corporations from the high-technology industry sectors in standard-setting activities. Such guidelines for

participants may cover the protection of trade secrets during participation in SDO activities. The guidelines will decrease the risk of knowledge spillover and thus increase the utility of participation at the corporate level, promote participation, and benefit the internal control process of corporations. As standardization activities are becoming more essential, especially for corporations in ICT industries, a good balance between participation in standardization activities and the protection of trade secrets must be achieved. In other words, a balance between open innovation and closed innovation is essential. The risk of unintentional leaks of R&D information may be implied by the research results showing that participation on ANSI modern standardization committees is related to an increase in the number of patents obtained (Gandal et al. 2007). The worst case is if information revealed in the SDO is patented by other participants. Unfortunately, while this is an important policy issue relating to SDOs, it has not been addressed at this point, even though the public policy instruments to protect trade secrets and prevent unfair competition are being actively pursued in efforts to improve corporate innovativeness in many countries through intellectual property management.

### iii) Corporate size

It is found that almost all the corporations in the JISC committee are large firms. An increase in participation from a wide range of corporations would cover a wide range of policy needs. To

this end, a pooling of the candidates or an introduction of pre-entry registration system of participation is considered useful. The pooling system registers and makes a roster of corporations interested in JISC committee activities. The JISC bureau can nominate JISC members from the list. This system will reduce the cost to the JISC of nominating corporations as well as the costs for the corporations themselves. In addition, for the promotion of participation in standardization, observer participation may be used as a method to increase the corporate understanding of standard activities. In this case, observers do not have the right to vote but information about standard setting becomes available to them.

Needless to say, all standards are not required to be industry-oriented or innovation-oriented. There are standards needed that focus on aspects beyond innovation. Ultimately, it is up to the policy authority to decide whether to adopt the methodology.

## **7. Conclusion**

As stated in the goals of this study, the present research has revealed that among JISC committee members, the average R/S ratio of participating corporations is lower than the industry average in high R/S industries. For example, in the ICT industry there are no participating corporations that have a higher R/S than the sector average. This is not

the case for the other industries.

First, the previous research on standardization activities in Europe has shown that de jure standardization activities are ineffective in promoting innovation in high-technology industry sectors in the case of de jure standard formation in the European Union (Blind 2006). In Japan, the result for de jure standard setting revealed the same tendency. The result suggests that standards for these industries are more formulated in the de facto or consortium standard formation organizations. To improve the participation of the high R/S ratio corporations or sectors in the de jure standard, the benefit of participation should be increased and the cost should be reduced. To this end, the guidelines for protecting propriety information in the de jure standard development process are useful for the improvement of risk control.

Second, almost all participants are large corporations. This is due to the high transaction cost of membership. It is important to let a variety of firms participate in the JISC committees so as to incorporate the policy needs of a variety of corporations. To this end, a pre-registration system of the candidate firms seems effective.

Third, on the basis of previous research results, equations on costs and benefits from

participation in SDO activities were described from the perspective of R&D and membership restrictions. Under the restricted membership case, the analysis suggested that the transaction cost of participation should be lowered administratively in order to improve the participation of corporate sectors, as can be seen from the following equation:

$$\begin{aligned}
 \text{Utility of participation} &= \text{information of R\&D} + \text{benefit of standardization of own (or} \\
 &\quad \text{complementary) technology} - \text{risk of knowledge spillover} - \\
 &\quad \text{transaction cost of membership} \\
 &= \text{information of R\&D} + \text{benefit of standardization of own (or} \\
 &\quad \text{complementary) technology} - g(\text{kind of industry}) \times \\
 &\quad h(\text{corporate size}) - (\text{information gathering of SDOs} + \\
 &\quad \text{transaction cost of membership}).
 \end{aligned}$$

From the equation, the reason why high R/S corporations are not participating is that the benefit of information on R&D is low in the sector.

In general, the observed result is in line with the general understanding of SDO activities. In the high-technology industry sector, leading corporations are making consortium standards outside JIS, and in the JIS, following corporations participate. As the JIS is a domestic standard, the consortium standard development and JIS is more and more necessary from an international perspective.

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Figure 1. Roles of the JISC Technical Committees and drafting committees

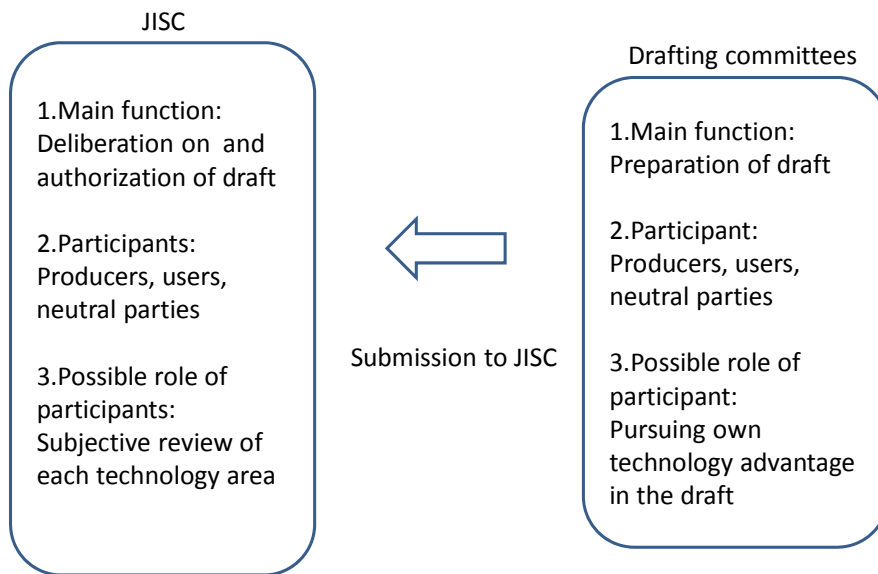




Table 1. R&D tendency by industry sector

Industry sector	Average R/S in each technology area (where ICT=1.00) 1)	Sales growth in each technology area (2011-2012) 1)	Average R/S among participating corporations 2)	Median R/S of participating corporations 2)	Maximum value of R/S among participating corporations 2)	Number of corporations for which R/S is above sector average 2)	Number of corporations reporting R&D expenditure 3)	Number of corporations participating 3)	Number of SMEs 3)
Production machinery	3.19 (0.44)	24%	4.00	4.958	6.63	4	7	9	0
Transportation machinery	5.29 (0.82)	3.5%	2.61	3.306	6.539	1	17	20	0
Non-ferrous metals	1.67 (0.23)	-19.4%	1.12	0.815	2.062	2	5	5	0
ICT	7.25 (1.00)	-45.9%	4.08	4.456	6.63	0	8	10	1

Data sources:

1)Basic Survey of Japanese Business Structures and Activities, 2)Securities report of each corporation, 3)JISC HP

Table 2. Leading firms and R/S in terms of participation

	Average R/S of participants <u>less</u> than sector average	Average R/S of participants <u>greater</u> than sector average
Sector <u>without</u> participation from leading corporations	ICT	(None)
Sector <u>with</u> participation from leading corporations	Transportation machinery Non-ferrous metals	Production machinery