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Hiroyuki Okamuro
(Hitotsubashi University)

Junichi Nishimura
(Gakushuin University)

Naka 2-1, Kunitachi, Tokyo 186-8601, Japan
Phone: +81-42-580-9076 Fax: +81-42-580-9102
URL: http://www.econ.hit-u.ac.jp/~cces/index.htm
E-mail: cces@econ.hit-u.ac.jp

Governance and Performance of Publicly Funded R&D Consortia*

Hiroyuki OKAMURO
Hitotsubashi University, Graduate School of Economics
okamuro@econ.hit-u.ac.jp

Junichi NISHIMURA
Gakushuin University, Faculty of Economics
junichi.nishimura@gakushuin.ac.jp

Abstract:
R&D consortia have been regarded as an effective means of promoting innovation, and several R&D consortia obtain public financial support, which may affect its governance structure and performance. This study investigates the governance mechanisms of publicly funded R&D consortia and their effects on innovation. Regarding R&D consortia, few studies have empirically addressed the effect of project monitoring by the government. Moreover, the role of project leadership in R&D consortia remains poorly explored. Focusing on a major support program for R&D consortia in Japan and using a sample of 315 firms that participated in publicly funded R&D consortia from 2004 to 2009, we empirically confirm that project leadership by a private firm, especially its coordination capability, significantly increases the probability of project success (early commercialization of innovation outcomes). We also find that project performance is positively affected by the strictness of project monitoring and evaluation by the government. Finally, we find no complementarity between project leadership and government monitoring with regard to the effects on project performance.

Keywords: R&D consortia, public subsidy, leadership, monitoring, commercialization
JEL Classification Code: O31, O32, O38

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1. Introduction

Collaborative R&D projects among private firms, universities, and public research institutes (hereafter R&D consortia) have been attracting increasing attention in several countries as an effective means of promoting innovation (Etzkowitz and Leydesdorff 2000; Hemmert et al. 2014). In Japan, public support for collaborative R&D projects has concentrated since the early 1960s on those among large private firms in the same industry (see for example Sakakibara 1997 and 2001 for more details). However, under the Science and Technology Basic Plan, the Japanese government started in 1997 financial support for R&D consortia with the "Consortium R&D Project for Regional Revitalization" (hereafter CRDP), which was implemented by the Ministry of Economy, Trade and Industry (METI) for 11 fiscal years until 2007[1]. The analysis of this paper focuses on this program, not only because it was the first public support program for R&D consortia in Japan, but also because it was based on commissioned R&D contract with METI, which is an important aspect of project governance.

This program aimed at commercializing scientific seeds of universities and public research institutes through collaborative R&D with private firms and thus promoting local economic growth. Therefore, the targets of this program were local R&D consortia with at least a firm and a university or a public research institute. Regarding the project governance, the government (METI) concludes a commissioned research contract for 2 years with the project management organization, which in turn is expected to coordinate the consortia partly by concluding joint research contracts with all project members. METI selects R&D consortia to be financially supported based on project proposals and evaluates the performance of subsidized projects after the first year (midterm evaluation) and the second year (final evaluation). Thus, both project leadership and public monitoring may be important for project performance, as internal and external disciplines[2].

Efficient governance of R&D consortia is a difficult task because they include both academic and business partners that have different interests and incentives. Free-riding and opportunistic behavior may also occur. Therefore, the governance of R&D consortia matters for innovation performance (Mora-Valentin et al. 2004; Morandi 2013). Moreover, government often provides financial support to R&D

[1] METI renewed the CRDP in 2008 as “Regional Innovation R&D Program”.
[2] We will later explain this program in more detail in Section 3.

consortia in order to promote innovation. Such public support may affect project performance directly by increasing R&D expenditures, but also indirectly through project monitoring (Okamuro and Nishimura 2015).

However, regarding R&D consortia, few studies have empirically addressed the effect of project governance. Specifically, the effect of project monitoring by the government has scarcely been investigated. Moreover, the literature of innovation management has long recognized the role of innovation champions in private R&D (e.g. Chakrabarti 1974), but the role of project leadership in R&D consortia remains poorly explored. Therefore, focusing on the effects of project leadership and public monitoring, this paper empirically examines the determinants of project performance of publicly funded R&D consortia in Japan using original survey data. In this way, we will investigate the contribution of project leadership and public monitoring to generating innovation.

The remainder of this paper is organized as follows. In the next section, we provide a brief review of previous literature. In Section 3, we describe the focal support program in more detail. In Section 4, we present conceptual framework and some hypotheses for empirical estimation. In Section 5, we explain the data, sample, and estimation models, and show the results of empirical estimations. Section 6 concludes this paper with contributions and limitations of our analysis and some future research agenda.

2. Previous literature

Several studies have investigated the effect of the participation in R&D consortia (Zucker and Darby 2001; George et al. 2002; Motohashi 2005; Eom and Lee 2010) and public support for R&D (Klette et al. 2000; Czarnitzki et al. 2007) on innovation outcomes. Nishimura and Okamuro (2015) examined the spillover effects of CRDP participation at the firm level, including the benefits for the customer firms of CRDP participants. However, to the best of our knowledge, few studies have empirically addressed the effect of project organization or project governance on the performance of R&D consortia, although it has often been argued that organization of R&D cooperation matter for innovation (e.g. Mora-Valentin et al. 2004; Morandi 2013, Casper and Miozzo 2013).

Okamuro (2007) examined how project characteristics such as contractual rules affect the technological and commercial success of inter-firm cooperative R&D projects, but not that of R&D consortia including both private firms and universities.

Okamuro and Nishimura (2013) explored the impact of university's intellectual property right policy on the performance of R&D consortia. Hemmert et al. (2014) provided an international comparison, comprising the US, Japan, and South Korea, on the effects of project characteristics on trust formation in the university-industry research collaboration, but not on project performance.

Especially the literature of innovation management has long recognized the role of innovation champions in private R&D (e.g. Chakrabarti 1974, Hemmert et al. 2014), but the role of project leadership in R&D consortia remains poorly explored, regarding econometric studies, due to data constraints. Some studies in the management literature have addressed the effects of project leadership (Anantatmula, 2010; Chaudhry et al. 2012), but they are mostly based on case studies or very small samples.

Moreover, the effect of project monitoring by the government has scarcely been investigated, although we could expect that project monitoring would have a significant impact on project management and performance. Regarding *inter-firm* R&D cooperation, both theoretical and empirical studies have been conducted on the contractual design (Aghion and Tirole 1994, Lerner and Merges 1998, Lerner and Malmendier 2010) and contractual modes (Hagedoorn and Hesen 2007, 2009; Van de Vrande et al. 2006), which are not directly applicable to R&D consortia that comprise both private business and academia.

Specifically, scientific research on the governance of publicly funded R&D consortia, especially focusing on external monitoring, has been scarce. Some empirical studies argue that public subsidy for R&D consortia reduces opportunistic behavior of participants (Tripsas et al. 1995) or promotes trust among participants and thus increases project performance (Okamuro and Nishimura 2015), but they do not explicitly consider the role of government monitoring and evaluation. Thus, this paper bridges these gaps and examines whether and how the type of project leader and project leadership as well as the project monitoring by the government improve innovation performance of R&D consortia.

3 Overview of the "Consortium R&D Project for Regional Revitalization" (CRDP)[3]

This program is carried out as R&D projects contracted by METI to competitively selected research consortia, so that the R&D expenditures of the supported projects are

[3] Information on this program was obtained from the website of METI. http://www.meti.go.jp/ (last accessed August 12, 2015).

fully covered by the subsidy. The subsidy is paid for the contracted work; thus, payment is received after a project is finished. Each consortium has a management organization that can be a private firm, university, public research institute or a public agency and that prepares for and submits applications (project proposals). These proposals include detailed information on research and commercialization plans, project schedules, budget plans, management organization, project leaders, sub-leaders, and each of the members (e.g., firms, university professors, etc.), and each member's role in the project.

Upon acceptance, the management organizations of selected consortia must enter into a formal contract with a regional department of METI to conduct the projects. Then, management organizations usually enter into subcontracting agreements with project members. Project members are also asked to provide collective confirmation for the commercialization of research outcomes.

After finishing the project (typically within two years), each management organization submits a project report to METI, which then reimburses the R&D expenditures for the project. Project evaluation is conducted by METI based on the final report provided by the management organization. In the final report and evaluation, not only the technological achievements of the project, but also the efficiency of project coordination and any efforts to improve it are taken into consideration. METI publishes information on the selected consortia, including membership and the final reports of these projects. Moreover, METI follows up on further research and the commercialization of project outcomes by the supported consortia for five years after the end of the projects.

In this way, METI and its regional departments monitor and evaluate UIC projects, enforce clear mutual agreements among members, and publicize project information. We expect such an institutional background to encourage trust formation in UIC projects.

4 Conceptual framework and hypotheses

Publicly funded R&D consortia have two important contractual aspects. The first one is the relationship among the participants including both private firms and research institutes with different interests and incentives. Another aspect is the relationship between the provider and the recipient of public funding, namely the government and the project leader. Therefore, an efficient governance mechanism of publicly funded R&D consortia should consider both contractual relationships (Figure 1).

R&D consortia comprise players with different incentives for R&D: Private firms seek for profits by patenting and commercializing R&D outcomes, while universities and public research institutes aim at creation and dissemination of new findings and ideas by presenting and publishing research outcomes. Hence, it is fundamentally important for the project success to efficiently coordinate different interests of different members. In this regard, the role of project leaders is essential. As mentioned above, METI's support program aims at commercialization of innovation outcomes, which is in line with the incentives of private firms. Therefore, project leadership by a private firm and her coordination ability are the keys for the performance of R&D consortia supported by METI. Project leader may play various roles in project management, such as project planning, progress checks, negotiation with the funder (government), coordination among project members, and his own contribution to R&D. We pay our special attention to his coordination among members for discouraging free riding and opportunism and for motivating the members to innovation.

Especially in the case of METI's CRDP, government can be regarded as the principal and project leader the agent, because both parties conclude a commissioned R&D contract[4]. Under information asymmetry, the agent knows his or her ability and efforts (and those of the other members to some extent), while the principal has no or little information about the agent. In such circumstances, moral hazard of the agent may occur and lower project performance. A first-best solution of this problem would be an incentive contract, in which the payment to the agent is set to depend on his performance. However, this solution is difficult to apply to public funding of R&D projects because usually a public subsidy does not depend on the achieved performance (ex post measures), but is fixed ex ante based on some selection criteria.

Thus, instead of incentive contract, monitoring and evaluation by the government should play an important role in the governance of publicly funded projects. The government may check the progress of cooperative R&D and possibly intervene after midterm evaluation with advices and requests, sometimes with changes in the amount of subsidy. The consortia with lower performance may be excluded from supplemental (follow-up) support after the project term and new public subsidy in the next round[5]. In

[4] In fact, not the project leader, but the project management organization concludes R&D agreements with the regional agency of METI. However, the organization only controls project budget, thus the real partner for METI is the project leader.

[5] In this line of argument, Lerner and Malmendier (2010) stress the importance of the option of contract termination as an effective means to prevent opportunistic behavior in private R&D alliances.

this sense, government monitoring involves an ex post incentive mechanism. It provides an incentive mechanism in the long term, but not in the short term.

Thus, we can discuss the governance of publicly funded R&D consortia from the viewpoints of internal and external disciplines (Figure 1). The former refers to the role of the project leader and the relationship among consortium members. The latter comprises project evaluation and monitoring by the government. Main questions regarding project leadership are 1) whether a consortium has a distinct leader, 2) who the project leader is, a manager of a private firm or a university professor, 3) what roles the project leader plays (project design, progress control, coordination, etc.) and 4) how formally is the relationship among members determined. Regarding government monitoring, key questions include how strict it is with regard to 1) budget control, 2) progress control, and 3) evaluation.

Based on the above discussion, we present the following hypotheses for the empirical analysis in the next section, expecting that both project leadership and government monitoring matter for project performance:

H1: Project leadership by a private firm, as compared to that by a university or a public research institute, increases the probability of project success.
H2: Strong project leadership increases the probability of project success.
H3: Strict monitoring by the government, especially midterm evaluation, increases the probability of project success.

However, as discussed above, both project leadership and government monitoring have different aspects. Strong leadership or monitoring may be effective in some aspects, but may not be so or even discourage members' incentives in other aspects. Therefore, in the empirical part, we will distinguish between different aspects. Moreover, we may expect that project leadership and monitoring be complementary, if the latter strengthens the former (especially the leader's coordination ability). It is possible when, for example, the members are more willing to accept project leader's coordination under stricter monitoring by the government. Complementarity means that the combination of strong leadership and strong monitoring increases project performance. We will also empirically check whether complementarity exists between leadership and monitoring.

5. Empirical analyses

5.1 Data and sample

We focus on a major support program for R&D consortia in Japan, the "Consortium R&D Project for Regional Revitalization" (CRDP) by the Ministry of Economy, Trade and Industry (METI), which aims at commercializing scientific seeds of universities and public research institutes. We conducted a questionnaire survey in early 2011 to 1,550 firms that were selected to the CRDP during the period from 2004 to 2009 (fiscal years)[6]. Our final sample comprises 315 respondents to this survey (response ratio: 20%). Among them, 80% are SMEs with less than 300 employees. The ratio of R&D expenditures to sales of the sample firms amounts to 7.3% on average, so that our sample comprises R&D-intensive firms.

Comparing these respondents with the no-response firms using TDB company data in 2010, we find that smaller and less profitable firms are more likely to respond to the survey (See Table 1). For example, the average number of employees of the respondents is 623, whereas that of the no-response firms is 802. Regarding after-tax profit, the respondents have a deficit on average, but the no-response firms have a surplus. The ratio of listed firms in the non-respondents is higher than in the respondents. The no-response firms have higher productivity calculated as sales per employee than the respondents. Thus, we cannot reject response bias for our sample firms, but at least an upward bias may be excluded[7].

The consortia in which the sample firms participated are distributed in all regions in Japan and in various high-tech areas such as manufacturing technology (27%), biotechnology (22%), nanotechnology (14%), environmental technology (13%), and information/communication technology (10%). Only 8% of these consortia can be classified to basic research projects, 32% to applied research projects, and 60% to development. They comprise 7 members on average: 3 private firms and 4 universities, public research institutes, etc. All subsidized consortia have project leaders, of whom 46% belong to private firms and 50% to universities or public research institutes. 75% of the consortia concluded formal internal contracts with consortia members regarding task assignment, treatment of R&D outcomes (IPR), project budget, and schedule.

These consortia obtained on average 60 million yen in the first year and 35

[6] This program started in 1997, but we could obtain the list of supported consortia with member firms and institutes from METI only for the period from 2004 to 2009 (fiscal years). We are grateful to METI for providing us this list.

[7] We further checked both the location and industry distribution of the respondents and the no-response firms. These distributions are not significantly different between them.

million yen in the second and last year as public funds. Around 20% of the respondents report that their projects experienced the reduction of the amount of subsidy in the second year according to the results of the midterm evaluation. After the funding period, 25% of the consortia obtained follow-up support from METI including additional subsidy, and invitations to research seminars and business matching. By March 2010, 22% of the R&D consortia of the sample firms have achieved the commercialization of their innovation outcomes, which lies below the target of this support program (30%). 18% reported project failure (no prospect for commercialization) and 57% have not yet achieved commercialization, expecting it in the near future.

5.2 Models and variables

We hypothesize that both project leadership that generates internal discipline and government monitoring as external discipline affect the incentive and efficiency of project members to achieve the purposes of the consortia, thus project performance. We measure it as the probability of commercialization of project outcomes, which is the aim of this support program. Thus, we use the commercialization dummy (*d_commercial*), which takes the value 1 if project outcomes have already been commercialized, and 0 otherwise, as the dependent variable. Because this is a dummy variable, we employ a binary probit model for the empirical analysis.

The independent variables include those for project leadership and public monitoring. An important variable for project leadership is the type of project leader (*business*), which takes the value 1 if a private firm is the project leader and 0 otherwise (university or public research institute). According to Hypothesis 1, we expect that the coefficient of this variable be positive and significant. Other variables for project leadership represent subjective evaluations by the respondents on the following characteristics of project leadership: 1) project planning (*leader_planning*), 2) checking progress (*leader_progress*), and 3) coordination among project members (*leader_coordination*)[8]. These variables are measured with a 4-point Likert scale (from 1: weak to 4: strong). Moreover, considering positive correlation across these variables, we construct an integrated variable *leader* as the first principal component by the principal component analysis of the leadership variables (Cronbach's alpha: 0.836). According to Hypothesis 2, we expect that the coefficients of these leadership variables

[8] See Appendix for questionnaire items in detail.

be positive and significant.

Further, we measure the strictness of government monitoring as subjective evaluations by the respondents on the following monitoring: 1) budget (*monitor_budget*), 2) checking progress (*monitor_progress*), and 3) midterm project evaluation (*monitor_midterm*)[9]. These variables are measured also with a 4-point Likert scale (from 1: weak to 4: strong). Also in this regard, we construct an integrated variable *monitor* as the first principal component by the principal component analysis of the monitoring variables (Cronbach's alpha: 0.783). According to Hypothesis 3, we expect that the coefficients of these variables be positive and significant.

We will check the complementarity between project leadership and government monitoring by using the interactive terms of *leader_coordination* and *monitor_ midterm* in Model 2 as well as *leader* and *monitor* in Model 3. Both factors can be complementary if government monitoring strengths the effect of leadership on project performance (and vice versa). For this interactive term, we expect a positive coefficient if leadership and monitoring are complementary.

We also control for some basic characteristics of R&D consortia including the number of participants (*project_size*), the entire volume of the public subsidy in logarithm (*subsidy_size*), and research orientation of the consortia (basic or applied research: *basic*, *applied*)[10]. We expect that the consortia that have small input (regarding the number of participants and the subsidy volume) and that conduct basic research be less likely to commercialize project outcomes than those including many members, with large amount of subsidy, and focusing on development stage. Moreover, we control for the regional knowledge base (the opportunity of forming R&D consortia) using the number of universities in the same prefecture (*prefecture_university*).

We include in the estimation models also the starting year of the subsidized consortia (dummy variables for the fiscal years 2005, 2006, 2007, and 2008; using 2004 as the baseline reference), and their technology fields (dummy variables for IT, biotechnology, manufacturing, environment, energy, and other fields; using biotechnology as the baseline reference). We have to control for technology fields of the projects because the probability of early commercialization of project outcomes may differ across technology fields. Moreover, we face a truncation problem because we collected information including the commercialization of project outcomes using a

[9] See Appendix for questionnaire items in detail.

[10] We classify research orientation of R&D consortia into basic research, applied research, and development, and regard the last one as the baseline reference.

questionnaire survey in early 2011. Public funding for a selected R&D consortium was provided for two years, so that the first cohort in our sample starting in April 2004 ended in March 2006, while the last cohort starting in April 2008 ended in March 2010. It means that the first cohort had more than 7 years for commercializing project outcomes, whereas the last cohort had less than 3 years for this purpose by our survey: The older the project, the more likely is the commercialization.

Table 2 presents the basic statistics (mean and standard deviation) of the variables explained above. As mentioned before, 22% of the respondents report that their project has already achieved commercialization of project outcomes. Regarding leadership variables, 43% of the respondents point out that the project leader belonged to a private firm in their projects. Moreover, they provide relatively high average scores (around 3 in the four-point scale) for the evaluation of project leadership. Also the strictness of government monitoring is relatively highly evaluated with mean scores around 3 in the four-point scales). Table 3 shows the correlation matrix of the variables.

5.3 Estimation results and discussion

Table 4 provides the estimation results. After excluding several responses with missing values, the empirical analyses are based on 293 observations. The estimation includes dummy variables for starting years and technology fields of the projects, which are not shown in the table to save space. The marginal effects and robust standard errors of the variables are presented here.

The empirical estimation of the propensity of commercialization (*d_commercial*) using a probit model shows that, as expected, project leadership by a private firm (as compared to a university or a public research institute) (*business*), and specifically project leader's coordination capability (*leader_coordination*), significantly increases the probability of commercialization of project outcomes. The consortium whose leader belongs to a private firm is 14% more likely to achieve commercialization than that whose leader belongs to a university or a public research institute. We also confirm that, regarding government monitoring, project performance is positively affected by the strictness of progress monitoring (*monitor_progress*) and midterm evaluation (*monitor_midterm*). Specifically, the marginal effect of midterm evaluation (*monitor_midterm*) is relatively higher, which may suggest that the contractual option of reducing the funds is an effective means to enhance the performance[11]. These results

[11] In our survey, 62% of the respondents reported that project members became more

support all hypotheses presented before.

In Model 3, the aggregated leadership variable (*leader*) has a highly significant effect, while the aggregated monitoring variable (*monitor*) does not have a significant effect, on project performance. In Models 2 and 3, the coefficients of the interactive (cross) terms are not significant, suggesting that leadership and monitoring contribute independently to project performance.

Regarding the control variables, we find that the number of project members has a positive and significant effect on the propensity of commercialization, while the effect of subsidy volume is not significant. However, the project size has only a weak impact, because an additional member increases the propensity of commercialization only by 1.8%. Moreover, as expected, the dummy variable for basic research (*basic*) shows a significant and negative effect: R&D consortia focusing on basic research are 15% less likely to achieve commercialization than those focusing on applied and development stages. Surprisingly, neither the subsidy size nor the number of universities in the region has a significant effect on the probability of commercialization. Neither the starting years nor the technology fields of consortia show significant effects on project performance, which is not reported in Table 3.

5.4. Robustness checks

We conducted some additional estimation for robustness checks. First, we used leadership and monitoring variables separately (interchangeably) in the estimations and confirmed that the estimation results did not significantly differ from those presented in Table 4. Second, we added some variables for respondents' characteristics such as firm size, age, and R&D intensity, but they did not show any direct significant effects on project performance.

Third, we conducted an ordered probit estimation using another performance variable *commercial*. This variable can take 3 values: 1 if a consortium failed in commercializing project outcomes, 2 if it has not yet commercialized the outcomes but has it in prospect, and 3 if it has already commercialized the outcome. In this way, we alternatively estimate the determinants of the extent of commercialization of project outcomes. The results are very similar to those of probit estimation.

Fourth, we conducted a sub-sample estimation focusing on the consortia that

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motivated to their R&D consortia after midterm evaluation. Further, 52% of the respondents answered that project plans were improved after midterm evaluation.

started in the fiscal years 2004 to 2006 (190 respondents), to consider the truncation problem more seriously. Regarding this sub-sample, all consortia had at least 3 years after the funding period to commercialize their research outcomes. We consider 3 years after the funding period according to METI's criterion: It measures the project success with the commercialization within 3 years after the funding period. The results of this sub-sample estimation are similar to those of the full sample estimation.

Fifth, for several projects we obtained responses from multiple participants. Their information may differ even for the same project because of subjective differences in evaluation, which may induce measurement errors. Therefore, we deleted all these redundant responses (hence, the sample size is reduced to 186) and conducted the same empirical estimation. The results are very similar to the previous ones, except that the coefficients of private firm leadership (*business*) and project size are no more significant. Therefore, our estimation results are quite robust except for Hypothesis 1.

6. Concluding remarks

R&D consortia are often funded by the government for the purpose of promoting innovation. Several empirical studies have been carried out on R&D consortia and its performance, but few studies have focused on the roles of project leadership and public monitoring, although such internal and external disciplines should be important in the governance of organizations. Therefore, we empirically addressed these issues by using original survey data on publicly funded R&D consortia in Japan, focusing on METI's CRDP that is the first major public support program for R&D consortia.

Regarding CRDP, R&D consortia to be supported are competitively selected upon application. METI concludes a commissioned research contract for 2 years with the management organization (project leader) of each selected project, which in turn is expected to have R&D contracts with all consortia members. We argued that both project leadership as internal discipline and government monitoring as external discipline are important for project performance when incentive contract is not feasible, at least in the short term. Moreover, we argued that project leadership and government monitoring might be complementary.

Based on our empirical results, we may conclude that, for the performance of publicly supported R&D consortia, project governance matters. Specifically, project leadership by a private firm seems to be more effective in commercializing project outcomes than that by a university or a public research institute. Strong leadership especially in coordinating among project members increases the probability of

commercialization. Moreover, government monitoring, especially strict progress check and midterm evaluation, is important for project performance. Thus, major contributions of this paper are that we empirically investigated and confirmed the roles of internal discipline (project leadership) and external discipline (public monitoring) for the innovation performance of R&D consortia. We found, however, no complementarity between internal and external disciplines, suggesting that both are independently important.

We can derive following policy implications from these results. First, project leader's type (affiliation) may be related to the incentive mechanism in the consortia and thus to project outcomes. Therefore, in order to promote the commercialization of R&D outcomes, project leadership by a private firm may be more appropriate than that by a university or a public research institute. Second, project monitoring and evaluation by the government also matters for project performance. Specifically, the contractual option of reducing the funds in the midterm can be effective for the commercialization of research outcomes. Therefore, public support of R&D consortia should be combined with a strict project evaluation (especially in the midterm), but not with strict application procedures or budget control.

Despite these contributions and implications, our analyses have still some limitations. First, we target a specific support program and use a specific performance measure. For more generality, future research should compare different support programs with different schemes and look at multiple performance measures.

Second, we conducted project-level analyses based on the data that are obtained from individual participants of R&D consortia. Regarding subjective evaluation, especially on project leadership and monitoring, the responses may differ among project members. It is not sure whether the response we obtained may be representative for the consortia members, at least for private firms. Thus, it is difficult to strictly identify the real differences in the project leadership and government monitoring across consortia from those across individual respondents. Therefore, as a next step, we are preparing for a firm-level analysis of the relationship between project leadership and monitoring and the firm performance.

Third, our investigation is based on micro data from a retrospective one-shot survey, although R&D consortia involve a dynamic process. Therefore, we should also take the dynamics of the whole project explicitly into consideration: for example, project leadership may change during the project, especially after the midterm evaluation based on the comments or demands by the evaluators. Therefore, future research should more appropriately consider dynamic changes in some variables. For

example, we should consider the effects of project leadership and government monitoring on the engagement of participants in joint R&D processes, such as commitment and free-riding, which in turn may affect project performance. In this sense, it will be promising to focus on the mechanism of the effects of project leadership and government monitoring in R&D consortia.

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Figure 1: Conceptual framework

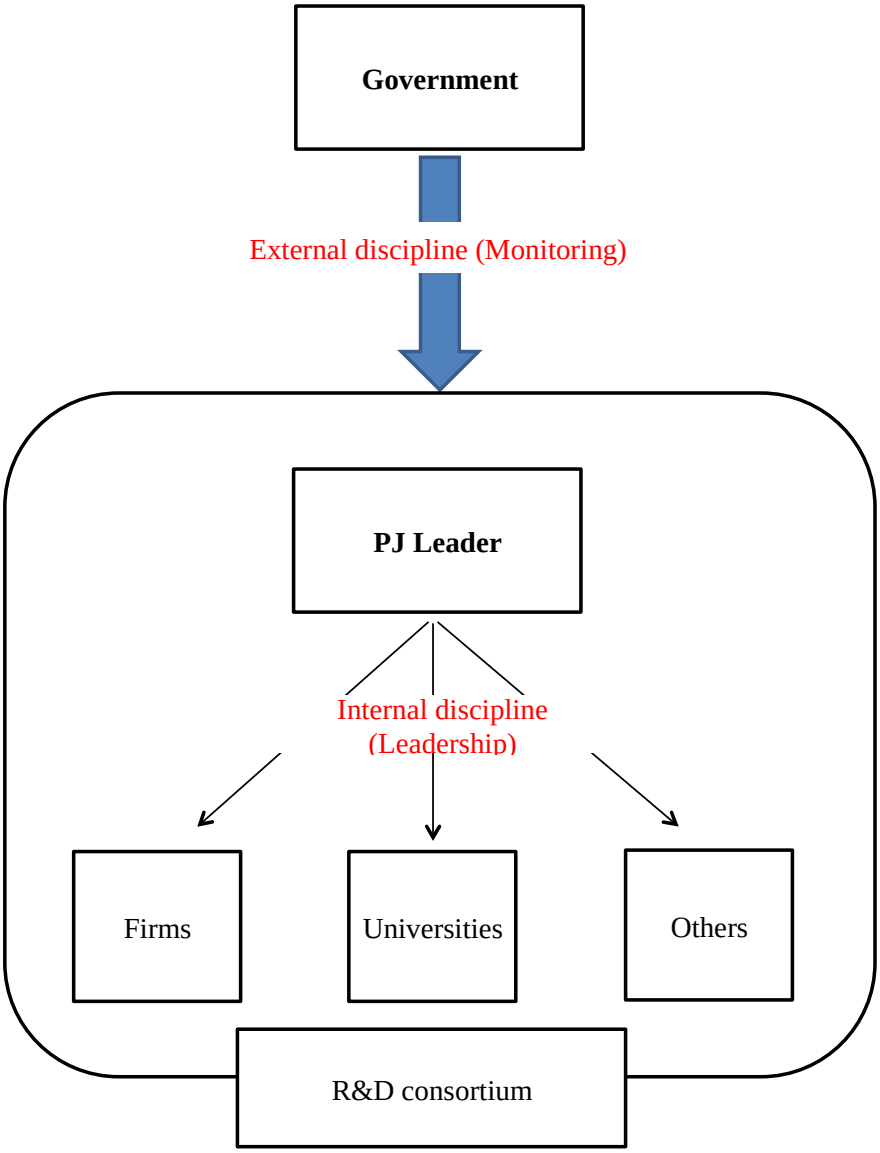

Table 1: Comparison between the respondents and the no-response firms

	Respondent			Non-Respondent			Wilcoxon rank-sum test
	Obs.	Mean	S.D.	Obs.	Mean	S.D.	p-value
Capital (thousand yen)	296	5004658	32100000	1076	8474263	40800000	0
Employee	291	623	2915	1061	802	2821	0
Firm age	297	39.92	22.83	1076	42.22	23.38	0.094
Sales (Million yen)	297	40248	247521	1077	76187	407943	0
After-tax profit (thousand yen)	297	-387398	8008988	1077	1165153	15600000	0.005
capital ratio (%)	297	22.25	25.43	1077	26.65	27.93	0.019
Sales growth (%)	297	1.99	84.53	1073	-3.34	74.13	0.207
CEO age	275	59.88	10.14	970	59.30	8.89	0.562
affiliated firm	297	0.15	0.36	1077	0.21	0.41	0.013
listed firm	297	0.12	0.33	1077	0.20	0.40	0.002
Sales per employee	291	34.70	40.46	1061	46.73	97.10	0.017

Note: Financial data of the firms in 2010 were obtained from Teikoku DataBank, LTD.

Table 2: Basic statistics of the variables

		Obs.	Mean	S.D.
Performance	*d_commercial*	306	0.222	0.416
Leadership	*business*	315	0.432	0.496
	leader_planning	302	3.215	0.763
	leader_progress	302	2.980	0.760
	leader_coordination	302	3.007	0.765
	leader	302	0.000	1.445
Monitoring	*monitor_budget*	298	3.450	0.705
	monitor_progress	299	2.819	0.705
	monitor_midterm	299	2.973	0.660
	monitor	298	0.000	1.404
Project	*project_size*	315	7.384	3.601
Characteristics	ln (*subsidy_size*)	315	2.041	0.655
	basic	308	0.081	0.274
	applied	308	0.318	0.467
	prefecture_university	315	31.057	33.568

Table 3: Correlation matrix of the variables (Obs. = 293)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	*d_commercial*	1														
2	*business*	0.16	1													
3	*leader_planning*	0.04	-0.02	1												
4	*leader_progress*	0.08	0.07	0.53	1											
5	*leader_coordination*	0.13	0.07	0.42	0.67	1										
6	*leader*	0.10	0.05	0.76	0.89	0.84	1									
7	*monitor_budget*	0.00	-0.01	0.29	0.22	0.21	0.28	1								
8	*monitor_progress*	0.02	-0.09	0.12	0.22	0.26	0.24	0.37	1							
9	*monitor_midterm*	0.08	0.08	-0.10	-0.18	-0.18	-0.19	-0.41	-0.66	1						
10	*monitor*	-0.03	-0.08	0.20	0.25	0.26	0.29	0.70	0.85	-0.87	1					
11	*project_size*	0.02	-0.25	0.10	0.01	-0.01	0.04	-0.01	-0.03	-0.03	0.00	1				
12	ln (*subsidy_size*)	-0.09	-0.32	0.09	0.03	-0.01	0.04	0.05	-0.01	-0.02	0.02	0.67	1			
13	*basic*	-0.11	-0.05	0.01	0.00	-0.04	-0.01	-0.16	-0.10	0.08	-0.13	0.07	0.06	1		
14	*applied*	0.03	0.05	0.04	0.03	0.09	0.06	0.01	0.09	0.01	0.04	-0.03	-0.02	-0.21	1	
15	*prefecture_university*	-0.01	-0.08	0.05	0.03	0.00	0.03	0.03	0.03	-0.03	0.03	0.08	0.08	0.05	0.00	1

Table 4: Estimation results on the commercialization of project outcomes (probit estimation)

Dep. Variable	*d_commercial*	Model 1		Model 2		Model 3	
		Marginal Effect	Robust S.E.	Marginal Effect	Robust S.E.	Marginal Effect	Robust S.E.
Leadership	*business*	0.141**	0.059	0.140**	0.060	0.137**	0.059
	leader_planning	0.006	0.039	0.006	0.038		
	leader_progress	0.013	0.048	0.011	0.047		
	leader_coordination	0.064*	0.034	−0.022	0.103		
	leader					0.041**	0.017
Monitoring	*monitor_budget*	0.008	0.038	0.005	0.038		
	monitor_progress	0.072**	0.034	0.070**	0.034		
	monitor_midterm	0.138***	0.047	0.008	0.158		
	monitor					−0.023	0.018
Cross term	*coordination * midterm*			0.040	0.046		
	*leader * monitor*					−0.004	0.011
Project	*project_size*	0.018**	0.009	0.018**	0.009	0.016*	0.009
characteristics	ln (*subsidy_size*)	−0.101	0.072	−0.101	0.073	−0.100	0.073
	basic	−0.153**	0.052	−0.157**	0.050	−0.150*	0.056
	applied	−0.025	0.050	−0.024	0.050	−0.010	0.051
	prefecture_university	0.000	0.001	0.000	0.001	0.000	0.001
	starting year dummies	yes		yes		yes	
	technology fields dummies	yes		yes		yes	
	Pseudo R square	0.113		0.116		0.092	
	Log pseudo likelihood	−138.655		−138.169		−142.032	
	Observations	293		293		293	

Note: *: 10%, **: 5%, ***: 1% significance level.

Appendix: Questionnaire items for the leadership and monitoring variables
(translated from the Japanese original into English by the authors)

2-4. Please evaluate the strength of leadership by the project leader of the entire consortium for each of the following items by the four-point scale:
1: weak, 2: rather weak, 3: rather strong, 4: strong.

(1) Designing the research plan of the project
(2) Progress control of the project
(3) Coordination among the participants during the project
(4) Efforts to achieve the goal of the project

* We did not use (4) in our estimation because it is too general and correlated with all other items.

2-5. Please evaluate the strictness of project monitoring by the government for each of the following items by the four-point scale:
1: weak, 2: rather weak, 3: rather strong, 4: strong.

(1) Reminders in project application procedures
(2) Budget (expenditures) control
(3) Progress check in R&D
(4) Midterm evaluation
(5) Final evaluation