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Subsidy and networking: The effects of direct and indirect support programs of the cluster policy

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Abstract

Industrial clusters have attracted considerable attention worldwide for their expected contribution to regional innovation. Recently, policymakers in various countries have developed specific cluster policies. However, there exist few empirical studies on cluster policies. Focusing on the Industrial Cluster Project (ICP) in Japan initiated by the Ministry of Economy, Trade and Industry in 2001, we address two research questions on the support programs of the cluster policies: if the project participants who exploit various support programs are more successful in network formation within the cluster than others, and which kind of support program contributes to firm performance. We pay special attention to the differences between direct R&D support and indirect networking/coordination support. The estimation results, which are based on recent original survey data, suggest that cluster participants who exploit support programs (especially indirect support measures) expand the industry-university-government network after participating in the ICP. Moreover, we find that not every support program contributes to firm performance; firms should therefore select the program that is most aligned with their aims. Indirect support programs have an extensive and strong impact on output whereas direct R&D support has only a weak effect.

Keywords: cluster policy, industrial cluster, R&D support, subsidy, networking
JEL codes: O25; O38; R11

1. Introduction

Industrial clusters have been attracting considerable attention worldwide for their expected contribution to regional innovation and development, especially through enhanced collaboration and knowledge spillover among local firms and research organizations. Ever since the 1990s, policymakers in various countries have launched specific cluster policies (see Appendix 1).

However, to the best of our knowledge, there exist few empirical studies on the effects of cluster policies on the performance of local firms, whereas agglomeration theories derive a major implication that regional differences in agglomeration explain differences in regional industry structure and performance (Porter, 1998; Glaeser et al., 1992; Rosenthal and Strange, 2003)[1]. Moreover, the question of what conditions are necessary for successful organization of cluster policies is still open (Yang et al., 2009).

In this study, we use original questionnaire data to evaluate the Industrial Cluster Project (ICP) initiated by the Ministry of Economy, Trade and Industry (METI) in 2001. In particular, controlling for firm characteristics and considering the endogeneity problem and selection bias, we examine two research questions concerning the cluster policies: if the project participants who exploit various support programs are more successful in network formation within the cluster than others, and which kind of support program contributes to improving firm performance. Finally, we address the conditions necessary for the effective organization of cluster policies to improve firm performance.

Unlike similar previous projects in Japan, the ICP aims at the autonomous development of regional industries and includes both direct R&D support and indirect networking/coordination support. Cluster policies can be regarded as regional, industrial, or technological policies and implemented as targeted subsidization or networking support under any of these aspects. In recent years, the focus of public support for local firms has clearly shifted toward networking and coordination for those who help themselves. Therefore, in this paper, we pay special attention to the differences in the effect of direct R&D support and indirect networking/coordination support on firm performance.

We define ICP support programs with heavy (hard) government intervention as direct R&D support, such as the support for R&D consortia, other R&D subsidies, and incubation services. Indirect networking/coordination supports are characterized by light (soft) government intervention. The ICP provides indirect support programs such as those for the provision of information via websites, the organization of meetings and other events, and the consultancy and advisory services. While cluster participants can choose to use indirect support programs, their applications for direct support programs should be selectively approved.

As mentioned before, few empirical studies with micro data have been conducted to date on the effects of cluster policies. Therefore, this paper is one of the pioneering empirical evaluations of cluster policies based on micro data, and this is the first contribution of this paper. Using firm level data, we can control for endogeneity

[1] Regional innovation systems have attracted many researchers (e.g., Abramo et al., 2009; Acs et al., 2002; Aldieri and Cincera, 2009; Anselin et al., 1997; Audretsch and Lehmann, 2005; Dahl and Pedersen, 2004; Fritsch and Franke, 2003; Furman et al., 2006; Jaffe et al., 1993; Owen-Smith and Powell, 2004; Rondé and Hussler, 2005; Squicciarini, 2008). Most previous studies have arrived at the general consensus that geography matters in determining the innovative capability of an economy.

and selection bias, which often cause serious problems in empirical estimations. Moreover, cluster policies comprise different types and contents of support programs, and it is a major advantage of this paper that we distinguish among various programs, specifically comparing the effects of direct and indirect programs. In this way, we can contribute to the recent discussion of how to organize effective public policies.

Our research is based on the data from an original survey conducted in 2009. Via each cluster project's website, we selected 2,668 manufacturing firms that participated in the ICP. We obtained effective responses from 511 firms (response ratio: 19%), from which 322 firms had utilized ICP support programs between 2006 and 2008. This survey specifically investigated the extent to which cluster participants used various support programs and the outcomes of the exploitation of these programs.

It is noteworthy that firms have to register themselves with the ICP before utilizing direct or indirect support programs. Therefore, in this paper, cluster participation is the same as registration with the regional cluster project and is different from the utilization of support programs, because some firms may be registered with the ICP without utilizing any programs. Moreover, not every firm in a specific technological field (such as biotechnology) in a cluster area participates in the ICP, although registration with the ICP is easy and free of cost[2]. Therefore, cluster participants are not the same as the firms in cluster regions in specific fields.

In the empirical estimation, we first use probit regression to examine the determinants of the use of ICP support programs. Thereafter, on the basis of the propensity score, we use the difference-in-differences (DID) method to analyze the degree of industry-university-government collaboration (hereafter, IUGC) before and after participating in the ICP. We then employ Heckman's two-step procedure and the negative binominal model to examine the effect of support programs on firm performance.

Our estimation results are as follows. First, the DID analyses results suggest that cluster participants who exploit support programs expand IUGC after participating in the ICP. In particular, indirect networking/coordination support contributes to building a new collaborative network. However, not every support program contributes to firm performance; firms should therefore select the program that is most aligned with their aims. Our estimation results clearly indicate the importance of indirect networking/coordination support. Indirect support programs have an extensive and strong impact on output (especially innovation outcomes), whereas direct R&D support has only a weak effect.

The rest of this paper is organized as follows. Section 2 provides a review of the theoretical and empirical literature. Section 3 explains the basic characteristics and support programs of the ICP. Section 4 presents our data construction and the basic statistics of sample firms. Section 5 discusses analytical models. Section 6 provides estimation results. Section 7 concludes the paper.

2. Literature review

2.1 Theoretical literature

[2] Firms can participate in the ICP by sending their applications through the internet.

A theoretical justification for government-sponsored R&D support can be found in the economic literature. There are two kinds of market failure on R&D. First, the gap between private and public returns to R&D because of knowledge spillovers leads to incomplete appropriability of the R&D results, which gives rise to market failure (Griliches, 1992; Spence, 1984; Teece, 1986). Second, R&D involves three types of uncertainties with regard to technological success, commercial success, and competitor behavior (Malmberg et al., 1996). If these uncertainties are high, firms tend to invest in R&D below the social optimum level. Industrial clusters can avoid the two kinds of market failure by promoting collaborative R&D, thus internalizing knowledge spillovers, and reducing uncertainties through collaboration and better coordination. In this way, cluster policies can increase the incentive to invest in R&D.

Moreover, David et al. (2000) list the following mechanisms through which public R&D support stimulates complementary private R&D expenditures: (1) R&D support generates learning effects that enhance the ability of firms to obtain the latest scientific and technological knowledge (absorptive capacity). (2) Public funds enable the use of experimental and research facilities and allow private firms to start projects with low additional costs (cost sharing). (3) Commissioned R&D from the public sector signals future demand for technologies, goods, and services diverted to the private sector (pump-priming effect)[3].

However, such direct R&D support fails to solve market failure if it generates the *crowding-out effect*. This occurs when public funds substitute private R&D expenditures. Government may tend to work toward avoiding the criticism of wasting public funds (Lach, 2002) and, therefore, select projects with lower risks and higher expected returns that could be undertaken without public funds (*pick-the-winner strategy*).

Furthermore, several scholars have recently expressed opposition to the targeting and subsidization of particular regions, industries, and technological fields, arguing that there is no reason to believe that policymakers are better informed than managers of local firms about the economic potential of the targets (Cowling et al., 1999; Hospers et al., 2009). This discussion is consistent with the public choice theory, which considers government failure as common as market failure because of massive information asymmetries and the arbitrary behavior of politicians and bureaucrats (Wolf, 1993). As Michael Porter explains, the cluster policy should aim at "removing obstacles, relaxing constraints, and eliminating inefficiencies that impede productivity and innovation in the cluster" (Porter, 2000).

A discussion by Malmberg et al. (1996) is consistent with the effectiveness of indirect networking/coordination supports. The innovation process is fundamentally uncertain in terms of technological feasibility and market acceptance. These characteristics of the innovation process imply that incremental and trial-and-error problem-solving enhances the need for continuous interaction, both formal and informal, with other organizations, such as related companies, customers, universities, and public

[3] Other economic theories have also been used to justify public R&D support. Darby et al., 2004 empirically analyze the effect of the Advanced Technology Programs on firms' innovation and demonstrate that this is an important channel to promote trust among participants in the government-sponsored R&D consortia (see also Das and Teng, 1998 and Zucker et al., 1996). Lerner, 1999, 2002) suggests that public funding for small technology-based firms may reduce information asymmetry as a signal of their high-quality innovation.

research institutes. Face-to-face contact accelerates the accumulation and exchange of knowledge and thus smoothes continuous interaction. In this sense, networking/ coordination support among innovators is essential for cluster policies, and face-to-face communication increases localized knowledge spillovers (Fujita, 2007).

2.2 Empirical literature

There are several empirical studies on the effectiveness of public R&D support from the viewpoint of the innovation output and subsequent market performance of subsidized firms (Branstetter and Sakakibara, 2002; Czarnitzki and Hussinger, 2004; Czarnitzki et al., 2007; Hujer and Radic, 2005; Hussinger, 2008; Grilli and Milano, 2009; Sebastien et al., 2010; Zucker et al., 1996). However, there seems to be no consensus in the literature. Grilli and Milano (2009), by categorizing R&D support into automatic and selective policy measures, find that selective schemes are more effective for firms' total factor productivity (TFP) than automatic ones. Selective schemes provide financial support to selected applicants, while automatic schemes give it to all applicants. Direct R&D support proposed by the ICP is characterized by selective schemes (see Section 3 for more detail).

The effectiveness of public R&D support may be partially offset by the crowding-out effect. Several recent papers empirically examine whether or not the crowding-out effect is serious. Using data of the European Community Innovation Survey (CIS-3), Czarnitzki and Ebersberger (2010) find that R&D subsidies result in more R&D spending at the firm level in Finland and Germany. Colombo et al. (2010) analyze the effect of public R&D support on the investment of new technology-based firms (NTBF) in Italy. According to their result, small NTBFs exhibit a strong and significant investment cash-flow sensitivity and public finance results in an increase of the investment rate, while large NTBFs are not financially constrained and their investments are not affected by public subsidies. From these analyses, we can infer that public support to NTBFs is helpful, only if public subsidies are targeted to firms that really need them, such as small and/or young ones.

Although cluster policies have been considered to be an important measure for supporting local SMEs and promoting regional innovation, there exist few empirical assessments. As a recent exception, Falck et al. (2010) evaluate the cluster policy in Germany using the DID methods. They find that the cluster-oriented policy increases the likelihood of innovation by a firm by 5.1 to 11.2 percentage points and suggest that government can support industrial prosperity by providing public infrastructure and other institutions that promote network formation and stimulate the innovation process. Contrary to this, McDonald et al. (2006) use data from 43 European industrial clusters and find that most government policies have no significant impact on the growth of industrial clusters and the development of cooperation within these clusters. However, these empirical estimations are based on macro level (regional) data. In order to examine precisely the effects of cluster policies on network formation and innovation, it is necessary to control for firm heterogeneity, endogeneity problem, and selection bias by using micro (firm level) data.

Nishimura and Okamuro (2010) evaluate the ICP in terms of university-industry partnerships using micro data and find that the effect of participation in the cluster project on R&D productivity is enhanced by collaboration with national universities within the same cluster area. However, their analysis focuses on the overall relationship between the participation in the ICP and R&D productivity and does not address the effect of each support program on firm performance. We will fill this gap by empirically evaluating and comparing the effects of direct and indirect support programs of the ICP.

Thus, this paper will contribute to the literature in the following points: 1) This is a pioneering empirical evaluation of the effects of various support programs in the cluster policy; 2) Using micro data from original survey, we can precisely estimate the effect of each support program controlling for firm heterogeneity, endogeneity problem, and selection bias; and 3) We explicitly compare the effects of direct and indirect support programs of cluster policies and discuss the relative efficiency of contrasting policy approaches. As a recent trend, cluster policies often consist of direct and indirect support programs not only in the ICP but also in other countries' cluster policies such as Europe (Hospers et al., 2009). In this way, this paper can contribute to the recent discussion of how to organize effective public policies.

3. Characteristics and support programs of the ICP

3.1 Characteristic of the ICP

METI started the ICP in 2001 with the purpose of supporting self-sustaining development of the local economy. METI (2005, p. 17) defines an industrial cluster "not as a mere agglomeration of companies etc. without interactions, but as an innovative business environment where new firms sharing business resources with each other are created one after another through horizontal networks such as industry-academia- government collaboration and inter-firm collaboration, and the resulting state in which industries with comparative advantage play a central role in promoting industrial agglomeration." The intention of the industrial cluster policy can be stated as "to form industry-academia-government networks and industry-industry networks throughout our country for the purpose of forming industrial clusters and to create new industries and businesses by promoting regional innovation" (ibid.).

METI has completed the first project period (2001–2005) and is engaged in the second period (2006–2010) with 17 regional clusters, most of which cover two or more prefectures. The regional projects primarily cover five technological fields: biotechnology, IT, advanced manufacturing, environment, and energy technologies. Firms can easily participate in the ICP and benefit from several government support programs (see Section 3.2). Overall, METI invested approximately 110 billion yen in the project during the first period[4].

From the comparative perspective, the ICP has some distinctive characteristics. First, its policy approach is in contrast with the former promotion policies of regional innovation based on, for example, the "Technopolis Law" (1983) and the "Brain Location Law" (1988). While these policies aimed at deliberate generation and promotion of new high-tech clusters, the ICP supports autonomous development of existing regional industries without direct intervention in the clustering process.

Second, through the ICP, METI mainly supports network formation among the participants of existing clusters and offers them information on and contacts with the

[4] See Nishimura and Okamuro (2010) for detailed information on each regional project in the ICP. Appendix 1 also summarizes basic characteristics of the ICP in Japan and several European cluster policies.

business and academic community as well as funding opportunities. In this sense, METI fundamentally changed its approach toward the cluster policy from focusing on the targeting and subsidization of particular industries to working for the facilitation of development and functioning of existing clusters, an approach described as the "facilitation policy" (Hospers et al., 2009).

Third, METI's new policy approach is similar to the approaches of successful European clusters. Hospers et al. (2009) find that the following three elements are common to the successful clusters in Europe[5]: (1) Clusters utilize existing regional resources, (2) Clusters steadily transform themselves according to their environment, and (3) Public authorities are largely absent in the clustering process but organize networking events, offer technological advice, and provide business/financial matches that facilitate the function of clusters. Public support provided in the ICP is indeed comparable to that offered by the European clusters.

Finally, the geographical scope of each regional project is considerably wider than that of any other cluster policies, implying that the ICP supports network formation both within and beyond local areas. The definition of cluster boundaries is inherently vague. Most cluster policies focus on specialized narrow areas; however, as Desrocherz (2001) insists, local firms typically regard outside collaborative partners as more important than their neighbors, even in highly advanced clusters, such as Silicon Valley.

3.2 Support programs of the ICP

Table 1 summarizes the types of support programs provided under the ICP (see METI (2005) for further details): (1) network formation, (2) R&D support, (3) incubation service, (4) marketing support, (5) financial support, and (6) fostering human resources.

[Insert Table 1 here]

METI emphasizes network formation and promotes it in the following ways: it dispatches coordinators to participating firms and universities; holds university-industry seminars, and symposia; and develops and provides databases on firms, researchers, and supporters via websites. METI created regional networks between 6,100 firms and 250 universities by 2005 (METI, 2006). Marketing support and financial support are given through similar series of network formation and coordination among firms, universities, and financial institutions.

R&D support is one of the most important ICP support measures. R&D consortia and the other R&D subsidies are the two major types of R&D support. The Consortium R&D Project for Regional Revitalization is one of the direct R&D support programs for industrial clusters. This program aims to promote local collaboration between industry and university. Approximately 60% of 1,130 R&D consortia formed by 2004 involve the participants of the ICP (METI, 2006). Every direct R&D support measure is based on the selective schemes. In addition, an incubation service is involved in R&D support; this service includes the access to research facilities that is provided through a competitive process.

[5] Hospers et al. (2009) select several regions--Baden-Württemberg, Emilia-Romagna, Jutland, and Manchester--as examples of successful clusters in Europe.

4. Data and sample characteristics

In this section, we first explain our data. Then, we summarize the basic statistics on the participants in the ICP. From our survey, we finally obtained 511 sample firms, of which 189 firms (37%) have not used any support programs since 2006 despite their participation in the ICP. Therefore, we also conduct a comparative test between the firms that have used support programs (322 *users*) and the others (189 *non-users*).

4.1 Questionnaire data

Our research is based on the data from an original survey conducted in March 2009. This survey was aimed at investigating the extent to which cluster participants exploit support programs provided under the ICP and the effect of each support program on the performance of its users. Several support organizations of the regional projects provide databases of their participants on their websites, but the information is restricted to the names and addresses of the participating firms. Therefore, we matched the list of cluster participants (approximately 5,000) on the websites, which cover 13 regional projects, with another company database to arrive at a definitive list of these 2,668 firms. We sent our questionnaire to these firms and obtained effective responses from 511 firms (response ratio: 19%), out of which 322 firms had utilized ICP support programs between 2006 and 2008.

From our survey, we collected data on several characteristics of firms, such as R&D intensity, technological fields[6], patent application, educational background of managers, and the year of and motivation for participation in the ICP. The survey also included questions on the extent of the IUGC before and after participating in the ICP. We use such basic information to control for the endogeneity in the empirical model.

In order to analyze the effects of various support measures, we classified them into the following ten groups: (1) provision of information and database via websites, (2) research meetings, (3) business matching events, (4) matching events with financial institutions, (5) technological consultation and advice, (6) management consultation and advice, (7) financial consultation and advice, (8) promotion of R&D consortia, (9) R&D subsidy, and (10) incubation services. Then, we gathered information on the support measures that cluster participants had utilized between 2006 and 2008 and the outcomes based on these support programs.

4.2 Sample characteristics

As already mentioned, 189 cluster participants had not used any support programs under the ICP since 2006. Therefore, we classified the cluster participants into 322 *users* and 189 *non-users* and compared basic statistics on them to examine the differences between them.

Table 2 compares the basic statistics on firm characteristics of the *users* and the *non-users*. We also conducted comparative tests between them. The results show some differences between them. First, *users* are larger than *non-users* in terms of the number of employees (significant at the 1% level)[7]. *Users* may be able to grow faster thanks to support programs under the ICP. Another interpretation is that *users* may be

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[6] The ICP focuses on biotechnology, IT, advanced manufacturing, and environment and energy technologies.

[7] We also find that sales and capital of *users* are larger than those of *non-users*.

representative firms in the local area and thus become core participants in the ICP. From this table, we cannot tell which explanation is more appropriate.

Second, *users* are more actively engaged in academic societies (significant at the 1% level) and trade associations (significant at the 5% level). This finding suggests that *users* have tighter connections with academia and other firms in the same industry. Network formation with universities is the primary purpose of the ICP. We do not know yet if *users* form networks with universities after participating in the ICP, and will investigate in the empirical section the degree of network formation before and after participating in the ICP.

Finally, we find that the motivation for the ICP is a significant factor in the use of support programs. In particular, *users* are more interested in network formation, R&D support, and incubation services (significant at the 1% level). Of course, as might be expected, the motivation of cluster participants is important for activating the organization of the ICP, considering that there are so many *non-users* (37% in this survey).

Table 2 shows some other important characteristics of the cluster participants. For example, they are highly R&D-intensive firms. In particular, the R&D ratio to sales of *users* exceeds 25%. The year of participation in the ICP is 2004 on average, so that more than half of the cluster participants have been members since the first project period (2001–2005). With regard to the distribution of technological fields (biotechnology, IT, advanced manufacturing, environment and energy, and the others) and educational backgrounds of top managers, we find no significant differences between *users* and *non-users* according to χ-square tests.

[Insert Table 2 here]

In sum, we find several significant differences between *users* and *non-users* with regard to the characteristics of firms and top managers. In the empirical section, we try to estimate the effects of ICP support programs on firm performance and the development of the IUGC, considering these differences.

4.3 Support programs and the ICP performance

Support programs

Table 3 summarizes the ratios of *users* in each category of support programs and the average value of outputs of the ICP. We classified ten support measures into four major types: (1) provision of information on websites, (2) organizing of meetings and events, (3) service of coordinators and advisors, and (4) R&D support.

As shown in Table 3, cluster participants are most actively involved in the meetings and matching events: 219 firms (44%) attend research meetings and 169 firms (35%) take part in business matching events[8]. Such events are an important part of the infrastructure to boost exchanges among industry, university, and government.

Cluster participants are also interested in R&D support as the motivation for the ICP. Actually, 148 firms (30%) obtain R&D subsidies, while 96 firms (20%)

[8] This result is positively correlated with their major motivation to participate in the ICP (network formation). The correlation between research meetings (business matching events) and motivation for network formation is 0.30 (0.28).

participate in R&D consortia, which must include at least a local university. R&D support directly aims to promote the IUGC and improve R&D activities of cluster participants.

Cluster participants also utilize other support programs. 113 firms (23%) obtain information on the other participants, events, and R&D support via project websites. Among the coordinator services, participants mostly use the consultation with technological advisers. In sum, cluster participants exploit support programs related to network formation and R&D support more actively than the other programs.

[Insert Table 3 here]

Among these types of support programs, we regard websites with information, event organization, and coordinator services as indirect and institutional arrangements that remove obstacles and relax constraints in the clusters. Cluster participants can utilize these indirect supports without being subject to a selection process, while the government can interfere directly with R&D activities of cluster participants through R&D support because of selective schemes. Previous cluster policies in Japan have never laid emphasis on indirect support programs. One of the major concerns of this study is to evaluate the effects of direct and indirect support programs on firm performance and to examine which is more important.

The ICP performance

Table 3 also shows the outcomes of the ICP. As proxies for the outcomes of the ICP, we prepared several measures such as the number of network formation (with firms, universities, and public research institutes), financial deals, sales transactions, and new products and processes. The survey also provides subjective evaluation by the respondents on the improvement in sales, profits, technology, and reputation (5-point Likert scale: 1 = none to 5 = very high).

On average, cluster participants formed new contacts with 2.71 firms, 1.64 universities, and 1.27 public research institutes, with some distinct exceptions (including those connected with 40 firms and 10 universities). We find that most firms did not obtain financial support (0.36). The average number of sales transactions is quite large (7.29), while its median is zero. Therefore, more than half of cluster participants found no business contacts based on the ICP. Cluster participants create new products and processes (1.81) through support programs. As these concrete outcomes imply, at this stage, the subjective evaluation on improvement in sales and profits indicates that this is on average less significant than that in technology and reputation.

5. Empirical models

5.1 Estimation strategy

Major industrial cluster policies including the ICP comprise both direct (R&D) and indirect (networking/coordination) support programs. As already mentioned in Section 2, both programs can contribute to the improvement of firm performance from the theoretical viewpoint. However, to our best knowledge, previous literature has not yet answered to the questions of which type of the support programs is more preferable in terms of cost-benefit balance in the cluster policies and what are the conditions necessary for effective organization of such policies. Thus, we try to contribute to the literature by comparatively assessing direct and indirect support programs of the ICP.

This section explains our empirical framework. In order to accurately evaluate the ICP and its various support programs, we cannot simply compare the values of *users* and *non-users* of particular support programs, nor can we solely compare the values of *users* before and after exploiting these programs. We should be aware of the difference between the observed values of the supported (treated) firms and the unobservable counterfactual situation, and carefully estimate the average values of performance that the treated firms would have shown if they had not been treated. To this purpose, we use the following empirical strategies.

The propensity to utilize support programs of the ICP is neither exogenous nor randomly given. Therefore, we should at first control for such endogeneity or selection problem in evaluating the ICP. Thus, we first examine the determinants of the exploitation of ICP support programs by binary probit regression and calculate the probability of each cluster participant in our sample to use them (propensity score). Then, based on the propensity score, we conduct the difference-in-differences (DID) estimation to compare the extent of engaging in industry-university-government collaboration (IUGC) by the ICP participants before and after participating in the ICP and between *users* and *non-users* of support programs (the methodology is explained later in more detail). In this way, we can estimate the real impact of ICP support programs on network formation.

Finally, we investigate the effect of exploited support programs on firm performance by using Heckman's two-step procedure and the negative binominal model. We employ these estimation models according to the characteristics and distribution of the dependent variables that are measured in different ways. On the one hand, we made four performance measures of subjective evaluation based on 5-point Likert scale, for which we can employ OLS as the second step in Heckman's two-step procedure. On the other hand, we measure firm performance as count data in ten specific outcomes such as the number of established research collaboration with universities or that of new products and processes. We employ negative binominal estimation to analyze the determinants of these performance variables.

Heckman's two-step procedure is used further to control for possible selection bias: if the productivity of *users* is higher than that of *non-users* because *users* are inherently more interested in innovation activity, estimates of usual linear regressions should be upwardly biased. Heckman's two-step procedure is a usual and appropriate method to check and cope with such selection bias.

We explain these empirical models and variables in more detail in the following sections.

5.2 Network formation: DID estimation and probit regressions

Firms can freely participate in the ICP, but *non-users* of support programs do not receive any benefits from public supports. Therefore, they do not improve their performance through support programs. In this regard, they are not different from the firms that did not participate in the ICP. We regard *users* as the treatment group and *non-users* as the control group and compare *users* with *non-users* in terms of network formation. The estimation equation is formulated as follows:

$$Y_{it} = \alpha + \beta_1 users_i + \beta_2 postICP_t + \beta_3 (users * postICP)_{it} + \varepsilon_{it} \qquad (1),$$

where *i* stands for the firm, and *t* for the two periods (before and after participating in the ICP). The outcome variable *Y* is the extent of engaging in the IUGC before and after the ICP (5-point Likert scale: 1 = none to 5 = very high).

The variable *users* is a dummy variable that takes on the value "one" if cluster participants use support programs by the ICP, and "zero" otherwise. The variable *postICP* is a dummy variable that takes on the value "one" after (and "zero" before) participating in the ICP. The coefficient of our primary interest is β_3, which measures the increase in the network formation for *users* after the participation in the ICP beyond that which is observed for *non-users*.

There may be a serious endogeneity problem with regard to the utilization of support programs. *Users* may be more actively engaged in R&D and IUGC and thus be more innovative firms. Further, the government might preferentially induce such innovative participants to exploit support programs ("pick-the-winner" strategy). If this is the case, the samples of *users* and *non-users* would not be randomly selected, and the DID estimators would be biased.

As in other recent empirical works, we try to control for this selection problem using the propensity score method[9]. First, the probability of cluster participant *i* to use support programs is estimated conditional on some observables capturing firm characteristics, pre-ICP network formation, and the degree of motivation to participate in the ICP. Then each *user* is matched with a control firm (*non-user*) endowed with a similar propensity score. Under this approach, the control group is assumed to represent a good proxy of what the outcome of a *user* would have been if it had not used support programs[10]. In order to obtain the propensity score, we consider the following simple setup:

$$p(user = 1 \mid X) = \phi(\delta X) + \nu \qquad (2)$$

This equation specifies the probability of cluster participants using support programs as a function of variables *X*. Our independent variables principally consist of four groups of variables: firm capability, network of top managers, the extent of IUGC before participating in the ICP, and the importance of motivations to participate in the ICP.

First, firm capability is captured by firm age (*age*), the ratio of R&D expenditure to sales (*rd_ratio*), the number of employees (*emp*), and the dummy variable of patent applications before participating in the ICP (*d_pat*). Younger firms may actively exploit support programs because of their limited experience and reputation. We expect that relatively large and R&D-intensive firms are actively engaged in the ICP for their higher absorptive capacity and because such firms tend to

[9] The propensity score to select a control sample was first introduced by Rosenbaum and Rubin (1983). Dehejia and Wahba (2002) show the importance of the propensity score method in evaluating labor training programs.

[10] Blundell and Costa Dias (2000, p.438) affirm that "…a non-parametric propensity score approach to matching that combines this method with diff-in-diffs has the potential to improve the quality of non-experimental evaluation results significantly."

be invited to the ICP as representative participants[11]. Moreover, firms with patent applications may be active in innovation activity and easier to participate in the ICP support programs because of their higher capability.

Second, we include the variables of the extent of top managers' participation in the meetings of academic societies (*meet_acad*), trade associations (*meet_trade*), and the local chambers of industry and commerce (*meet_chamber*). They represent top managers' network and information activity. We include these variables because cluster participants who have extensive relations with academia, industrial and professional community, and local business community are assumed to use support programs actively because they make it relatively easy to gather information. The core purpose of the ICP is to promote networking between firms and universities, thus we expect that the firms which have direct connections with academic societies via their top managers are more likely to exploit the ICP support programs.

Third, we introduce the degree of IUGC before participating in the ICP, the degree of inter-firm, firm-industry, and firm-government (public research institutes) collaboration before participating in the ICP (*collabo_ff*, *collabo_fu*, and *collabo_fg*, respectively). We expect that the participants who have been actively engaged in the IUGC even before participating in the ICP are more likely to use support programs

Fourth, we create variables which capture the importance of the following support programs as the motivation to participate in the ICP: network formation (*imp_net*), R&D support (*imp_rd*), incubation services (*imp_inc*), marketing support (*imp_sale*), and financial support (*imp_fin*). We expect that highly motivated participants are more likely to use public supports. Especially, motivation for network formation should be emphasized in the ICP.

Finally, we also control for firms' technological fields and top managers' educational backgrounds. The ICP focuses on biotechnology, IT, advanced manufacturing technologies, and environment and energy technologies. Top managers' educational backgrounds such as undergraduate and graduate degrees as well as the education in natural or social/human sciences may also affect their exploitation of the ICP support programs. These independent variables are summarized in Table 4.

[Insert Table 4 here]

5.3 The effect of support programs on firm performance: Heckman's two-step procedure and the negative binominal model

As already mentioned, we use Heckman's two-step procedure to account for the possible selection problem. First, the probability of being a *user* is estimated with a probit model as previously mentioned. Then, we estimate an equation of the form:

$$P_i = \theta \sum Support_i + \gamma_1 age_i + \gamma_2 rd\_ratio_i + \gamma_3 emp_i + \phi \sum tech\_fields_i + \delta\lambda(X\beta) + u_i \qquad (3),$$

[11] Our interviews of several firms participating in the ICT in Hokkaido area reveal that the public organizers of local cluster projects preferably invite representative firms of focal technological fields in the region as the core members of the local cluster projects.

where $\lambda(X\beta)$ is the inverse Mill's ratio constructed from the first step estimates, which controls for the selection problem. The dependent variables are the subjective measures of evaluation of the improvement in sales, profits, technology, and reputation (*out_sale*, *out_profit*, *out_tec*, and *out_repu*, respectively)[12].

The variables *Support* denote four major types of support programs (see Table 3). The variable *d_web* is a dummy variable that takes on the value "one" if a cluster participant utilizes websites of the cluster project and "zero" otherwise. Similarly, *d_event* is a dummy variable on event participation, *d_cord* on coordinator services, and *d_rd* on R&D support. We also use ten detailed support measures as indicated in Table 3 (*d_web*, *d_meeting*, *d_business*, *d_finance*, *d_technology*, *d_evaluation*, *d_funding*, *d_consortium*, *d_rdsubsidy*, and *d_incubator*, in order).

We also use the measures of concrete outputs as the dependent variables, such as the number of network formation with different types of partners (*network_f*, *network_u*, and *network_p*), financial deals (*finance*), sales transactions (*business*), and new products and processes (*innovation*). They are count data; therefore, we employ the negative binominal estimation[13].

Our major research question is which kind of support programs of the ICP contributes to firm performance, after controlling for firm characteristics and coping with the endogeneity problem. As already mentioned, the ICP aims at the autonomous development of regional industries and comprises both direct R&D support and indirect networking/coordination support. Therefore, special attention is paid to the differences between the direct and the indirect support.

6. Estimation results

6.1 Characteristics of firms to use support programs

Table 5 shows the determinants for cluster participants' use of support programs (equation (2)). We find that the estimation results are almost similar to those in Table 2. First, the coefficient of the variable *emp* is positive and significant, indicating that larger firms are more likely to use public supports. Our interview with the president of a large participant revealed that his firm is often requested to act as a center for network formation and utilize support programs because it is a member of a committee related to the ICP.

Second, the coefficient of the variable *meet_acad* is also significant and positive. Firms that are actively engaged in academic societies tend to utilize support programs. The primary purpose of the ICP is to build up a collaborative network between industry and university; thus, those firms highly interested in collaboration with universities may use support programs.

Third, the coefficient of the variable *d_pat* is also positive and significant. Therefore, the firms that have applied for patents before participating in the ICP are more likely to use support programs. These firms have already developed technologies and products and are thus well prepared to actively participate in research meetings and

[12] These dependent variables are measured on a 5-point Likert scale; thus, we also estimate the ordered probit model. The result of this estimation is not different from that of Heckman's two-step procedure.

[13] We also conducted Heckman's two-step procedure. However, the inverse Mill's ratio was not significant, which indicates that selection bias is not serious.

business matching events. They can also apply for R&D support to put their technologies to practical use. The government may also induce such innovative firms to use support programs.

Finally, we find that motivation to participate in the ICP is extremely important. As indicated in Table 5, the coefficients of the variables *imp_net*, *imp_rd*, and *imp_inc* are all positive and significant. Highly motivated firms, especially those motivated by a desire for network formation and R&D support, are likely to use support programs. The president of an IT firm told us that his firm participated in the ICP in order to gather information on and build a network with rival firms and business partners, and that it has actively participated in several such events.

[Insert Table 5 here]

6.2 Performance on network formation

Table 6 summarizes the results of the DID estimations (Equation (1)) based on the propensity score estimated in the previous section. The coefficient of β_3 in Equation (1) is estimated in the DID column.

[Insert Table 6 here]

The results strongly support the statement that *users* (as opposed to *non-users*) significantly enhance the degree of IUGC after participating in the ICP. In particular, our estimation results suggest that *users* are more likely to construct collaborative networks with universities than *non-users* are. The survey also asks for the location of the research partners and finds that after firms participate in the ICP, over 70% of their university partners are located within the same prefecture.

In this sense, we can positively evaluate the ICP, because its primary aim is to promote industry-university partnership within the same cluster. The participants may obtain valuable information on potential partners through the support of the cluster projects. Such information may provide them with new opportunities to build networks with potential partners.

6.3 The effect of support programs: subjective evaluation

Table 7 (1) shows the estimation results of Heckman's two-step model (Equation (3)). The dependent variables are the subjective evaluations of the ICP on the improvement in sales, profits, technology, and reputation (*out_sale*, *out_profit*, *out_tec*, and *out_repu*). Independent variables include four major types of support programs, firm age, R&D intensity, firm size, and technological fields[14]. Moreover, we find that the coefficients of inverse Mill's ratio $\lambda(X\beta)$ are strongly significant in all models, which indicates that significant selection bias is controlled for. We further conduct the estimations by using

[14] In addition, we include the year of participation in the ICP and the variables of R&D collaboration before and after participating in the ICP in the estimation model. We find that the participation year is not important for firm performance. In fact, the participation year has no impact on the probability of cluster participants becoming *users* as per our findings. R&D collaboration has significantly positive effect on firm performance only after participating in the ICP.

ten detailed support measures instead of four major groups. These results are summarized in Table 7 (2)[15].

[Insert Tables 7 (1) and 7 (2) here]

These results clearly suggest which kind of support programs of the ICP contributes more to firm performance. First, *d_event* and *d_cord* have positive and significant impacts on sales growth. This suggests that event participation and coordinator service increase sales. In particular, business matching and consultation services significantly contribute to sales growth. Our results also indicate that business matching improves the profit of the *users*.

Second, the coefficients of *d_web* and *d_rd* are positive and significant on firms' technological capability. Direct R&D support through R&D consortia and R&D subsidies improve the technological capability of cluster participants. It may seem strange that the utilization of project websites enhances the technological capability of *users*. Some websites display technological information on the cluster participants including firms, universities, and public research institutes, and introduce several successful cases of collaborative R&D proposed by the participants. Thus, the participants using websites can gather more information on technological development.

Third, all support programs lead to an improved reputation for cluster participants. In particular, event participation is the most effective tool to obtain recognition. Reputation is also important for the improvement of firm performance because the websites proposed by the ICP publish the list of participants and promote network formation among these participants.

Finally, we find that R&D subsidy improves firm performance in all four measures, as indicated in Table 7 (2). Moreover, business matching has a significant effect on the improvement of sales, profits, and reputation. Therefore, these two support programs seem to be the most important for cluster participants[16]. In the following section, we will examine the effects of support programs on each output measure in order to check the robustness.

6.4 The effect of support programs: discrete outcomes

Table 8 (1) summarizes the results on discrete outcomes. The dependent variables are the number of networks formed (*network_f* for firms, *network_u* for universities, and *network_p* for public research institutes), financial deals (*finance*), sales transactions (*business*), and new products and processes (*innovation*). Independent variables are the same as those in Table 7 (2). Serious multicollinearity arises when the variables of ten support measures are included all together in the model. Therefore, we also conduct the negative binominal regression using each of ten support measures separately (see Table 8 (2)).

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[15] The problem of multicollinearity is serious if we include ten support measures all together in the model. Thus, we estimate Heckman's selection model by interchangeably using these variables in Table 7 (2).

[16] We additionally estimated Heckman's sample selection model with double probit estimations for the robustness check. We transformed the values on the 5-point Likert scale into binary values. In this case, the dependent variable at the second stage is the dummy variable, which takes on the value "one" if the evaluation according to the 5-point Likert scale is higher than one (positive effects), and "zero" otherwise (no effects at all). The result of this estimation is not different from that of Heckman's two-step model.

[Insert Tables 8 (1) and 8 (2) here]

First, we find that the exploitation of indirect networking/coordination support programs is positively related with the development of IUGC. In particular, event participation in research meetings and business matching and management consultation lead to network formation. On the contrary, R&D support does not always promote network formation. Only *d_rdsubsidy* has a positive and weakly significant effect on *network_u*.

Second, the number of financial deals is also affected by the utilization of indirect public supports. The participation in the events for matching with financial institutions and consultation with management advisers has positive effects on the success of financial deals.

Third, most of the indirect networking/coordination support and direct R&D support measures significantly increase the number of sales transactions and new products and processes. The variables *d_business* (marginal effect: 0.71), *d_finance* (1.30), *d_technology* (0.64), *d_funding* (1.77) and *d_rdsubsidy* (1.01) have positive effects on commercial success. Also, the variables *d_business* (marginal effect: 1.00), *d_evaluation* (0.75), *d_funding* (0.67), *d_consortium* (0.49) and *d_rdsubsidy* (0.75) have positive and significant effects on innovation outputs.

As already indicated, R&D subsidy seems to be the most important program of R&D support. Nonetheless, comparing the marginal effects of indirect support programs with that of R&D subsidy, we find that the former have greater influence on commercial success and innovation activity, despite a much smaller budget than the latter (2 billion compared to 55 billion yen from 2001 to 2004).

7. Conclusions

In this study, we use original questionnaire data to evaluate the ICP initiated by the METI in 2001. We address two research questions on the effects of the ICP after controlling for firm characteristics and coping with the endogeneity problem and the selection bias: if the project participants who exploit various support programs are more successful in network formation within the cluster than others, and which kind of ICP support program contributes to firm performance. We are especially interested in the differences between direct R&D support and indirect networking/coordination support, which indicate the conditions necessary for the effective organization of cluster policies.

Though cluster policies have attracted considerable attention in recent years, few empirical studies have been conducted on these policies. As one of the pioneering empirical evaluations of the cluster policies, a major contribution of this paper is that it distinguishes among various support programs and explores different effects of different support programs. Moreover, using micro data from original survey, we can precisely estimate the effect of each support program, controlling for firm heterogeneity, endogeneity problem, and selection bias. Finally, we explicitly compare the effects of direct and indirect support programs of cluster policies and discuss the relative efficiency of contrasting policy approaches. In this way, this paper can contribute to the recent discussion of how to design and organize effective public policies.

In sum, our estimation results clearly suggest the importance of indirect networking/coordination support. Indirect support programs have an extensive and strong impact on discrete outcomes, especially on innovation outcomes, whereas direct R&D support has a rather weak effect. This is an important result from the viewpoint of cost-benefit performance, because direct R&D support costs much more than indirect support programs; the government invested approximately 55 billion yen in R&D support under the ICP between 2001 and 2004 but only 2 billion yen in indirect support. Our results suggest the effectiveness of such indirect support systems that remove obstacles and relax constraints in the cluster (Falck et al., 2010; Hospers et al., 2009; Porter, 2000).

There are several policy implications in our estimation results. First of all, we can positively evaluate the ICP because various support programs improve the performance of local firms (especially that of SMEs). They have limited resources and thus, greater difficulties in finding appropriate partners for collaboration; the ICP is therefore expected to support local firms in finding and selecting optimal partners. As implied by the DID analysis results, cluster participants who exploit support programs expand IUGC after participating in the ICP. In particular, indirect networking/ coordination support contributes to building up new collaborative networks within clusters.

Moreover, we find that the effect of indirect support is significantly higher than that of direct R&D support. The ICP support programs correspond to the measures of a knowledge-oriented industry policy. The government is considered to be able to alleviate various knowledge-specific failures in the knowledge-based economy, whereas the rationale for traditional industry policy derives from welfare economics and market failure arguments (Dobrinsky, 2009). Knowledge-specific failures involve a large number of agents/stakeholders and complex links and interactions among them. Arnold and Thuriaux (2003) point out several aspects of such failures. For example, network failures are the problems in interaction among different agents/stakeholders because of poor inter-linkages among them, low degree of trust, and highly perceived transaction costs. Capability failures in firms and other agents are their inability to act in their own best interests; these failures are derived from poor managerial or technological skills and the inability to absorb externally generated technologies. Indirect support programs can be effective as policy measures to overcome these knowledge-specific failures[17]. Our empirical results suggest the effectiveness of such “soft” policy intervention and the role of government as an innovation intermediary.

An interpretation for the limited effect of direct R&D support derives from government failure such as the crowding-out effect. In order to avoid the criticism of wasting public funds, the government may finance projects with lower risks and higher private returns, which would be undertaken even in the absence of public subsidies. This is consistent with the findings of Nishimura et al. (2009) that indicate the problem of public R&D in Japan on the basis of a survey of patent inventors. Another interpretation is related to the limitation of data. Our data on the outcomes are count data. Therefore, we cannot control for the quality of the outcomes and may underestimate the effects of public R&D supports.

Finally, participation in the ICP means no more than registration, and therefore, is not necessarily equal to the utilization of the support programs. It is noteworthy that

[17] According to Dobrinsky (2009), direct R&D support in knowledge-oriented industry policy also brings about notable changes.

according to our survey, only 63% of the cluster participants have utilized any support programs. In fact, an interviewee from an IT firm told us that the ICP has many support programs but he is not aware of the details. Indeed, Nishimura and Okamuro (2010) confirm that participation in the ICP itself does not improve firm performance. Instead, cluster participants should actively exploit support programs to establish and expand their alliances and networks. In this regard, specific motivation to participate in the ICP is one of the most important factors contributing to the exploitation of support programs. Therefore, it may be necessary to encourage the exploitation of various support programs.

Moreover, we can derive several managerial implications for cluster participants to improve their performance. We empirically examine which support program of the ICP contributes to firm performance and find that not every support program contributes to this aim; firms should therefore select the program that is most aligned with their aims. Generally speaking, we find that participation in meetings and events and using coordination and advisory services enhance firm performance such as network/alliance formation, financial and sales transactions, and innovation activity, while R&D subsidy leads to increase of sales transactions and innovation activity.

This result is important because many participants including SMEs have never used the ICP support programs as indicated above. In recent years, the focus of public support for local firms has clearly shifted toward networking and coordination for those who help themselves. Thus, cluster participants should be actively engaged in the ICP support programs to improve their performance. This is also important for the development of industrial clusters because active communication among cluster participants leads to higher productivity of innovation activity in the region (Fujita, 2007).

To finish this paper, we mention some limitations of this paper that future research should address more explicitly. First, as mentioned earlier, we do not control for the quality of outcomes, and therefore cannot conduct an accurate cost-benefit analysis. Second, the time frame of the evaluation may be too short. By evaluating the effects of support programs within a few years in the middle of the ICP, we may underestimate their effects. However, the fact that we have nevertheless obtained significant results for several programs will support our argument. Third, we used firm level data for the analyses, and this is our contribution to the literature. However, by using individual data on personal relationships especially with university researchers, we might be able to enrich and deepen our analysis.

Fourth, we cannot completely identify the effect of each support program with a specific outcome in our estimation. The questionnaire asks about the utilization of support programs between 2006 and 2008 and the outcomes *generated by exploiting them*. Thus, we can exclude the causality problem, given that the respondents correctly understand our questions. However, we cannot exclude the possibility of estimating the effect of a support program utilized in 2008 on the outcome in 2007, which may be, in fact, the outcome of another support program utilized in 2006. To cope with this problem, we would have to create a panel dataset regarding the utilization of each support program and its outcomes.

Fifth, these overall results may differ across cluster areas. Our survey covers 13 (out of 18) cluster areas in Japan that are considerably different from each other in terms of technological fields, budget size, the number and characteristics of participants, and the utilization of support programs. For example, our additional analysis focusing on biotechnology clusters suggests that the support of R&D consortium including at least a university has a positive and significant effect on commercial success and inventive activity of the participants, while this effect is not significant in the overall estimation results covering all technological fields. This implies that the most effective support programs may differ according to the technological characteristics of clusters. We have included technology dummies in our estimation model, but further analysis should more explicitly consider and highlight the different characteristics of each cluster.

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Table 1 Support programs provided by the ICP and their concrete examples

Support programs	**Examples**
Network formation	1) Establishment of organizations promoting cluster formation, networking with related organizations 2) Dispatch of coordinators to participating companies and universities 3) Information transmission through web sites and e-mail magazines 4) Holding industry-academia collaboration exchange meetings, joint meetings for announcing the results, symposiums, seminars, and workshops 5) Development of database on companies, researchers, and supporters
R&D support	1) Promotion and collaboration of R&D by public funds based on selective schemes 2) Promotion of utilization of research results 3) Support for protection and strategic use of intellectual property (establishment of local intellectual property strategy headquarters, etc.)
Incubation function	1) Development of incubation facilities 2) Fostering incubation managers 3) Formation of network between incubation organizations and incubation managers
Marketing support	1) Holding events for business matching and exhibition of products (including overseas market) 2) Collaboration with specialized trading firms 3) Establishment of distribution system 4) Market cultivation through coordinators 5) Support for cross-industrial collaboration
Financial support	1) Collaboration with local financial institutions (holding the Industrial Cluster Support Finance Conference) 2) Establishment of local venture capital 3) Holding meetings for announcing business plans
Fostering human resources	Fostering highly specialized human resources (manufacturing personnel, technology management personnel, and judging personnel, etc.)

Source: Based on METI (2005).

Table 2 Differences in the firm characteristics of *users* and *non-users*

Items	*users*	*non-users*	Comparative test
Participation year	2004 (2.14)	2004 (2.38)	
Firm age (year)	28.57 (18.72)	27.44 (17.76)	
R&D ratios to sale (%)	25.31 (232.20)	9.93 (37.57)	
Number of employees	86.56 (208.08)	43.79 (60.21)	***
Number of patents before ICP	9.62 (23.86)	11.64 (32.76)	
Meeting participation (5-point Likert scale)			
Academic society	2.30 (1.29)	1.89 (1.25)	***
Trade association	3.20 (1.42)	2.87 (1.46)	**
Chamber of commerce	2.57 (1.41)	2.42 (1.39)	
Motivation for the ICP (5-point Likert scale)			
Networking formation	3.62 (1.23)	2.85 (1.31)	***
R&D support	3.76 (1.23)	3.11 (1.40)	***
Incubation	2.50 (1.31)	2.08 (1.20)	***
Market exploitation	3.28 (1.45)	3.09 (1.48)	
Financial support	2.95 (1.54)	2.68 (1.57)	*

Note 1: Average value in columns and standard deviation in parentheses.

Note 2: This table shows the results of two-sample mean comparison tests under unequal variances. Level of significance: *** 1%, ** 5%, * 10%.

Table 3 Utilization of support programs and outputs of the ICP

Support programs		Number of responses	*users* (%)	S.D
Provision of information on websites (*d_web*)	Utilizing websites (*d_web*)	481	0.23	0.42
Organizing meetings and events (*d_event*)	Research meetings (*d_meeting*)	494	0.44	0.50
	Business matching events (*d_business*)	488	0.35	0.48
	Matching events with financial institutions (*d_finance*)	482	0.18	0.38
Service of coordinators and advisors (*d_cord*)	Technological consultation and advice (*d_technology*)	492	0.27	0.45
	Management consultation and advice (*d_evaluation*)	483	0.13	0.33
	Fiinancial consultation and advice (*d_funding*)	482	0.09	0.29
R&D support (*d_rd*)	R&D consortia (*d_consortium*)	487	0.20	0.40
	R&D subsidy (*d_rdsubsidy*)	490	0.30	0.46
	Incubation services (*d_incubator*)	483	0.14	0.35
Outputs		Number of responses	Mean	S.D
Number of technology, manufacturing, and sales alliance networks formed	Firms (*network_f*)	142	2.71	5.27
	Universities (*network_u*)	152	1.64	1.66
	Public research institutes (*network_p*)	145	1.27	1.28
Number of financial deals, sales transactions, and innovations	Number of financial deals (*finance*)	145	0.36	1.05
	Number of sales transactions (*business*)	147	7.29	58.32
	Number of new products and processes (*innovation*)	160	1.81	2.45
Subjective overall evaluation	Sales (*out_sale*)	316	2.01	1.17
	Profits (*out_profit*)	316	1.92	1.08
	Technology (*out_tec*)	316	2.71	1.32
	Reputation (*out_repu*)	313	2.96	1.39

Note 1: The names of the dependent and independent variables in empirical models (Section 5.3) are in parentheses.

Table 4 Definition of variables with summary statistics

Variable	Definition	Obs	Mean	Median	Std. Dev.	Min	Max
Firm capability							
age	Firm age	510	28.16	24.5	18.40	1	94
rd_ratio	The ratio of R&D expenditure to sales (%)	499	19.52	2	186.22	0	4063
emp	Number of employees	509	70.68	22	170.45	1	1859
d_pat	Dummy variable which takes on the value one if the firm at least applies for a patent	511	0.55	1	0.50	0	1
Meeting participation							
meet_acad	Degree of participation in academic societies	480	2.15	2	1.29	1	5
meet_trade	Degree of participation in trade associations	498	3.08	3	1.45	1	5
meet_chamber	Degree of participation in chamber of commerce	496	2.52	2	1.41	1	5
Industry-University-Government collaboration before the ICP							
collabo_ff	Degree of inter-firm collaboration before the ICP	466	2.00	1	1.25	1	5
collabo_fu	Degree of firm-university collaboration before the ICP	477	2.23	2	1.37	1	5
collabo_fg	Degree of firm-government collaboration before the ICP	467	1.95	1	1.24	1	5
Importance of support programs as the motivation for the ICP							
imp_net	Importance of network formation	469	3.36	3	1.32	1	5
imp_rd	Importance of R&D support	475	3.54	4	1.33	1	5
imp_inc	Importance of incubation	451	2.36	2	1.29	1	5
imp_sale	Importance of market exploitation	467	3.22	3	1.47	1	5
imp_fin	Importance of financial support	455	2.87	3	1.56	1	5

Note 1: The dummy variables of technological fields and top managers' educational backgrounds are omitted from this table.

Table 5 Determinants of the exploitation of support programs

	Coef.	Robust S.E.
Firm capability		
age	−0.003	0.005
rd_ratio	0.000	0.002
emp	0.002**	0.001
d_pat	0.343**	0.161
Meeting participation		
meet_acad	0.126*	0.069
meet_trade	0.062	0.058
meet_chamber	−0.019	0.059
IUGC before the ICP		
collabo_ff	0.072	0.067
collabo_fu	0.001	0.080
collabo_fg	0.052	0.081
Motivation for the ICP		
imp_net	0.183***	0.062
imp_rd	0.155**	0.067
imp_inc	0.126*	0.069
imp_sale	−0.006	0.057
imp_fin	0.009	0.059
Other control variables		
technology fields	included	
educational backgrounds	included	
constant	−1.641***	0.387
N	379	

Note 1: Level of significance: *** 1%, ** 5%, * 10%.

Table 6 DID estimation on network formation:

Inter-firm

	Before	After	DID
users	2.14	2.79	0.423 (0.141)
non_users	1.78	2.04	

Firm-University

	Before	After	DID
users	2.44	3.32	0.766 (0.212)
non_users	1.87	2.26	

Firm-Government

	Before	After	DID
users	2.15	3.02	0.528 (0.183)
non_users	1.60	1.95	

Note 1: Standard errors are in parentheses.

Table 7 (1) Estimation results of Heckman's two-step model:
Effects of four major support programs on firm performance (subjective evaluation)

	out_sale	*out_profit*	*out_tec*	*out_repu*
d_web	0.176 (0.156)	0.118 (0.140)	0.428** (0.169)	0.360* (0.189)
d_event	0.485** (0.204)	0.361** (0.157)	0.261 (0.195)	0.663*** (0.218)
d_cord	0.330** (0.161)	0.194 (0.134)	0.188 (0.162)	0.389** (0.182)
d_rd	0.184 (0.157)	0.218 (0.140)	0.609*** (0.168)	0.516*** (0.188)
age	−0.007 (0.005)	−0.006 (0.004)	0.000 (0.006)	0.001 (0.007)
rd_ratio	−0.002 (0.002)	−0.002 (0.001)	−0.002 (0.002)	−0.002 (0.002)
emp	−0.001*** (0.000)	−0.001** (0.000)	−0.001 (0.000)	−0.002** (0.001)
constant	2.367*** (0.344)	2.161*** (0.305)	2.739*** (0.387)	2.808*** (0.437)
lambda	−0.928*** (0.312)	−0.755*** (0.279)	−1.495*** (0.354)	−1.702*** (0.401)
technology fields	included			
N	361	362	362	359

Note 1: Standard errors are in parentheses.
Note 2: Level of significance: *** 1%, ** 5%, * 10%.

Table 7 (2) Estimation results of Heckman's two-step model (summary): Effects of ten support programs on firm performance (subjective evaluation)

	out_sale	*out_profit*	*out_tec*	*out_repu*
d_web			+*	+*
d_meeting				+**
d_business	+*	+*		+*
d_finance				+*
d_technology	+*			
d_evaluation	+*			
d_funding	+*			
d_consortium			+**	
d_rdsubsidy	+*	+*	+**	+*
d_incubator				

Note 1: Level of significance: ** 1%, * 5%.

Note 2: Other independent variables are included in the model, but omitted in the table.

Table 8 (1) Estimation results of the negative binominal model:
Effects of ten support programs on firm performance (discrete outcomes)

	network_f	*network_u*	*network_p*	*finance*	*business*	*innovation*
d_web	0.105 (0.240)	0.103 (0.159)	0.301* (0.178)	0.081 (0.398)	−0.222 (0.363)	0.085 (0.176)
d_meeting	0.700** (0.289)	0.121 (0.204)	0.269 (0.268)	0.279 (0.575)	0.106 (0.467)	−0.096 (0.265)
d_business	0.092 (0.2639)	0.382** (0.160)	0.171 (0.223)	0.483 (0.430)	0.769** (0.387)	0.797*** (0.230)
d_finance	0.220 (0.226)	0.021 (0.149)	0.345* (0.180)	0.625* (0.392)	1.034*** (0.316)	0.082 (0.218)
d_technology	0.027 (0.236)	−0.033 (0.165)	−0.095 (0.211)	−0.764 (0.507)	1.014*** (0.382)	−0.052 (0.204)
d_evaluation	0.831*** (0.300)	−0.034 (0.204)	0.070 (0.282)	1.457*** (0.522)	0.061 (0.463)	0.463** (0.208)
d_funding	0.172 (0.365)	0.225 (0.230)	−0.02 (0.337)	−0.253 (0.580)	1.280** (0.585)	0.417* (0.252)
d_consortium	−0.301 (0.196)	−0.042 (0.154)	0.028 (0.164)	−0.418 (0.433)	0.438 (0.356)	0.333* (0.191)
d_rdsubsidy	0.190 (0.205)	0.279* (0.164)	0.008 (0.183)	0.330 (0.471)	0.987*** (0.362)	0.546*** (0.196)
d_incubator	0.190 (0.266)	0.085 (0.165)	−0.04 (0.193)	−0.331 (0.479)	−0.036 (0.466)	−0.229 (0.206)
age	−0.007 (0.007)	0.006 (0.005)	−0.002 (0.006)	−0.005 (0.012)	0.022 (0.014)	0.009 (0.006)
rd_ratio	−0.002 (0.003)	−0.003 (0.003)	0.000 (0.003)	−0.004 (0.007)	−0.008 (0.007)	−0.002 (0.004)
emp	0.001** (0.000)	0.001 (0.001)	0.000 (0.000)	−0.002** (0.001)	−0.004** (0.002)	−0.001** (0.000)
constant	0.149 (0.389)	−0.422* (0.240)	−0.227 (0.330)	−1.601* (0.864)	−2.690*** (0.630)	−0.787** (0.322)
technology fields	included	included	included	included	included	included
N	121	128	123	124	124	135
LL	−227.803	−189.417	−169.417	−88.672	−192.447	−216.664

Note 1: Robust standard errors are in parentheses.
Note 2: Level of significance: *** 1%, ** 5%, * 10%.

Table 8 (2) Estimation results of the negative binominal model (summary):

Effects of ten support programs on firm performance (discrete outcomes)

	network_f	*network_u*	*network_p*	*finance*	*business*	*innovation*
d_web			+*			+*
d_meeting	+**		+*	+*	+**	
d_business		+*			+**	+**
d_finance			+*	+*	+**	
d_technology	+**				+**	+**
d_evaluation	+**	+*		+*	+**	+**
d_funding	+**	+*			+**	+**
d_consortium						+*
d_rdsubsidy					+**	+**
d_incubator					+**	

Note 1: Level of significance: ** 1%, * 5%.

Note 2: Other independent variables are included in the model, but omitted in this table.

Appendix: Examples of national cluster policies in Japan and Europe

Project Name	**Industrial Cluster Project**	**Cutting-edge cluster competition**	**BioRegio**	**Fond Unique Interministériel**	**Finnish Center of Expertise (CoE) Program**	**Vinnväxt**
Country	Japan	Germany	Germany	France	Finland	Sweden
Budget	110 billion yen (2001－2004)	EUR 600 million	EUR 75 million	EUR 1500 million (2006－2008)	EUR 578 million (1999－2006)	75M SEK per year
Period	2001－2005 (first), 2005－2009 (second), 2010－2020 (third)	2007－2016/17	1995－2005	2006－	1994－1998 (first), 1999－2006 (second), 2007－2013 (third)	2003－2005 and at least 10 years onward
Program Initiator	Ministry of Economy, Trade and Industry (METI)	Federal Ministry of Research and Education (BMBF)	Federal Ministry of Research and Education (BMBF)	DGE (General Directorate for Enterprise, Ministry for Economy, Finance and Industry)	Ministry of Interior	Swedish Governmental Agency for Innovation Systems (VINNOVA)
Source of Fund	Ministry of Economy, Trade and Industry (METI)	Federal Ministry of Research and Education (BMBF)	Federal Ministry of Research and Education (BMBF)	Ministry for Economy, Finance and Industry, Ministry of Interior and regional development	Ministry of Interior, Ministry of Trade and Industry etc.	Swedish Governmental Agency for Innovation Systems (VINNOVA)
Number of Selected Regional Clusters	17 (second project period)	5	starting with 26, later focus on 3	71	13	12
Focus on SMEs	Yes	No	Yes	No	Yes	No
Cross Country/Interregional Activity	Yes (from the second period onward)	No	No	No	Yes (from the third period onward)	No
R&D Support	Collaborative R&D/networking	Collaborative R&D to support commercialisation	Application-oriented research	Applied research (The R&D projects must include at least two firms and a laboratory or a research center.)	Collaborative R&D/networking	Very high, this is one of the main focuses of the program.
Selection Process and Program Contents	METI selects 19 regional projects based on comparative advantages and provides support as follows: (1) network formation, (2) R&D support, (3) business start-up support, (4) marketing support, (5) management support, and (6) fostering human resources.	Based on applications or appointments: Regions/Clusters apply for and are selected through a competitive audition process. The program will single out Germany's top cutting-edge clusters in prioritized fields for awards and funding in a competition.	Based on applications or appointments: Regions apply for and are selected through a competitive audition process. Integrated concepts for biotechnology research and transfer of the results in industrial activity.	Based on applications or appointments: Regions/Clusters apply for and are selected through a competitive audition process. The aim is to support applied research for the development of services or products that could enter a market in a short/medium term.	The process is based on submission of proposals (more bottom-up than top down). What the national level offers is long-term basic funding. The centers of expertise launch cooperation projects (public-private) between the research sector, educational institutions, and industry.	Based on applications: Regions should have established cooperation within the Triple Helix. The infrastructure of innovation systems should be built up, i.e., support for new companies, venture capital, and specialized work force, etc.

Source: METI (2005), European Cluster Observatory (http://www.clusterobservatory.eu/index.php?id=1&article=25&nid), Oxford Research (2009).