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*Division of Labor between Innovation Intermediaries for SMEs: Productivity Effects of Interfirm Organizations in Japan**

by Nobuya Fukugawa

Innovation intermediaries are individuals or organizations that help others improve productivity. This study examines how small- and medium-sized enterprises (SMEs) chose intermediaries and how intermediaries affected total factor productivity (TFP) growth of participants through different channels. Estimated switching regression models reveal that cooperative associations improved TFP of participants through cost sharing, such as joint logistics, while voluntary groups improved TFP of participants through knowledge sharing, such as joint R&D. Innovative SMEs appear to have exploited different intermediaries so that the benefit from each intermediary would be complementary to TFP growth. The results suggest the division of labor between intermediaries.

Introduction

Innovation intermediaries are individuals or organizations that help others improve productivity. They connect actors in national, sectoral, and regional innovation systems, thereby indirectly fostering innovations, as well as directly helping actors innovate as external sources of knowledge (Howells 2006; Stankiewicz 1995). According to detailed definitions of innovation intermediaries, as a consultant, they provide clients with solutions to technological problems in R&D. As a broker, they foster market transactions among clients. As a mediator, they foster nonmarket-based, mutually beneficial collaborations among clients. As a resource provider, they secure clients in collaborations access to financial, technological, and physical resources to achieve a collaborative outcome (Howard Partners 2007). Intermediation function is particularly important for innovative activities of small- and medium-sized enterprises (SMEs) that tend to suffer from market and systemic failure. SMEs tend not to retain sufficient business record, tangible assets, and reputation in the business community, which are required to secure financial resources from the capital market. SMEs also are vulnerable to weak appropriation of innovative returns in the product market as they tend not to retain sufficient complementary assets. Innovation intermediaries also deal with systemic failure that makes it difficult for SMEs that tend not to retain sufficient social capital to identify relevant external sources of knowledge, develop ties to potential partners, and exploit the linkages for their innovative activities.

Empirical studies on intermediaries for SMEs focused on public intermediaries, most of which were established as a part of regional innovation policy to promote technology transfer to SMEs.

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They stressed the role of intermediaries as a consultant which provides technological knowledge and solutions to the problems that SMEs encounter. Examples of public intermediaries for SMEs include the Manufacturing Extension Partnership in the United States, the Industrial Research Assistance Program in Canada, the Steinbeis Foundation in Germany, the Federación Española de Entidades de Innovación (Spanish Federation of Innovation and Technology Organizations or FEDIT), Regional Board for Economic Development in Emilia-Romagna of Italy, Technology Innovation Centres in the United Kingdom, TNO in the Netherlands, the Instituto Nacional de Tecnología Industrial in Argentina, and local public technology centers in Japan (Shapira, Youtie, and Kay 2011). Most findings show that public intermediaries acted as sources of knowledge for SMEs and had positive impacts on their productivity growth and innovations (Fukugawa 2016; Jarmin 1999; Ponds, Oort, and Frenken 2010). Another strand of research stresses the importance of the division of labor between public and private intermediaries (Intarakumnerd and Chaoroenporn 2013). They argue that public intermediaries, such as national research institutes, should play an active role in producing public goods that are necessary for the general technological upgrading of firms in the sector while private intermediaries, such as trade associations, should play active roles in creating club goods that can be used among private actors. Furthermore, public intermediaries tend to be important as a consultant and a resource provider while private intermediaries tend to be important as a broker, creating competitive advantage according to needs of users.

Regarding the division of labor between public and private intermediaries for SMEs, there are two types of interfirm organizations, both of which were uniquely developed in Japan: cooperative associations and voluntary groups. Cooperative associations among SMEs in the same industry were established and promoted as a part of industrial policy of the Ministry of International Trade and Industry since 1949. SMEs at the time were deemed vulnerable to the abuse of bargaining power by their larger counterparts in the product market. Therefore, the key aim of the policy was to secure SMEs opportunities for the fair economic activities by bundling SMEs in the same sector to improve their bargaining power in the product market. Cooperative associations made policy loans more accessible for SMEs, thereby mitigating constraints with which an individual SME faced in the capital market. Furthermore, by gathering managerial resources in the same sector at a point to which scale economies prevail, they aimed to improve productivity which was deemed significantly lower than their larger counterparts. According to the aforementioned definitions of intermediaries, SME cooperative associations are considered as policy-based intermediary as a resource provider.

Unlike SME cooperative associations, voluntary groups do not obtain legal entity status that enables them to receive policy loans and tax credit. Among voluntary groups, a cross-industry interaction group (CIG) is an interfirm organization consisted of SMEs from various industries, which aims at information exchange and R&D cooperation (Small- and Medium-Sized Enterprise Agency 1981). CIGs initiate their activities through information exchange among small business owners. After gaining familiarity with each other, some participants go further and exploit other firms' resources through transactions. Finally, when participants find other firms' resources complementary, some of them initiate R&D collaborations, such as joint product development. Thus, CIGs are considered as a private intermediary that acts as a mediator and a broker.

Taking these interfirm organizations as examples of public and private intermediaries for SMEs acting as a broker, mediator, and resource provider, this study aims to unveil the division of labor between different types of intermediaries, thereby filling research gap where intermediaries for SMEs other than public intermediaries as a consultant have been understudied. Specifically, this study identifies different channels through which different intermediaries could improve productivity of SMEs and assesses how these channels affected productivity growth differently, which makes key contributions of this study to the previous literature.

Another strength of this study lies in its empirical approach. This study compares productivity effects between two types of intermediaries. The difficulty in making such evaluation lies in selection bias where the probability of firms' applying for a specific program is significantly correlated with unobservable factors that affect firms' performance, which makes it difficult to extract a genuine program impact. This study employs the firm level data including both participants and nonparticipants in intermediaries, combined with econometric technique of switching regression to estimate genuine productivity effect of intermediaries after controlling for selection bias.

Foreshadowing the key results, a genuine negative impact of SME cooperative associations was detected, which suggests mismanagement of cooperative associations. In contrast, a genuine positive program impact of voluntary groups was confirmed. These intermediaries contributed to productivity growth of SMEs through distinct channels (i.e., cost sharing and knowledge sharing), and innovative SMEs appear to have exploited different types of intermediaries so that the benefit from each intermediary would be complementary, suggesting the division of labor between intermediaries.

The remainder of the paper is organized as follows. The *Interfirm Organizations as Innovation Intermediaries for SMEs* section provides basic information about SME cooperative associations and voluntary groups, particularly CIGs as innovation intermediaries. The *Hypotheses* section discusses the channels through which interfirm organizations improve productivity of participants, on which hypotheses build. The *Method* section describes the econometric model, variables, and data used in empirical analysis. Estimation results are shown in the *Results* section, and their theoretical and practical implications are discussed in the *Discussion* section. The *Conclusion* section summarizes contributions of this study and refers to directions for further research.

Interfirm Organizations as Innovation Intermediaries for SMEs

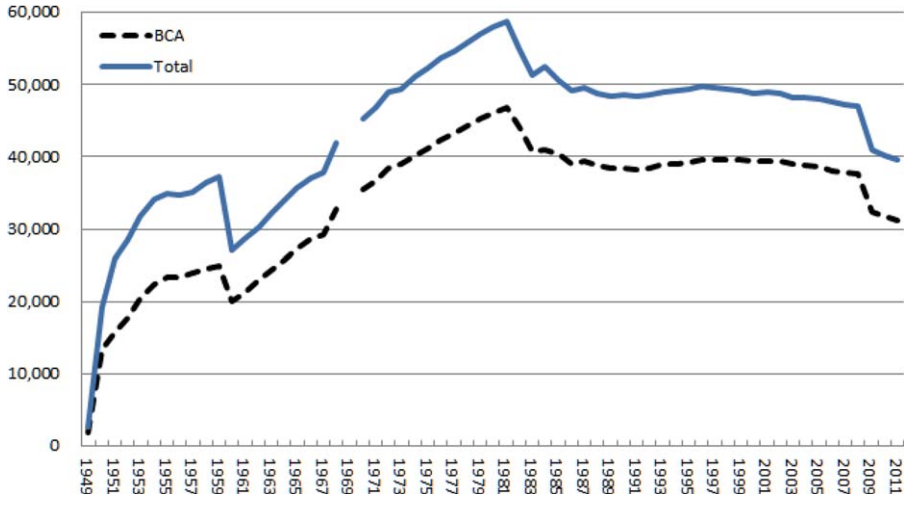
The SME Cooperative Association Law was enacted in 1949.[1] Article 3 of the SME Cooperative Association Law defined four (later six) types of SME cooperative associations, one of which was business cooperative associations (BCAs). Figure 1 shows the number of all types of SME cooperative associations and BCAs in all sectors, respectively. The number of BCAs peaked in 1981, and has since gradually declined, stagnating in the 1990s, and sharply declined after 2008. Approximately, 80 percent of SME cooperative associations are organized as BCAs, which means that examining BCAs is virtually equivalent to assessing industrial policy to promote SME cooperative associations. Therefore, in econometric analysis, this study focuses on BCAs to analyze SME cooperative associations. Among BCAs established in 1980, 21 percent of them were engaged in manufacturing, 34 percent in wholesale and retail, 21 percent in construction, and 9 percent in service. In 2010, the ratio was 14 percent in manufacturing, 12 percent in wholesale and retail, 16 percent in construction, and 25 percent in service [National Federation of Small Business Associations (NFSBA 2011)]. This reflects changes in the industrial structure, such as servicification, during this period.

The SME Cooperative Association Law defined its goal as "to secure opportunities for the fair economic activities and improve the economic position of SMEs" (Article 1). The assumption lying behind the policy was that individual SMEs were vulnerable to the abuse of dominant bargaining position of their larger counterparts, which was why joint activities of SME cooperative associations were exempted from the application of the Anti-Monopoly Act (Article 7).[2] The weak position of SMEs was assumed not only in a product market but also in a capital market. The SME Cooperative

[1]The root of SME cooperative associations in Japan can be traced back to informal cartels among manufacturers and exporters in industries like ceramics and textiles in the late 19th century. They controlled price, prevented low-quality goods from being exported, and enforced sanctions against a participant that broke the cartel. They were gradually institutionalized as cooperative associations by the government before and during WWII. In the occupation era (1945–1951), they were dismantled by the enactment of the Anti-Monopoly Act in 1947 (Aoyama 1999). However, they were restored under the increasingly intense Cold War, reflected in domestic political conflict between the conservative party and the party in opposition. The establishment and promotion of cooperative associations of SMEs was initially put forward by the conservative government, which was seriously concerned about winning the general election of 1947. The conservative government aimed to attract the self-employed and small business owners who used to be a base of the opposition political party by offering them a financial advantage of policy loans and debt guarantee through government-affiliated financial institutes. This symbolizes SME policy as "compensation scheme" for a political crisis that has been established since then (Calder 1988). Although the party in opposition won the general election, this SME policy proposed by the conservative party was inherited by the new government, resulting in the enactment of the SME Cooperative Association Law in 1949.

[2]The number of exempted cartels based on Article 7 was 652 in 1966 at its peak, and then decreased to zero in 1995.

Figure 1
The Number of SME Cooperative Associations: 1949–2011 [Color figure can be viewed at wileyonlinelibrary.com]



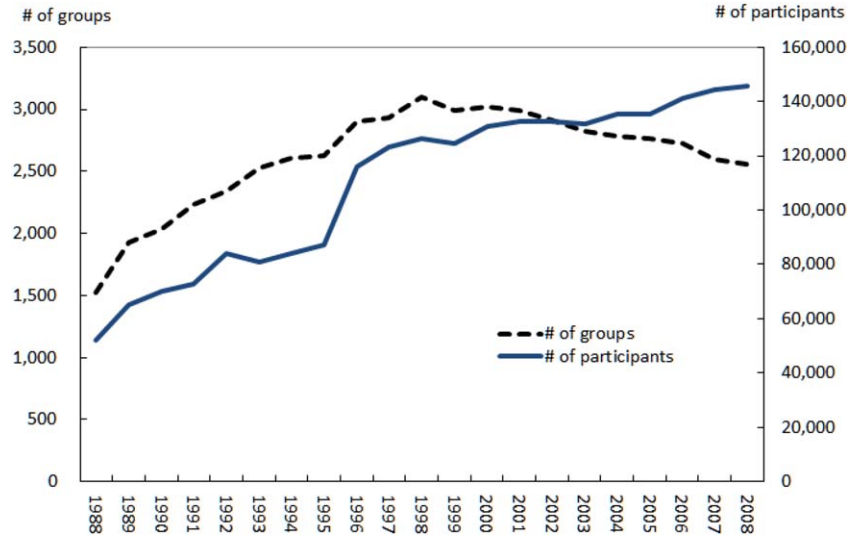
Notes:
1. Author's elaboration based on NFSBA (2000) and NFSBA (2011).
2. Total = business cooperative associations (BCA) + other types of SME cooperative associations.

Association Law designated cooperative associations as receivers of long-term capital from government-affiliated financial institutions as SMEs were considered to have difficulty in raising capital from the commercial banks because of asymmetric information. Another assumption was that SMEs were too small in size and thus inefficient in cost structure. Therefore, cooperative associations were expected to bundle SMEs in the same industry to the point at which economies of scale prevailed. In sum, SME cooperative associations are considered as a policy-based intermediary that helps SMEs improve productivity through scale economies prevailed, enhanced bargaining position in the product market, and mitigated capital constraints. In light of the definitions of intermediaries (Howard Partners 2007), these elements characterize SME cooperative associations as a resource provider that secures participants access to financial, managerial, and technological resources.

Voluntary groups without legal entity status take various forms, and it has been known that cross-industry interaction groups (CIGs), an interfirm organization among SMEs from various industries to promote information exchange and R&D cooperation, are the most notable example (Small- and Medium-Sized Enterprise Agency 1981). Although it is difficult to precisely identify their origin, CIGs are considered to have emerged as a response to a drastic change in business environments: from the high growth era where economies of scale worked best to the low growth era where the promotion of innovation became more important. According to the Japan Small and Medium Enterprise Cooperation (JASMEC 2008), 16 percent of CIGs that exist as of 2008 were initiated before 1980 while 41 percent of them were established between 1988 and 1992. The upsurge in this period was influenced by the enactment of an extraordinary measures law in 1988 which aimed to promote the exploration of a new business frontier by integrating knowledge among SMEs from various industries.[3] Although this policy did not directly aim to promote CIGs, it provoked collaborations among SMEs from various

[3]This enactment had been presaged by the establishment of Clearinghouse for Technology and Market Information by the Small and Medium-sized Enterprise Agency in 1981, which aimed to help small firm managers exchange information about innovations and business opportunities.

Figure 2
The Number of Cross-Industry Interaction Groups and Participants: 1988–2008 [Color figure can be viewed at wileyonlinelibrary.com]



Note: Author's elaboration based on JASMEC (2008).

industries, thereby increasing the necessity of innovation intermediaries like CIGs. Figure 2 shows that the number of CIGs and participants nearly doubled during 1990s. By 2008, there were 2,557 CIGs and 145,421 participants, almost all of which (96 percent) are SMEs. By definition, CIGs include participants from various industries. Ninety-two percent of CIGs answered that at least one of their participants was in the manufacturing sector, followed by the wholesale and retail industry (56 percent) (JASMEC 2008).

CIGs hold regular meetings for information exchange several times in a year, thereby providing participants with opportunities to share information about managerial problems and to identify new business opportunities. After gaining familiarity with each other and sharing information about new business opportunities, some participants go further and exploit others' resources through transactions. Utilizing each other's resources helps participants to realize the competitive advantage of others and to identify potential R&D partners. Finally, when participants find others' resources attractive and complementary, and vice versa, they initiate innovative activities, such as joint product development.[4] The proportion of CIGs that aim information exchange is 89 percent. The ratio is 24 percent for transaction and 34 percent for joint R&D (JASMEC 2008). The structure of CIGs varies according to their purposes. Twenty-two percent of CIGs have fewer than 10 participants while 20 percent of them have more than 50 participants. Smaller CIGs tend to focus on joint R&D. The proportion of CIGs that aim joint R&D is 44 percent for CIGs with less than 10 participants while the ratio is 30 percent for CIGs with more than 50 participants. Conversely, larger CIGs tend to focus on information exchange. The proportion of CIGs for information exchange is 77 percent for CIGs with less than 10 participants while the ratio is 95 percent for CIGs with more than 50 participants. This indicates the consistent relationship between structure and purpose of interfirm organizations in that weak ties and diversified network are conducive to gaining new information on business opportunities whereas strong ties and dense network are better suited for joint innovation. Therefore, CIGs are considered as a

[4]This process of joint innovation has been known among participants as "discovering each other," "exploiting each other," and "exploring together."

voluntarily-formed intermediary that helps SMEs improve productivity through information sharing and knowledge sharing, which eventually leads to joint innovation. In light of the definitions of intermediaries (Howard Partners 2007), these elements characterize CIGs as a mediator and a broker that promotes market-based and nonmarket-based interactions among participants.

Hypotheses

Interfirm organizations are valuable particularly for SMEs that need to harness external resources to augment limited internal resources, thereby improving productivity of participants either through cost sharing or knowledge sharing. Cost sharing in interfirm organizations refers to scale economies resulting from participants' gathering individual production factors. Examples include exploitative collaborations in distribution (March 1991). Engaging in such joint activities enables SMEs to spread fixed cost and improves bargaining position in the product market (e.g., procurement). As well as cost reduction, interfirm organizations enable participants to initiate business projects that otherwise would have been impossible, which eventually increases their outputs. These attributes of interfirm organizations aiming at cost sharing should have a positive implication on productivity growth of participants. Interfirm organizations for cost sharing are typically formed by a large number of organizations that are homogenous in terms of technological and commercial capabilities (Irwin and Klenow 1996) as they need to have the similar cost structure to spread the fixed costs. This suggests that SMEs in the same industry that retain less internal resources would find cost sharing-oriented collaborations more significant. In light of the aim and nature of SME cooperative associations described in the previous section, it can be said that cooperative associations are a form of exploitative interfirm organizations that aim to improve productivity of participants through cost sharing. Based on these discussions, it is hypothesized that

H1: Cooperative associations improve productivity of participants through joint activities aiming at cost sharing.

Knowledge sharing in interfirm organizations refers to participants' having opportunities to learn complementary knowledge from other participants, thereby improving the quality of participants' knowledge resources (Anand and Khanna 2000). As knowledge sharing is more feasible in the upstream rather than downstream of R&D, knowledge resources of participants that are improved through the acquisition of complementary knowledge could have more general implications on productivity growth. In other words, improved knowledge resources will be productive not only in the ongoing joint R&D project, but also in future internal R&D projects (Arvanitis, Sydow, and Woerter 2008). Thus, explorative collaborations for knowledge sharing could contribute to improving R&D productivity of the participant in the long run, even though the ongoing collaboration fails to yield visible outcomes, such as new products (Fukugawa 2013). Such explorative collaborations are particularly effective when participants are heterogeneous in terms of technological and commercial capabilities (Mowery, Oxley, and Silverman 1998) as they need to have a certain level of diversity in knowledge that allows mutual learning among participants (Han, Han, and Brass 2014). This suggests that SMEs that face difficulty in gaining access to external sources of knowledge would find voluntary groups particularly important as explorative interfirm organizations that facilitate knowledge sharing among SMEs from various industries. In light of these discussions, it is hypothesized that

H2a: Voluntary groups improve productivity of participants through joint activities aiming at knowledge sharing.

When participants compete in the same product market (in that sense homogenous), there would be concerns about an asymmetric flow of knowledge (Katz 1986). Participants may want to garner knowledge from other firms as much as possible while concealing their own. Indeed, such opportunistic behavior could decrease participants' efforts and deteriorate productivity of R&D collaborations (Dickson, Weaver, and Hoy 2006). Therefore, it is hypothesized that

H2b: Cooperative associations do not improve productivity of participants through joint activities aiming at knowledge sharing.

SMEs may participate in different types of interfirm organizations simultaneously so that

benefit from each interfirm organization will be complementary. According to JASMEC (2008), 81 percent of the voluntary groups are organized as voluntary groups that do not obtain legal entity status. However, 13 percent of the voluntary groups obtain legal entity status as SME cooperative associations, allowing them to receive policy loans and tax credit. Thirty-eight percent of the voluntary groups that were formed as SME cooperative associations aimed to develop new products within the group while the ratio was 15 percent for voluntary groups that were formed as voluntary groups (Fukugawa 2006). Furthermore, among 387 voluntary groups that initiated joint product development, 63 percent of the voluntary groups that were formed as SME cooperative associations received public subsidies for their joint product development while the ratio was 29 percent for voluntary groups that were formed as voluntary groups. Such voluntary groups tend to be smaller in size. The ratio of voluntary groups that are formed as SME cooperative associations is 26 percent for voluntary groups with less than 10 participants while the ratio is 9 percent for voluntary groups with more than 50 participants. These facts suggest that innovative SMEs participating in voluntary groups may form cooperative associations to enable the voluntary group to obtain legal entity status to receive public financial support for joint product development under the voluntary group. Therefore, it is hypothesized that

H3: Innovative SMEs participating in voluntary groups exploit cooperative associations to establish access to public financial support for joint R&D project under the voluntary group, making productivity effect of cooperative associations through knowledge sharing positive.

Method

Model

The participation in a specific interfirm organization is not a randomly allocated variable but a choice variable of the firm, suggesting that care be taken to control for selection bias. If unobservable characteristics of firms that affect the probability of firms' participation in a specific interfirm organization significantly correlate with performance, other things being equal, then ordinary least square estimation would give a biased picture on the relationship between the participation in interfirm organization and performance. In order to control for selection bias, this study employs a switching regression model (Maddala 1983) described as follows.[5]

$$P^* = \gamma Z + v \tag{1}$$

$$\begin{cases} S=1 & \text{if} \quad P^* > 0 \\ S=0 & \text{if} \quad P^* \leq 0 \end{cases} \tag{2}$$

$$TFPG_1 = \beta_1 X_1 + u_1 \quad \text{if} \quad S=1 \tag{3}$$

$$TFPG_0 = \beta_0 X_0 + u_0 \quad \text{if} \quad S=0 \tag{4}$$

where *TFPG* denotes total factor productivity (TFP) growth of SMEs, *X* denotes the determinants of TFP growth including the participation in a specific joint activity (e.g., joint R&D),[6,7] *u* denotes unobservable factors influential in TFP growth, *P** denotes a latent variable representing the propensity of SMEs to participate in a specific interfirm organization (e.g., cooperative associations), *Z* denotes the determinants of SMEs' decision on whether to participate in the specific interfirm organization, and *v* denotes unobservable factors that affect the probability of SMEs' participating in the specific interfirm organization. Suffixes 1 and 0 represent a participant and nonparticipant in the interfirm

[5]Estimation is based on the full-information maximum likelihood method using the "movestay" command in Stata (Lokshin and Sajaia 2004).

[6]Coefficients of joint activities are expected to precisely capture the impact of a specific joint activity under a specific interfirm organization. However, it is possible that the impact of the same joint activity that the firm participated in another interfirm organization can be mixed. This is because the dataset employed in this study was compiled not at the project level but at the firm level. It is not possible from the dataset to rigorously discern the former impact from the latter. Therefore, care should be taken in interpreting the coefficients of joint activities.

[7]Hall, Mairesse, and Mohnen (2010) argues that it is preferable to regress the TFP growth on the change of *X* in order to control for unobserved time-invariant heterogeneity among firms. As I will describe in this section, the survey data used in this study had collected information on interfirm organizations only in 1992 and the 1995 survey did not collect the information, which made it impossible for this study to adopt this approach.

organization, respectively. Z includes exclusion constraint that is required as conditions for identification, which will be discussed later. A firm is a participant in a specific interfirm organization if P^* exceeds zero, and a nonparticipant otherwise. Equations (3) and (4) are henceforth referred to as the main equations that switch according to equation (1) which is referred to as the regime equation. After the estimation, the following can be calculated:

$$E(TFPG_1|x_1)=x_1\beta_1 \quad (5)$$

$$E(TFPG_0|x_0)=x_0\beta_0 \quad (6)$$

$$yc_{11}=E(TFPG_1|S=1,x_1)=\beta_1 x_1+\sigma_1\rho_1\frac{\phi(\gamma Z)}{\Phi(\gamma Z)} \quad (7)$$

$$yc_{01}=E(TFPG_0|S=1,x_1)=\beta_0 x_1+\sigma_0\rho_0\frac{\phi(\gamma Z)}{\Phi(\gamma Z)} \quad (8)$$

$$yc_{00}=E(TFPG_0|S=0,x_0)=\beta_0 x_0-\sigma_0\rho_0\frac{\phi(\gamma Z)}{1-\Phi(\gamma Z)} \quad (9)$$

$$yc_{10}=E(TFPG_1|S=0,x_0)=\beta_1 x_0-\sigma_1\rho_1\frac{\phi(\gamma Z)}{1-\Phi(\gamma Z)} \quad (10)$$

Equations (7) and (9) represent actual cases while equations (8) and (10) represent counterfactual cases where dependent variables are TFP growth of participants in the interfirm organization in the case that the SME had chose to stay out of the interfirm organization, and TFP growth of non-participants in the interfirm organization in the case that the SME had participated in the interfirm organization, respectively. $x\beta_1$ denotes the unconditional expectation of TFP growth of participants in the specific interfirm organization. $x\beta_0$ denotes the unconditional expectation of TFP growth of nonparticipants in the specific interfirm organization. yc_{11} denotes the conditional expectation of TFP growth of participants in the specific interfirm organization. yc_{00} denotes the conditional expectation of TFP growth of nonparticipants in the specific interfirm organization. yc_{01} denotes the conditional expectation of TFP growth of participants in the specific interfirm organization outside the interfirm organization. yc_{10} denotes the conditional expectation of TFP growth of nonparticipants in the specific interfirm organization in the interfirm organization. σ denotes the standard errors of u. ρ denotes the correlation coefficient between v and u. Φ denotes a cumulative normal distribution function while φ denotes a normal density distribution function.

If ρ_1 is positive, participants in the interfirm organization have above-average TFP growth, and if nonparticipants had participated in the interfirm organization, they would have shown lower TFP growth than that of participants in the interfirm organization. If ρ_1 is negative, participants in the interfirm organization have below-average TFP growth, and if nonparticipants had participated in the interfirm organization, they would have shown higher TFP growth than that of participants in the interfirm organization. Conversely, if ρ_0 is positive, nonparticipants in the interfirm organization have below-average TFP growth, and if participants had stayed out of the interfirm organization, they would have shown higher TFP growth than that of nonparticipants in the interfirm organization. If ρ_0 is negative, nonparticipants in the interfirm organization have above-average TFP growth, and if participants had stayed out of the interfirm organization, they would have shown lower TFP growth than that of nonparticipants in the interfirm organization.

Dependent Variables

Dependent variables of the regime equation are *CA* and *VG* which are binary dummies taking a value of one if the firm participates in either a cooperative association or voluntary group in 1992. It is assumed that the impact of interfirm organizations becomes visible immediately as it is not possible for the dataset to identify the year SMEs participated in interfirm organizations. Thus, a dependent variable of the main equation is annual average growth rate of total factor productivity of SMEs between 1992 and 1995 (*TFPG*). *TFPG* was measured by using the Cobb–Douglas production function, $Y=L^{\alpha}K^{1-\alpha}$ where Y denotes value added, L denotes labor, K denotes capital, and α denotes labor share, based on the assumption of a competitive market. To deflate capital and value added, the net fixed capital formation index and the GDP deflator in the System of National Account by the Economic and Social Research Institute were used. Any effect stemming from joint activities in interfirm organizations would result in the output growth of participants that cannot be explained by the growth of labor and capital. Thus, if joint activities in interfirm organizations contribute to improving productivity of participants, even after

controlling for unobservable firm-specific factors influencing productivity growth, there should be a positive correlation between *TFPG* and joint activities in interfirm organizations.

Independent Variables

As the variance in the size of tangible assets which SMEs retain is relatively small, intangible assets are considered to play a critical role in TFP growth of SMEs. Intangible assets can be decomposed into innovative property (e.g., intellectual property rights), computerized information (e.g., software), and economic competencies (e.g., brand) (Corrado, Hulten, and Sichel 2006). Proxy variables for innovative property are R&D intensity which is R&D expenditure divided by value added (*R&D*), the number of licensing-in agreements (*Licensing-in*), and the number of licensing-out agreements (*Licensing-out*). A proxy variable for computerized information is a binary dummy representing the presence of the investment into information communication technology (*ICT*). This variable takes a value of one when SMEs constantly use computer networks in either section of daily business (e.g., production, distribution, and procurement). Proxy variables for economic competencies are export-sales ratio (*Export*) and advertisement-sales ratio (*Advertising*). In addition to brand loyalty and global nature, this study considers two types of relational assets as another important economic competency of the firms: contract-based and ownership-based relational assets. Analyzing keiretsu (supply chain networks uniquely developed in Japan) in the electrical machinery industry, Suzuki (1993) finds that subcontractors receive knowledge spillover from a core firm, resulting in cost reduction. Urata and Kawai (2002) reports that subcontracting is positively associated with TFP growth of SMEs presumably because of technical assistance from parent firms, and that such a positive impact is salient among smaller subcontractors. Furthermore, examining the chemical industry, Nakamura (1991) provides evidence of technology transfer from parent firms to subsidiaries, resulting in higher profitability and sales growth of subsidiaries. In light of these findings, this study introduces a subsidiary dummy (*Subsidiary*) and a subcontractor dummy (*Subcontractor*) to represent ownership-based and contract-based relational assets, respectively. Each of them is expected to positively correlate with TFP growth of SMEs for the abovementioned reasons.

Intangible assets are predicted to exert positive impacts on TFP growth (Borgo et al. 2013; Miyagawa and Hisa 2013), but would have different effects on the probability of SMEs' participating in interfirm organizations. Innovative property variables capture absorptive capacity to identify, evaluate, assimilate, and exploit external sources of knowledge (Cohen and Levinthal 1990). Furthermore, SMEs with greater innovative property variables would find innovative networks significant for their survival and growth as they would seek new opportunities and diverse information for radical innovations. Thus, innovative property variables represent not only a "qualification" to learn efficiently from external sources of knowledge, but also the "necessity" to acquire complementary knowledge that has a long-term impact on innovation and productivity. Voluntary groups comprising SMEs from various sectors are suitable for the identification of new opportunities and acquisition of diverse and complementary knowledge for innovation while it is hard to extract such benefits from cost-sharing-oriented networks comprising SMEs from the same industry. Thus, innovative property variables are predicted to exert positive effects on the participation in voluntary groups but not in cooperative associations.

Next, SMEs that aim to survive competition in a global market and differentiate themselves from others in the market are predicted to collaborate on R&D with others as they would seek to introduce new-to-the-world innovations and to develop products that are better suited for a local market in foreign countries. Such network characteristics are relevant for knowledge-sharing-oriented interfirm organizations but not for cost-sharing-oriented interfirm organizations. Thus, economic competency variables are predicted to exert positive effects on the participation in voluntary groups but not in cooperative associations.

Last, subsidiaries may find policy loans available at cooperative associations unnecessary as they can resort to financial support from a parent firm when they need bridge loans. Thus, a dummy variable *Subsidiary* is expected to negatively correlate with the probability of participation in cooperative associations. Conversely, subsidiaries may find voluntary groups beneficial because of the diverse sources of knowledge which may not be offered by a parent

firm. Thus, the variable is predicted to positively correlate with the probability of participation in voluntary groups. As shown above, subcontractors are likely to be able to extract some benefits, such as technical assistance from a core firm, from supply chain networks, which may make them consider other types of interfirm organizations for innovation beneficial as well. Therefore, a binary dummy *Subcontractor* is expected to positively correlate with the probability of participation in voluntary groups. Meanwhile, subcontractors tend to exhibit lower profitability in return for risk sharing by a parent firm, which results in more stable profitability (Asanuma and Kikutani 1992; Okamuro 2001). This may make policy loans available through cooperative associations attractive for subcontractors. Therefore, this variable is predicted to positively correlate with the probability of participation in cooperative associations.

Identification Strategy

This study employs two variables as exclusion constraint for identification, which affect the decision whether to participate in an interfirm organization but are not influential in TFP growth, and thus included only in the regime equation. First, the importance of access to policy loans would be salient in industries where extensive investment into physical assets is critical. Thus, the ratio of tangible assets to total assets (*Tangible assets*) is predicted to positively correlate with the probability of participation in cooperative associations. Conversely, firms with rich complementary assets, such as production facilities, tend to find joint R&D unnecessary and go it alone (Bayona, Garcia-Marco, and Huerta 2001). Therefore, this variable is considered to negatively correlate with the probability of participation in voluntary groups. Unlike intangible assets, physical assets are not associated with innovativeness of SMEs, and thus considered to act as an exclusion restriction. Second, high transportation costs may induce SMEs to participate in cooperative associations for cost sharing. Thus, the ratio of transportation cost to sales (*Logistics*) is predicted to positively correlate with the probability of participation in cooperative associations. SMEs with a problem in cost management may want to participate in voluntary groups for knowledge sharing. Therefore, this variable is considered to positively correlate with the probability of participation in voluntary groups. The ratio of transportation cost to sales may affect the level of profitability but not necessarily affect TFP growth as the productivity growth measured by this study is the real term concept. Thus, this variable is considered to act as an exclusion restriction. Sargan's (1958) test of over-identifying restrictions fails to reject the null hypothesis that all the excluded variables are uncorrelated with the error term. Thus, it can be said these variables are correctly excluded from the main equation.

Control Variables

The years since the establishment (*Firm age*) is expected to negatively correlate with the probability of participation in interfirm organizations. This is because younger firms would retain less internal resources and be more motivated to participate in interfirm organizations to augment internal resources. Regarding cooperative associations, young firms which are yet to establish legitimacy in the business community would be motivated to participate in cooperative associations to improve reputation in the business community. Another control variable is firm size as measured by log of the number of employees (*Firm size*). Two-digit industry dummies are included in the regression model to control for industry fixed effects.

Data

This study collected information on financial data of SMEs and interfirm organizations among SMEs from the Basic Survey of Business Activities by the Ministry of International Trade and Industry. This survey covered establishments with 50 employees or more, or firms with capitalization of 30 million yen or more in the mining, manufacturing, wholesale, retail, and restaurants sector. This survey was tentatively initiated in 1992 and annually conducted after 1995. The 1992 survey had collected information on interfirm organizations including cooperative associations, and the 1995 (and after) survey did not collect the information. Therefore, it is impossible for this study to establish panel data nor to employ the recent data on interfirm organizations for SMEs. The sectoral distribution of 24,345 observations in the 1992 survey is 56.2 percent in manufacturing, 41.4 percent in wholesale, retail, and restaurants, and 1.3 percent in mining. This study used the data of SMEs in the manufacturing sector. TFP growth of SMEs was measured by the geometric average of TFP level in 1992 and that in 1995. Independent variables were generated from the 1992 survey. Thus, this study assumes

that productivity effects of interfirm organizations become visible within 3 years.

In order to identify SMEs, this study employs the official definition of SMEs provided by the Small and Medium-sized Enterprise Basic Law. In the manufacturing industry, firms with 300 employees or less, *or* firms with a capitalization of 300 million yen or less are defined as SMEs. It should be noted that firms with more than 300 employees (the maximum value is 4,794) appear in the sample because the SME Basic Law requires SMEs to satisfy a requirement for *either* the amount of capital *or* the number of employees.[8] The official definition established in 1963 was altered due to the amendment of the SME Basic Law in 1999. As this study used the data of the pre-reform period, the previous definition was employed. As described previously, this survey focused on firms with more than or equal to 50 employees, suggesting that care be taken in interpreting the results as startups were excluded from the data. The number of observations is 8,980. Appendix Table 1 provides definitions and descriptive statistics of variables. Appendix Table 2 shows correlation matrix.

Results

Estimation results are shown in Table 1. Regarding Panel C of Table 1, the subsample consists of innovative SMEs participating in voluntary groups. Innovative SMEs are defined as SMEs with above-average R&D intensity, which is 2.3 percent as shown in Appendix Table 1. The null hypothesis of joint independence of the main and regime equations was rejected at the one percent level of statistical significance in all the regression models, which suggests that selection bias needs to be corrected.

Among participants in cooperative associations, only joint logistics has a positive impact on TFP growth, which means that cooperative associations help participants share the cost of transportation. However, such a positive impact cannot be observed in other types of joint activities related to cost sharing, which lends partial support to H1. Among participants in voluntary groups, joint R&D has a positive impact on TFP growth, which means that voluntary groups help participants share knowledge and promote innovation. Such a positive effect cannot be observed for participants in cooperative associations and SMEs that stay out of voluntary groups. Therefore, both H2a and H2b are supported. Furthermore, SMEs that stay out of cooperative associations improve TFP by performing joint R&D, which means that joint R&D through interfirm networks other than cooperative associations help SMEs improve productivity through knowledge sharing. These results highlight that cooperative associations are interfirm organizations not for knowledge sharing but for cost sharing. Panel C of Table 1 shows a positive impact of cooperative associations on TFP growth through joint R&D when innovative SMEs participate in voluntary groups and form a cooperative association to obtain legal entity status. Therefore, H3 is supported, suggesting that it is beneficial to encourage SMEs performing joint R&D in voluntary groups to form SME cooperative associations to have their projects financed by public fund. This issue will be further discussed in the next section. It should be noted that such division of labor between innovation intermediaries is relevant only for innovative SMEs. Unreported results show that H3 does not hold for less innovative SMEs.

The rate of return to R&D (Griliches 1980), represented as coefficients of R&D intensity, is statistically not different from zero for participants in cooperative associations while it is 25.2 percent for participants in voluntary groups. Such a great variation in the rate of return to R&D between the participants may have resulted from the characteristics of intermediaries. As I have mentioned previously, voluntary groups like CIGs help participants identify new business opportunities through information exchange, followed by joint product development by some of the participants. This may have enabled participants in voluntary groups to achieve commercial success not only in joint R&D, but also in own innovative activities, which led to higher rate of return to R&D. Knowledge sharing among participants in voluntary groups may have improved the quality of researchers of participants, which is conducive to the improvement in R&D productivity. The rate of return to R&D is 10.7 percent for nonparticipants in cooperative associations, which indicates that cooperative associations do not have such positive impacts on R&D productivity

[8]The ninety-ninth percentile of the number of employees ranges from 719 to 4794. There are 33 firms juristically defined as SMEs that have more than 1,000 employees.

Table 1
Estimated Switching Regression Models

	Panel A			Panel B			Panel C		
	Main: $TFPG_0$			Main: $TFPG_0$			Main: $TFPG_0$		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
j_rd	0.016	0.008	*	0.007	0.010		0.024	0.014	†
j_distribution	0.007	0.020		0.002	0.014		−0.024	0.041	
j_storage	−0.019	0.030		−0.003	0.021		−0.053	0.054	
j_logistics	−0.005	0.024		0.016	0.021		−0.015	0.062	
R&D	0.107	0.034	**	−0.060	0.061		0.116	0.051	*
Licensing-out	−0.001	0.008		−0.025	0.012	*	0.001	0.010	
Licensing-in	−0.003	0.003		−0.008	0.004	†	−0.005	0.006	
ICT	0.008	0.005		−0.025	0.006	**	0.017	0.014	
Advertising	0.758	0.154	**	0.438	0.212	*	0.953	0.373	*
Export	−0.716	0.559		0.017	0.807		−2.203	1.108	*
Subsidiary	0.002	0.005		0.010	0.007		−0.012	0.014	
Subcontractor	0.003	0.005		−0.015	0.006	*	0.018	0.014	
Firm size	0.005	0.004		0.006	0.005		0.003	0.011	
Firm age	−0.012	0.005	**	−0.041	0.006	**	−0.006	0.013	
constant	0.014	0.023		−0.029	0.032		−0.003	0.066	
	Main: $TFPG_1$			Main: $TFPG_1$			Main: $TFPG_1$		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
j_rd	0.009	0.009		0.016	0.007	*	0.050	0.017	**
j_distribution	0.006	0.012		0.000	0.010		−0.034	0.030	
j_storage	−0.022	0.022		0.001	0.012		−0.027	0.049	
j_logistics	0.029	0.016	†	0.010	0.017		0.021	0.040	
R&D	−0.103	0.069		0.252	0.036	**	0.356	0.118	**
Licensing-out	−0.009	0.009		0.002	0.007		−0.016	0.016	
Licensing-in	0.001	0.004		0.001	0.003		0.018	0.013	
ICT	0.026	0.007	**	0.015	0.005	**	0.002	0.022	
Advertising	−0.052	0.257		0.662	0.186	**	0.289	0.465	
Export	−1.948	0.908	*	−1.503	0.628	*	−0.085	2.162	
Subsidiary	−0.034	0.008	**	0.018	0.006	**	0.022	0.024	
Subcontractor	0.007	0.006		0.011	0.005	*	−0.053	0.018	**
Firm size	−0.002	0.005		0.006	0.004		−0.032	0.013	*
Firm age	0.013	0.008	†	−0.004	0.005		−0.056	0.023	*
constant	−0.211	0.038	**	−0.155	0.028	**	0.463	0.111	**
	Regime: *CA*			Regime: *VG*			Regime: *CA*		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
R&D	−1.207	0.301	**	2.204	0.263	**	−1.491	0.523	**
Licensing-out	0.032	0.046		0.053	0.049		−0.034	0.072	
Licensing-in	0.006	0.019		0.032	0.019	†	−0.077	0.049	
ICT	0.312	0.032	**	0.174	0.029	**	0.342	0.099	**

Table 1
Continued

	Regime: *CA*			Regime: *VG*			Regime: *CA*		
	Coef.	**S.E.**	**Sig.**	**Coef.**	**S.E.**	**Sig.**	**Coef.**	**S.E.**	**Sig.**
Advertising	0.447	1.134		−0.093	1.058		2.675	2.386	
Export	−4.895	4.257		0.961	3.794		−15.027	9.321	
Subsidiary	−0.461	0.036	**	0.008	0.032		−0.481	0.103	**
Subcontractor	0.138	0.031	**	0.115	0.029	**	0.213	0.089	*
Firm size	−0.069	0.025	**	0.070	0.023	**	0.074	0.069	
Firm age	0.327	0.034	**	0.122	0.029	**	0.317	0.102	**
Tangible	−0.022	0.078		−0.213	0.067	**	0.003	0.231	
Logistics	−1.195	0.453	**	0.719	0.381	†	0.170	1.292	
Constant	−1.417	0.267	**	−0.788	0.152	**	−1.595	0.581	**
rho0	0.520	0.036	**	−0.766	0.018	**	0.650	0.065	**
rho1	0.583	0.042	**	0.636	0.031	**	−0.805	0.057	**

[a]Panel A ($N = 8{,}980$) shows estimated switching regression models according to the participation in cooperative associations. Panel B ($N = 8{,}980$) shows estimated switching regression models according to the participation in voluntary groups. Panel C ($N = 1{,}331$) shows estimated switching regression models for the subsample of innovative SMEs participating in voluntary groups according to the participation in cooperative associations.
[b]Innovative SMEs mean SMEs with above-average R&D intensity.
[c]The level of statistical significance: $^{**}p < .01$; $^{*}p < .05$; $^{\dagger}p < .1$.
[d]*rho0* and *rho1* denote correlation coefficients between *u0* and *v* and between *u1* and *v*, respectively.

of participants. Regarding Panel C of Table 1, the rate of return to R&D becomes significantly positive. This suggests the possibility that innovative SMEs participating in voluntary groups that form cooperative associations to finance their innovative activities are exposed to greater external sources of knowledge that make internal knowledge resources more productive, which is not possible for participants in cooperative associations that exclusively aim at cost sharing.

As Panel B of Table 1 shows, licensing exerts no effect on TFP growth of participants in voluntary groups. This gives contrast to the result of R&D investment, which indicates a high rate of return to R&D. This suggests that knowledge sharing in interfirm organizations promotes transfer of tacit knowledge by R&D investment while codified knowledge measured by patents (both introduced and transferred) does not affect TFP growth of participants in voluntary groups. Investment into ICT improves TFP of participants in both cooperative associations and voluntary groups. It is surprising to find negative effects of export on TFP growth of participants in both types of interfirm organization. Advertisement has a positive impact on TFP growth of participants in voluntary groups but not in cooperative associations. Subcontracting exerts positive effects on TFP growth of participants in voluntary groups. This is consistent with previous findings that subcontracting promotes knowledge spillover from a core firm to subcontractors in the form of technical assistance to reduce costs and improve quality of intermediate goods (Suzuki 1993; Urata and Kawai 2002).[9] Another interesting finding from Panel C of Table 1 is that subcontracting is

[9]Belderbos et al. (2013) shows that positive impacts of subcontracting demonstrated by this dataset (1992–1995) would have disappeared in 2000s because R&D-intensive core firms had replaced domestic subcontracting networks with global supply chain networks and foreign direct investments, resulting in a significant decrease in geographical spillover to SMEs in major industrial clusters.

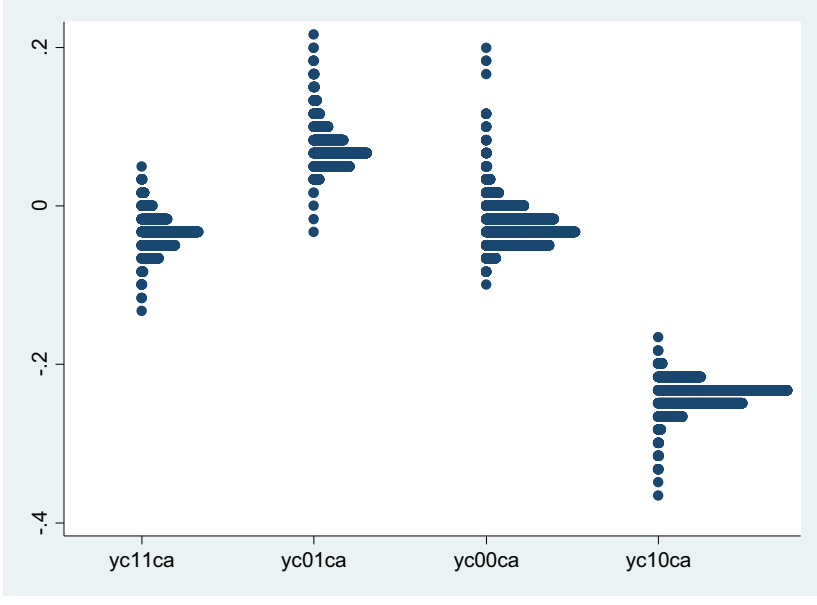
detrimental to innovative SMEs. This is also consistent with previous finding that, as subcontractors accumulate technological capabilities, they tend to require less risk sharing by a core firm and in return pursue higher profitability through innovation (Asanuma and Kikutani 1992). Subsidiaries exhibit positive effects on TFP growth of participants in voluntary groups while the impact is negative for participants in cooperative associations.

Regarding determinants of participation in interfirm organizations, R&D intensity positively correlates with the probability of SMEs' participating in voluntary groups while it is negatively associated with that of SMEs' participating in cooperative associations. Licensing-out does not affect the probability of participation in both types of interfirm organization. Licensing-in is positively correlated with the probability of SMEs' participating in voluntary groups but not in cooperative associations. The results are consistent with the prediction that innovative property variables would exert positive effects on the participation in voluntary groups aiming at knowledge sharing but not in cooperative associations aiming at cost sharing. There appears two ways for innovative property variables to exert positive impacts. On the one hand, innovative property variables represent a "qualification" to learn efficiently from external sources of knowledge. On the other hand, they represent the "necessity" to acquire new knowledge which is complementary to innovative activities and likely to be available from networks comprising diverse SMEs. Voluntary groups appear to have offered SMEs opportunities to tap into such knowledge networks. A computerized information variable shows positive effects on the participation in both types of interfirm organization. Economic competency measured by export and advertisement does not affect the probability of SMEs' participating in either type of interfirm organization. Another economic competency variable representing relational assets shows the results in accordance with the predictions. Subcontractors tend to participate in both types of interfirm organization while subsidiaries are less likely to participate in cooperative associations. Firm size negatively correlates with the probability of SMEs' participating in cooperative associations while it positively correlates with that of SMEs' participating in voluntary groups. Older firms are more likely to participate in both types of interfirm organization. Tangible assets negatively correlate with the participation in voluntary groups while it does not affect that in cooperative associations. The ratio of transportation cost to sales is negatively correlated with the probability of SMEs' participating in cooperative associations, which is contrary to the prediction. This variable is positively correlated with the probability of participation in voluntary groups.

Figure 3 shows the distribution of TFP growth of SMEs under or without business cooperative associations. As indicated in Panel A of Table 1, ρ_1 is significantly positive. This means that if nonparticipants in cooperative associations had participated in cooperative associations, they would have achieved lower TFP growth ($yc_{10} = -0.238$) than participants in cooperative associations ($yc_{11} = -0.034$). Panel A of Table 1 shows that ρ_0 is significantly positive. This means that if participants in cooperative associations had chosen to stay out of cooperative association, they would have achieved higher TFP growth ($yc_{01} = 0.071$) than that of nonparticipants in cooperative associations ($yc_{00} = -0.025$). Thus, it can be said that participants in cooperative associations would have above-average TFP growth whether they are under or without cooperative associations. In other words, participants in cooperative associations have an "absolute advantage." The impact of cooperative associations on TFP growth of SMEs that actually chose to participate in cooperative associations is -0.105 ($=yc_{11}$-yc_{01}), which indicates a negative impact of cooperative associations on TFP growth. The impact of cooperative associations on TFP growth of SMEs that actually chose to stay out of cooperative associations is -0.213 ($=yc_{10}$-yc_{00}), which implies that SMEs that actually chose to stay out of cooperative associations made a good choice.

Figure 4 shows the distribution of TFP growth of SMEs under or without voluntary groups. As indicated in Panel B of Table 1, ρ_1 is significantly positive. This means that if nonparticipants in voluntary groups had participated in voluntary groups, they would have achieved lower TFP growth ($yc_{10} = -0.206$) than participants in voluntary groups ($yc_{11} = -0.031$). Panel B of Table 1 shows that ρ_0 is significantly negative. This means that if participants in voluntary groups had chosen to stay out of voluntary groups, they would have achieved lower TFP growth ($yc_{01} = -0.267$) than that of nonparticipants in voluntary groups

Figure 3
TFP Growth of Participants and Nonparticipants in Cooperative Associations [Color figure can be viewed at wileyonlinelibrary.com]

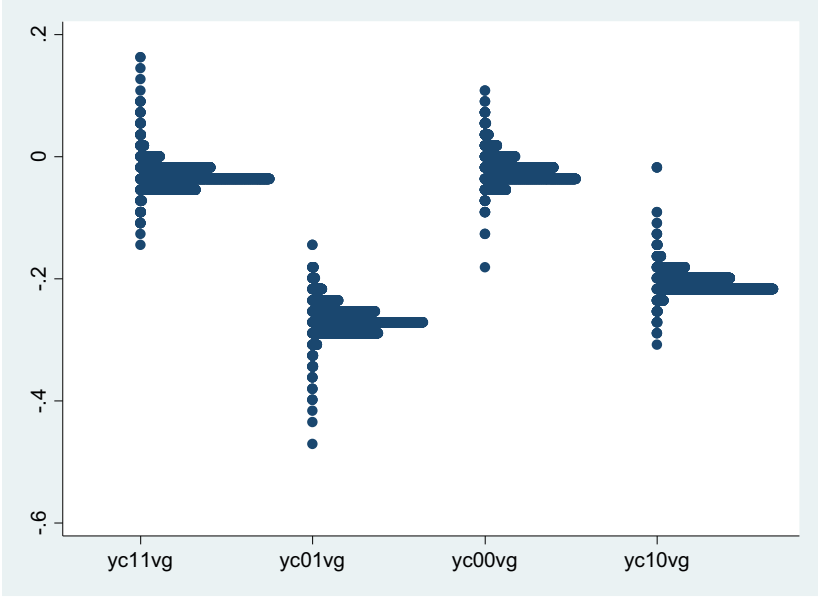


Notes:
1. *yc11ca*: the expected value of $TFPG_1$ conditional on the dependent variable being observed.
2. *yc01vg:* the expected value of $TFPG_1$ conditional on the dependent variable not being observed.
3. *yc00ca*: the expected value of $TFPG_0$ conditional on the dependent variable being observed.
4. *yc10vg*: the expected value of $TFPG_0$ conditional on the dependent variable not being observed.

($yc_{00} = -0.023$). Thus, it can be said that both participants and nonparticipants in voluntary groups better off according to their relative advantage. In other words, both of them are capturing their "comparative advantage." The impact of voluntary groups on TFP growth of SMEs that actually chose to participate in voluntary groups is 0.236 ($=yc_{11}$-yc_{01}), which indicates a positive impact of voluntary groups on TFP growth. The impact of voluntary groups on TFP growth of SMEs that actually chose to stay out of voluntary groups is −0.183 ($=yc_{10}$-yc_{00}), which implies that SMEs that actually chose to stay out of voluntary groups made a good choice.

In order to test the sensitivity of the results obtained from the abovementioned analysis, I used labor productivity growth as an alternative performance measurement. The results are reported in Appendix Table 3. The key findings were unaffected by this change. As labor productivity growth can be decomposed into TFP growth and capital deepening, the result suggests that contributions of capital deepening in labor productivity growth may have been relatively small. This presumably stems from the fact that capital deepening, such as an increase in ICT investment, has been notably inactive among SMEs since the 1990s (Fukao 2013), which constituted one of the major causes of secular stagnation in Japan. Next, a correlation matrix in Appendix Table 2 shows high correlation between joint activity variables. In order to

Figure 4
TFP Growth of Participants and Nonparticipants in Voluntary Groups [Color figure can be viewed at wileyonlinelibrary.com]



Notes:
1. *yc11vg*: the expected value of $TFPG_1$ conditional on the dependent variable being observed.
2. *yc01vg*: the expected value of $TFPG_1$ conditional on the dependent variable not being observed.
3. *yc00vg*: the expected value of $TFPG_0$ conditional on the dependent variable being observed.
4. *yc10vg*: the expected value of $TFPG_0$ conditional on the dependent variable not being observed.

check the sensitivity, I ran the same model using only a joint R&D dummy and found the key results regarding H2a, H2b, and H3 unaffected by this change. Running the same model using only a joint logistics dummy did not change the key results regarding H1. Furthermore, I estimated the fully interacted model with one equation with all the observations in which all regressors were multiplied by a dummy variable representing participants in cooperative associations and voluntary groups, respectively. The results are reported in Appendix Table 4. Joint logistics in cooperative associations has a positive impact on TFP growth and the level of statistical significance is 10.1 percent. Joint R&D exerts a positive effect on TFP growth of participants in voluntary groups and nonparticipants in cooperative associations, which is consistent with the estimation results of switching regression models. A Chow test shows that the coefficients significantly differ according to the participation in an interfirm organization, meaning that a switching regression model is more efficient. Last, I tested whether the results changed by excluding SMEs with R&D-intensity higher than the ninety-ninth percentile (25.9 percent) of the distribution from the estimation. The results lend support to hypotheses other than H3, which suggests that strategic uses of innovation intermediaries described by H3 were characteristic to very R&D-intensive SMEs.

Discussion

Analyzing the aggregated panel data, Beason and Weinstein (1996) show that policy instruments on tax, tariff, subsidy, and loans from the Japan Development Bank, the largest government-affiliated financial institutions at the time, yielded no significant effect on an industry level TFP growth, although they did not focus on SMEs. Urata and Kawai (2002) also analyze the aggregated panel data and finds a negative correlation between debt ratio to government-affiliated financial institutions and TFP growth of SMEs (firms with less than 100 employees in particular). This finding suggests the adverse selection where multipurpose policy loans, which did not directly aim to promote innovation, had attracted unmotivated small firm managers who simply wanted to maintain businesses without conducting innovative activities. This study employed the firm level data and econometric approach which made it possible to separate causality from correlation, which is the critical issue in program evaluation. The results show that participation in cooperative associations is more detrimental to TFP growth than staying out of cooperative associations. Furthermore, lower TFP growth of participants in cooperative associations does not result from that SMEs with lower TFP growth participated in cooperative associations. Actually, counterfactual analysis shows that participants in cooperative associations would have higher TFP growth than nonparticipants if they stayed out of cooperative associations (note that ρ_0 is significantly positive.). Therefore, the result does not stem from reverse causality, but indicates a genuine negative program impact, which suggests mismanagement of cooperative associations. As I have mentioned previously, the establishment of SME cooperative associations was closely associated with the political situation at the time when the conservative government aimed to create their base by offering small firm managers better access to policy loans which could be used for bridge financing. Such political situation may have allowed SME cooperative associations to adopt a less efficient strategy.

Alternative interpretation would be that the negative program impact may have resulted from a failure of the industrial policy to adapt changes in business environments that had occurred after the enactment. The results indicate that SME cooperative associations are likely to be formed where innovation and global competition are less important, which characterizes the initial goal of this industrial policy to protect SMEs as the vulnerable. However, by the time this study investigated, business environments changed greatly from the high growth era where economies of scale worked best to the low growth era where the promotion of innovation became more important. Furthermore, a rapid appreciation of yen in the mid-1980s accelerated foreign direct investments by large firms, which forced SMEs to follow parent firms or to expand market globally on their own, making SMEs aware of the significance of globalization. SME cooperative associations were not supposed to cope with these changes in business environments. The results show that tangible fixed assets held by SMEs do not affect the probability of participation in cooperative associations, which is inconsistent with the initial targeting of the policy. This suggests that the industrial policy to promote SME cooperative associations became less attractive for SMEs presumably because implicit assumptions of the policy SMEs as the socially vulnerable became less relevant due to the major changes in business environments.

Reflecting such dynamics of business environments, SME policy in Japan had greatly changed its purpose and nature after the fundamental amendment of the SME Basic Law in 1999 (Organization for Economic Co-operation and Development 2000). Policymakers became more aware of the importance of entrepreneurship and innovation, and prioritized the creation and promotion of innovative firms, rather than supporting SMEs as the socially vulnerable which previous SME policies aimed to reach. The results of this study give contrast to the findings about SME policies after the amendment of the SME Basic Law. They demonstrate that that support programs focusing on innovative SMEs have a positive impact on capital investment and firm growth (Harada and Honjo 2005; Motohashi 2001), which suggests the appropriateness of such a shift in SME policy.

Next, the results show that voluntary groups have a positive overall impact on TFP growth of participants. Participation in voluntary groups is more conducive to the improvement in TFP than staying out of voluntary groups. Furthermore, higher TFP growth of participants in voluntary groups does not result from that SMEs with higher TFP growth potential participated in voluntary groups. Actually, counterfactual analysis shows that participants in voluntary groups would have lower TFP growth than

nonparticipants if they stayed out of voluntary groups (note that ρ_0 is significantly negative.). Therefore, the results negate reverse causality, which proves a genuine positive program impact of voluntary groups. Specifically, voluntary groups improved TFP of participants through knowledge sharing, such as joint R&D. This is consistent with previous studies demonstrating positive impacts of knowledge networks on productivity growth of SMEs (Nieto and Santamaria 2010; Okamuro 2007; Rogers 2004). Although it is difficult for this study without the group level data to make an inference about the mechanism working behind positive impacts of voluntary groups on TFP growth, previous studies shed light on the contingency under what circumstances networks could promote innovation and productivity growth. Previous studies show that knowledge sharing is particularly effective when firms in collaborative activities are heterogeneous in terms of technological and commercial capabilities (Anand and Khanna 2000). However, knowledge sharing is difficult when firms share little recognition on the issue (Nahapiet and Ghoshal 1998) and demonstrate a greater disparity in absorptive capacity (Cohen and Levinthal 1990; Hansen 1999). Indeed, there is an inverse U-shaped relationship between the diversity of resources within a network and the outcomes of mutual learning (Mowery, Oxley, and Silverman 1998). Therefore, a certain level of knowledge variety is needed for knowledge sharing while excessive knowledge disparity makes knowledge transfer difficult (Han, Han, and Brass 2014). Indeed, CIGs' network characteristics in terms of knowledge variety and disparity change according to the phases of joint innovation (Fukugawa 2006).

The ratio of SMEs engaged in joint R&D is 11 percent even in the subsample of participants in voluntary groups. This suggests that other channels than joint R&D might have worked behind the positive program impacts of voluntary groups. In this regard, sharing knowledge about not only technologies but also business opportunities, which is one of the important aims of CIGs "discovering each other" (Fukugawa 2006), might have helped SMEs improve productivity. The knowledge spillover theory of entrepreneurship highlights such aspects of localized spillover (Acs, Audretsch, and Lehmann 2013; Ghio et al. 2015). This emerging theory argues that discovery of entrepreneurial opportunities is endogenous, as opposed to viewing entrepreneurship as individual's nature (e.g., genetic trait) which is exogenous. Knowledge stock created endogenously in a region results in localized spillover of (not only technological but also entrepreneurial) knowledge, which allows entrepreneurs to identify, create, and exploit opportunities. This is partially because greater knowledge stock tends to have greater portion of undeveloped ideas because of "asymmetries of valuation" on inventions that creates a "knowledge filter" (Acs et al. 2004). Another reason for localized knowledge flow is that knowledge about new opportunities and resource requirements tends to be tacit (Rocha and Sternberg 2005). As tacit knowledge tends to be disseminated through personal interactions, which prefers geographical proximity, entrepreneurial activities tend to be localized. Voluntary groups, normally formed locally, might have offered participants such opportunities to tap into localized spillover of information on new opportunities, resulted in the improvement in TFP of participants even though they did not engage in joint R&D which allowed them to tap into diverse sources of technological knowledge.[10] As described previously, SME cooperative associations were not designed to fulfill such a function, and thus did not act as an effective intermediary for this type of spillover.

The relationship between firm size and innovation has been a long-disputed issue in the economics of innovation since Schumpeter. It has been recognized as stylized fact from various empirical studies that scale economies do not prevail in the relationship between R&D input and output (Cohen 1995). One of the key reasons for this fact is that knowledge networks act as a significant source of innovations, which enables SMEs to exhibit higher R&D productivity than their larger counterparts (Acs and Audretsch 1990; Nooteboom 1994; Tsai and Wang 2005). The case of voluntary groups shows that innovation intermediaries that promote mutual learning among participants offer SMEs such advantages

[10]The knowledge spillover theory of entrepreneurship suggests that localized spillover of information on new opportunities could increase competitive pressures due to excessive entry, resulting in suppressed entrepreneurship in the region (Acs et al. 2009). Although this may have affected the impact of voluntary groups, it is not possible for this study to make a further inference without relevant and reliable data.

in innovation while this does not hold true for SME cooperative associations which aim at cost sharing. Furthermore, the results show that voluntary groups had a positive impact on R&D productivity of participants. This underpins the previous argument because the exposure to external sources of knowledge, intermediated by voluntary groups, makes internal knowledge resources more productive.

Last, despite the negative overall impact of cooperative associations on TFP growth, innovative SMEs participating in voluntary groups could exploit cooperative associations to establish access to public financial support for joint R&D project under voluntary groups, making productivity effect of cooperative associations through knowledge sharing positive. This implies that innovative SMEs exploit different types of intermediaries so that the benefit from each intermediary will be complementary. Specifically, they exploit the division of labor in that a policy-based intermediary acted as a resource provider backed by better access to government-affiliated financial institutions while a voluntarily-formed intermediary played a role of a broker and mediator that promoted networking via market and nonmarket activities. The results support the notion of Intarakumnerd and Chaoroenporn (2013) that different types of innovation intermediaries are required to play different roles according to the characteristics of national, sectotal, and regional innovation systems, thereby exerting efficient use of limited resources in the economy to help SMEs improve productivity. Therefore, helping innovative SMEs that are engaged in joint innovative activities under a voluntarily-formed intermediary have access to information about a policy-based intermediary would have a significant policy implication. One way for the government and local authorities to do this is to notify innovative SMEs that cooperative associations are available for such purpose via networks of debt guarantee scheme and local public technology centers which have been considered as effective to let small business managers know about SME policy (Fukugawa 2005; Yasuda 2014).

Conclusion

Innovation intermediaries are individuals or organizations that help others improve productivity. Intermediation function is particularly important for innovative activities of SMEs that tend to suffer from market and systemic failure. Taking examples of two types of interfirm organizations uniquely developed in Japan, this study shed light on the understudied important issue in this field of research: the division of labor among innovation intermediaries for SMEs. Hypotheses were developed by reviewing previous literature on the mechanisms through which interfirm organizations affected productivity or innovation of participants. The strength of this study lies in uses of the firm-level data including both participants and nonparticipants in intermediaries and an econometric technique that enabled one to conduct counterfactual analysis and separate causality from correlation, which was the critical issue in program evaluation. This study contributes to the previous literature by showing how different types of innovation intermediaries helped SMEs improve productivity, individually, and collectively. Specifically, cooperative associations, a policy-based intermediary as a resource provider, helped SMEs improve productivity through cost sharing like joint logistics. Conversely, cross-industry interaction groups, a voluntarily-formed intermediary as a broker and a mediator, helped SMEs improve productivity through knowledge sharing like joint R&D. Innovative SMEs appear to have extracted benefits from each innovation intermediary according to their roles and the phases of joint innovation, suggesting the division of labor among innovation intermediaries for SMEs. The data suit well with the hypotheses, giving support to the notion of Intarakumnerd and Chaoroenporn (2013).

The division of labor among innovation intermediaries is of wide applicability to various economic organizations. Recent research focusing on the period before the national innovation system reform in Japan shows that local public technology centers and liaison offices at national universities played different roles in technology diffusion and intermediation (i.e., the promotion of joint research with universities) in regional and sectoral innovation systems (Fukugawa 2017), suggesting the division of labor among public innovation intermediaries. Other policy instruments closely related to this issue are science parks and business incubators as a seedbed of innovative startups leveraging academic research. This understudied topic needs more academic attention and should be explored using more recent data. Furthermore, the appropriate unit of analysis can be individuals as it is people who connect unconnected people. Future research should collect relevant information, whether at the organizational or

individual level, to analyze which type of intermediaries fulfill which functions, individually and collectively, and what promotes the efficient division of labor among intermediaries.

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Appendix Table 1
Definitions and Descriptive Statistics of Variables

Variables	Definitions	Mean	S.D.	Min	Max
CA	Dummy for the participation in a BCA	0.342	0.474	0	1
VG	Dummy for the participation in a voluntary group	0.552	0.497	0	1
TFPG	Annual average of TFP growth (1992–1995)	−0.028	0.155	−0.913	0.991
R&D	R&D expenditure/value-added	0.023	0.059	0	1.295
Licensing-out	The number of licensing-out agreements	0.028	0.294	0	9
Licensing-in	The number of licensing-in agreements	0.089	0.774	0	23
ICT	Dummy for the use of ICT	0.696	0.460	0	1
Advertising	Advertising/sales	0.004	0.013	0	0.295
Export	Export/sales	0.001	0.004	0	0.067
Subsidiary	Dummy for a subsidiary	0.259	0.438	0	1
Subcontractor	Dummy for a subcontracting firm	0.308	0.462	0	1
Firm size	Log of the number of employees	4.923	0.589	3.912	8.475
Firm age	Log of years since the establishment	3.454	0.474	0.693	4.234
Tangible	Tangible fixed assets/assets	0.347	0.169	0.0003	1
Logistics	Transportation cost/sales	0.023	0.031	0	0.708
j_rd	Dummy for engagement in joint R&D	0.091	0.288	0	1
j_distribution	Dummy for engagement in joint distribution	0.027	0.161	0	1
j_storage	Dummy for engagement in joint storage	0.009	0.094	0	1
j_logistics	Dummy for engagement in joint logistics	0.015	0.122	0	1

Appendix Table 2
Correlation Matrix

	CA	*VG*	*TFPG*	*R&D*	*Licensing-out*	*Licensing-in*	*ICT*	*Advertising*	*Export*	*Subsidiary*	*Subcontractor*	*Firm size*	*Firm age*	*Tangible*	*Logistics*	*j_rd*	*j_distribution*	*j_storage*	*j_logistics*
CA	1.000																		
VG	−0.056	1.000																	
TFPG	−0.010	0.010	1.000																
R&D	−0.064	0.081	0.018	1.000															
Licensing-out	0.005	0.031	−0.002	0.090	1.000														
Licensing-in	0.004	0.033	−0.002	0.068	0.214	1.000													
ICT	0.082	0.082	0.009	0.049	0.034	0.038	1.000												
Advertising	0.004	0.014	0.009	0.068	0.003	0.007	0.041	1.000											
Export	−0.021	0.007	0.035	0.105	0.013	0.008	−0.050	0.011	1.000										
Subsidiary	−0.172	−0.010	0.021	−0.015	−0.024	−0.008	0.053	−0.102	−0.051	1.000									
Subcontractor	0.045	0.028	−0.006	−0.074	−0.024	−0.020	−0.004	−0.118	−0.028	0.013	1.000								
Firm size	−0.024	0.060	−0.005	0.064	0.054	0.052	0.197	0.064	−0.095	0.044	−0.054	1.000							
Firm age	0.147	0.050	−0.054	0.032	0.027	0.029	−0.019	0.059	0.023	−0.316	−0.015	0.049	1.000						
Tangible	−0.004	−0.049	−0.016	−0.082	−0.028	−0.027	0.018	−0.071	−0.041	0.079	0.043	0.019	−0.115	1.000					
Logistics	0.015	−0.012	−0.005	−0.004	−0.001	−0.001	−0.016	−0.003	−0.003	−0.006	−0.007	−0.001	0.003	−0.003	1.000				
j_rd	0.044	0.074	−0.002	0.122	0.043	0.065	0.066	−0.010	0.012	−0.013	−0.010	0.057	0.020	−0.040	−0.003	1.000			
j_distribution	0.127	0.020	−0.001	0.018	0.035	0.036	0.031	−0.014	−0.009	−0.006	−0.028	−0.006	0.018	−0.006	−0.001	0.115	1.000		
j_storage	0.046	0.031	−0.002	−0.001	−0.005	0.038	0.045	0.012	−0.011	0.014	0.019	0.021	−0.003	0.007	−0.001	0.109	0.138	1.000	
j_logistics	0.074	0.013	−0.001	−0.008	0.022	0.012	0.062	0.000	0.006	0.006	0.018	0.045	0.005	0.049	−0.001	0.105	0.131	0.289	1.000

Appendix Table 3
Estimated Switching Regression Models Using Labor Productivity Growth (*LPG*) as a Dependent Variable in the Main Equation

	Panel A			Panel B			Panel C		
	Main: LPG_0			Main: LPG_0			Main: LPG_0		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
j_rd	0.004	0.012		−0.001	0.009		0.015	0.014	
j_distribution	0.007	0.032		0.009	0.013		0.030	0.040	
j_storage	0.006	0.049		−0.021	0.019		−0.061	0.050	
j_logistics	0.005	0.039		0.016	0.020		0.000	0.056	
R&D	0.125	0.053	*	0.461	0.060	**	0.033	0.055	
Licensing-out	−0.004	0.012		−0.008	0.011		0.001	0.011	
Licensing-in	−0.006	0.005		0.000	0.004		−0.011	0.006	†
ICT	0.006	0.007		0.017	0.006	**	0.040	0.015	**
Advertising	0.587	0.246	*	0.293	0.206		0.157	0.408	
Export	0.400	0.892		1.384	0.776	†	−1.559	1.185	
Subsidiary	0.026	0.008	**	0.016	0.006	*	−0.051	0.015	**
Subcontractor	−0.004	0.007		0.012	0.006	*	0.042	0.015	**
Firm size	0.001	0.006		0.019	0.005	**	0.029	0.012	*
Firm age	−0.017	0.007	*	−0.012	0.006	*	0.018	0.014	
Constant	0.036	0.037		0.037	0.042		−0.230	0.072	**
	Main: LPG_1			Main: LPG_1			Main: LPG_1		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
j_rd	0.002	0.007		0.012	0.007	†	0.110	0.050	*
j_distribution	0.006	0.011		0.011	0.010		−0.038	0.069	
j_storage	0.009	0.019		0.001	0.011		−0.064	0.152	
j_logistics	0.026	0.013	*	0.005	0.017		−0.011	0.126	
R&D	−0.326	0.080	**	0.082	0.035	*	1.693	0.299	**
Licensing-out	0.001	0.012		0.002	0.006		−0.039	0.037	
Licensing-in	−0.002	0.005		−0.002	0.002		0.107	0.035	**
ICT	0.062	0.008	**	0.003	0.005		−0.138	0.048	**
Advertising	−0.075	0.302		0.005	0.175		−1.054	1.207	
Export	−1.857	1.124	†	−0.796	0.576		6.770	5.476	
Subsidiary	−0.086	0.010	**	0.020	0.005	**	0.249	0.055	**
Subcontractor	0.025	0.008	**	0.013	0.005	**	−0.141	0.047	**
Firm size	−0.007	0.006		0.007	0.004	*	−0.114	0.034	**
Firm age	0.061	0.009	**	−0.002	0.005		−0.338	0.049	**
Constant	−0.479	0.043	**	−0.108	0.043	*	2.191	0.250	**
	Regime: *CA*			Regime: *VG*			Regime: *CA*		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
R&D	−1.529	0.292	**	2.078	0.267	**	−3.491	0.700	**
Licensing-out	0.040	0.044		0.070	0.052		−0.032	0.081	
Licensing-in	0.010	0.020		0.029	0.018		−0.072	0.056	

Appendix Table 3
Continued

	Regime: *CA*			Regime: *VG*			Regime: *CA*		
	Coef.	**S.E.**	**Sig.**	**Coef.**	**S.E.**	**Sig.**	**Coef.**	**S.E.**	**Sig.**
ICT	0.278	0.031	**	0.180	0.029	**	0.620	0.119	**
Advertising	0.167	1.086		−0.238	1.035		2.778	2.542	
Export	−3.455	4.109		0.718	3.756		−27.489	12.352	*
Subsidiary	−0.409	0.035	**	0.011	0.032		−0.845	0.133	**
Subcontractor	0.099	0.030	**	0.127	0.029	**	0.393	0.111	**
Firm size	−0.061	0.024	*	0.082	0.023	**	0.226	0.084	**
Firm age	0.293	0.032	**	0.113	0.029	**	0.593	0.124	**
Tangible	−0.167	0.054	**	−0.383	0.067	**	−0.215	0.245	
Logistics	−0.426	0.312		−0.133	0.348		1.537	1.407	
Constant	−1.370	0.205	**	−0.734	0.152	**	−4.038	0.640	**
rho0	0.036	0.029		−0.968	0.002	**	0.101	0.214	
rho1	0.977	0.002	**	0.987	0.001	**	−0.016	0.336	

[a]Panel A ($N = 8{,}980$) shows estimated switching regression models according to the participation in cooperative associations. Panel B ($N = 8{,}980$) shows estimated switching regression models according to the participation in voluntary groups. Panel C ($N = 1{,}331$) shows estimated switching regression models for the subsample of innovative SMEs participating in voluntary groups according to the participation in cooperative associations.
[b]Innovative SMEs mean SMEs with above-average R&D intensity.
[c]The level of statistical significance: $^{**}p < .01$; $^{*}p < .05$; $^{\dagger}p < .1$.
[d]*rho0* and *rho1* denote correlation coefficients between *u0* and *v* and between *u1* and *v*, respectively.

Appendix Table 4
Estimated Fully Interacted Models

	Panel A				Panel B		
	Coef.	**S.E.**	**Sig.**		**Coef.**	**S.E.**	**Sig.**
CA_0	0.002	0.022		VG_0	0.015	0.027	
CA_0*j_rd*	0.016	0.007	*	VG_0*j_rd*	0.009	0.010	
CA_0*j_distribution*	0.004	0.019		VG_0*j_distribution*	−0.050	0.016	**
CA_0*j_storage*	−0.019	0.029		VG_0*j_storage*	−0.033	0.034	
CA_0*j_logistics*	−0.004	0.023		VG_0*j_logistics*	0.027	0.022	
CA_0*R&D*	0.159	0.031	**	VG_0*R&D*	0.193	0.054	**
CA_0*Licensing-out*	−0.002	0.007		VG_0*Licensing-out*	−0.011	0.011	
CA_0*Licensing-in*	−0.004	0.003		VG_0*Licensing-in*	−0.004	0.004	
CA_0*ICT*	−0.002	0.004		VG_0*ICT*	−0.006	0.005	
CA_0*Advertising*	0.775	0.146	**	VG_0*Advertising*	0.535	0.180	**
CA_0*Export*	−0.499	0.529		VG_0*Export*	0.313	0.697	
CA_0*Subsidiary*	0.016	0.005	**	VG_0*Subsidiary*	0.013	0.006	*

Appendix Table 4
Continued

	Panel A				Panel B		
	Coef.	**S.E.**	**Sig.**		**Coef.**	**S.E.**	**Sig.**
CA_0*Subcontractor*	−0.001	0.004		VG_0*Subcontractor*	−0.008	0.005	
CA_0*Firm size*	0.007	0.003	*	VG_0*Firm size*	0.013	0.004	**
CA_0*Firm age*	−0.022	0.004	**	VG_0*Firm age*	−0.030	0.005	**
CA_1	0.012	0.034		VG_1	−0.005	0.025	
CA_1*j_rd*	0.008	0.009		VG_1*j_rd*	0.015	0.007	*
CA_1*j_distribution*	−0.008	0.012		VG_1*j_distribution*	0.025	0.013	†
CA_1*j_storage*	−0.019	0.024		VG_1*j_storage*	−0.021	0.022	
CA_1*j_logistics*	0.029	0.018		VG_1*j_logistics*	0.010	0.018	
CA_1*R&D*	0.078	0.068		VG_1*R&D*	0.141	0.033	**
CA_1*Licensing-out*	−0.010	0.009		VG_1*Licensing-out*	−0.002	0.007	
CA_1*Licensing-in*	0.000	0.003		VG_1*Licensing-in*	−0.001	0.003	
CA_1*ICT*	−0.002	0.007		VG_1*ICT*	0.003	0.005	
CA_1*Advertising*	0.101	0.257		VG_1*Advertising*	0.678	0.178	**
CA_1*Export*	−1.310	0.890		VG_1*Export*	−1.532	0.597	*
CA_1*Subsidiary*	0.011	0.008		VG_1*Subsidiary*	0.018	0.005	**
CA_1*Subcontractor*	−0.003	0.006		VG_1*Subcontractor*	0.003	0.005	
CA_1*Firm size*	0.004	0.005		VG_1*Firm size*	0.001	0.004	
CA_1*Firm age*	−0.019	0.007	**	VG_1*Firm age*	−0.014	0.005	**
Chow test	$F(15, 8950) = 19.24$		**	Chow test	$F(15, 8950) = 13.63$		**

[a]A dependent variable is *TFPG*.
[b]$N = 8{,}980$.
[c]The level of statistical significance: $^{**}p < .01$; $^{*}p < .05$; $^{\dagger}p < .1$.