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Impact of the length of relationships upon the use of research institutes by SMEs

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Abstract

Recent studies of US industrial modernisation programmes argue that difficulties of establishing long-term relationships with users prevent them from facilitating development of innovation capabilities. The paper supports this argument through a survey of Japanese research institutes the US programmes were modelled on. In view of information asymmetries in their use, it tests the hypothesis that small and medium-sized firms start using the research institutes with 'low information gap' services and gradually move on to 'high information gap' services that often require more absorptive capacity. This is demonstrated both under one-to-one relationships and between groups of firms and a research institute.

Keywords: Industrial modernisation programmes; Small and medium-sized firms; Research institutes; Organisational learning; Relational assets

1. Introduction

For technology transfer policy supporting small and medium-sized enterprises (SMEs), the last two decades saw a shift of emphasis towards development of innovation capabilities within firms as well as creation of effective intermediaries between users and providers of knowledge (Commission of the European Communities, 1994; Dodgson and Bessant, 1996). Unlike its misconception as a once-and-for-all affair that completes successfully when a resource moves from a provider to a user, technology transfer is an ongoing learning process (Rosenberg, 1982). In the process, firms need to undergo several stages including recognition of opportunity or need, search, comparison and selection of knowledge sources, and acquisition, implementation and long-term use of knowledge (Dodgson and Bessant, 1996, p.39). Financial support for technology acquisition alone does not help SMEs to recognise their technical needs and make use of technology acquired. Successful technology transfer requires development of a capacity of SMEs to recognise opportunities and search, modify and adapt technology. Also where there is a wide gap between suppliers and users of technology in the process, there have to be appropriate intermediary agencies that connect them.

Amidst the broad policy shift, a series of industrial modernisation initiatives and programmes have been put in place by federal and state governments in the US since the late 1980s to aid modernisation and technological upgrading of SMEs (Shapira et al., 1995; Shapira, 1996). With the enactment of the Omnibus Trade Competitiveness Act of 1988, the National Institute of Standards and Technology (NIST) under the Department of Commerce was charged with overseeing seven Manufacturing Technology Centers (MTCs)

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that provide assistance for the transfer of manufacturing technologies from federal laboratories to private businesses. Similar in scope to the MTCs, NIST subsequently began the Manufacturing Extension Partnership (MEP) in 1992 to co-ordinate services, facilities, expertise and technologies among government, university and industry to better assist firms, with 60 MEPs currently in operation in 42 states. Further, numerous technology transfer programmes also exist at the state and regional levels, which include State Technology Extension Programs (STEPs). The recent growth of US industrial modernisation programmes, and particularly the direct involvement of the federal-level civilian agency NIST, is a departure from the previous US small business policy that had lacked a sectorally-based focus for technological development (Shapira, 1996; Aoyama, 1999).

These developments in the US have led to a number of studies that evaluate their performances as well as considering their theoretical underpinnings. They include Feller (1993, 1997), Feller et al. (1996), Gittell and Kaufman (1996), Kelley and Arora (1996), Luria and Wiarda (1996), Oldsman (1996), Shapira (1996, 2001), Shapira et al. (1996), Hassink (1997), Glasmeier et al. (1998) and Feller and Nelson (1999). Take-up of industrial modernisation services still remains small relative to the whole population of SMEs (Feller et al., 1996; Feller, 1997). Further, the studies find that these programmes are more often than not subject to political, rather than economic, decisions because of their difficulties of measuring benefits and costs. Many express a concern over consequences of the programmes' operation that have to stress short-term efficiency under the political landscape of the US (Shapira et al., 1995; Luria and Wiarda, 1996; Glasmeier, 1999). In their view, the lack of policy consistency and financial support for US industrial modernisation programmes prevent them from establishing long-term relationships with SMEs and hence building innovation capabilities within the firms. Glasmeier et al. (1998, p.119) argue that the learning behaviour of SMEs is history dependent and SMEs must be given time to learn about, trust, and use manufacturing extension organisations.

However, how the length of relationships affects the use of a knowledge provider is less than thoroughly examined in empirical studies. For example, the study of Oldsman (1996) of an extension service in NY state finds some correlation between the number of contacts (i.e. meetings and telephone calls) and the likelihood of the client's implementation of new techniques (e.g. total quality management). Yet, it fails to uncover how the client's usage of the extension service changes over time. There is a large literature studying supply- and demand-side factors affecting the use of a knowledge provider, such as distance, firm size and management style. In contrast, empirical examinations of how the length of relationships influences the usage of a knowledge provider are still in need. Do long-term relationships facilitate the usage that develops innovation capabilities within client firms rather than the usage that produces only short-term remedies? If so, how? How large is the impact of long-term relationships relative to other factors? Insights into this are of great importance to improve the operation of organisations that provide technology for SMEs.

The aim of this paper is to go some way towards answering this question through examining relationships between SMEs and Japanese research institutes called *kosetsushi* centres. *Kosetsushi* centres are one of the key programmes the US government studied and modelled their recent industrial modernisation effort on (US Congress Office of Technology Assessment, 1990; Shapira, 1996). When stepping up the industrial modernisation effort in his first term, President Clinton even proposed to set up 170 manufacturing centres that would match the number of *kosetsushi* centres in Japan (Shapira, 1996, p.296). Both Japanese *kosetsushi* centres and US modernisation programmes aim to cater for SMEs within their regions and have some types of services in common. Run by local (i.e. prefectural or municipal) governments, *kosetsushi* centres provide SMEs with a range of services at subsidised costs (Shapira, 1992, 1996; Hassink, 1997). Admittedly, *kosetsushi* centres differ from most US modernisation programmes in some respects. To start with, being 'intermediate' research institutes that bridge the gap between private industry and public science base, *kosetsushi* centres conduct applied, near-market research on their own.[1] Also, their staffing arrangements, as well as labour market conditions in the

[1] While Mason and Wagner (1999) refer to this type of research institutes as 'intermediate research institutes', Rush et al. (1996) and Joly and Mangematin (1996) call them as 'technology institutes' and 'research centres for the profession', respectively.

country, are different from those of US modernisation programmes. Yet, a study of *kosetsushi* centres has an undeniable advantage in the context of this paper: it is possible to examine the impact of long-term relationships as the centres have been in place providing a similar set of services over four decades.

The paper examines two *kosetsushi* centres under different contexts: one dealing with individual firms on a one-to-one basis and the other dealing with local trade associations as a major channel for information gathering and technology transfer. It is often argued that compared with the first one-to-one approach, the second collective network approach is more likely to succeed by supporting inter-firm learning opportunities. The comparison of the two cases helps to discern if there is any difference between the two approaches in the significance of long-term relationships.

The paper begins by reviewing a literature on the use of external sources of technical knowledge and presenting a hypothesis (Section 2). This is followed by an account of the methodology adopted (Section 3). The paper then moves on to an analysis of empirical findings (Section 4). The ensuing section discusses the generalisability of findings by closely examining differences between the *kosetsushi* system and US modernisation programmes (Section 5). Finally, the paper concludes with a summary of findings and policy implications (Section 6).

2. Previous research and hypothesis

The decision to use an external source of technical knowledge is conceptualised as a function of supply and demand factors. Apart from the price and quality of knowledge available at the source, a number of factors are identified as affecting the use (Charles and Howells, 1992). Of supply-side factors, the most frequently cited and examined is geographical proximity to a source of technical knowledge. Various studies argue that proximity facilitates the use of external sources, which in turn improves the innovative performance of firms (Mackun and MacPherson, 1997; Beise and Stahl, 1999; Bennett et al., 2000). The argument lends support to the policy that develops sources of technical knowledge with a view to improving accessibility. As for demand-side factors, a number of studies focus on the capability of SMEs to search and absorb technical knowledge (Rothwell and Dodgson, 1991; MacPherson, 1991; Hitchens et al., 1994; Fuellhart, 1999). The firm size and the number of qualified scientists and technologists are often used as a proxy representing the absorptive capability. Outward-looking style of management is another demand factor. Some contend that such demand-side factors are as important as, if not more important than, supply-side factors. In their view, there are enough sources of technical knowledge in developed economies, and the conventional emphasis upon the supply-side policy therein is not effective. Accordingly they suggest that policy efforts be directed at improvement of the absorptive capacity on the part of firms (Rothwell and Dodgson, 1991; Commission of the European Communities, 1994). While studies of supply- and demand-side factors differ in their focus and policy implications, they share the tendency to view users and sources of technical knowledge separately and not to consider factors specific to the relationships between them. This lack of attention leads to a failure in accounting for changes that take place in the relationships.

A key to understanding the relationships between a user and a knowledge provider is information gaps (or information asymmetries) between them. When using a knowledge provider like a research institute, a user in fact makes transactions of knowledge services. Services are distinct from goods in intangibility, inseparability, heterogeneity and perishability (Zeithaml, 1981). These natures of services subject a user to two types of information gaps.

First, the quality of knowledge services is not fixed at a de facto level according to a provider but varies to a considerable extent with the quality of communication between a provider and a user (O'Farrell and Hitchens, 1990; Bennett and Robson, 1999). A user is often uncertain about the kind of service it needs and unable to communicate the specific form of its demand, making the provider to guess. The quality of knowledge services depends upon how both sides overcome this type of information gap (type 1).

Second, a user faces another type of information gap (type 2) in assessing returns to the use of knowledge services both in advance of the purchase and after the purchase (Holmstrom, 1985; Zeithaml et al., 1990; Clark, 1995; Gallouji, 1997). Production and consumption of services often take place at the same time. This makes it hard to evaluate services unless

they are purchased and consumed. Also, impacts of their consumption often pervade to a wide range of activities, from which specific returns are difficult to measure. Further, returns may not appear immediately and occasionally take a long time. This forces a user to rely on evidence from previous use as well as reputation of the provider.

A firm considering the purchase of services is hence likely to face larger information gaps when compared with the purchase of manufactured goods. This is particularly evident with SMEs. Many SMEs fail to articulate their needs in terms of clear objectives, receiving services of sub-optimal quality. SMEs, who tend to be infrequent users, also find it difficult to evaluate the value of services and assess the differences among service providers (Gittell and Kaufman, 1996). Accordingly, average SMEs heavily underutilise producer services compared with manufactured goods (Storey, 1994).

The previous discussion suggests that services of a research institute (say, A) do not necessarily involve the same degree of information gap. The degree of information gap varies among services provided by research institute A, depending on factors specific to each service. The factors include the following three: (1) significance of communication in the service's production: the bigger role communication plays in its production process, the higher a degree of information gap; (2) degree to which the service is intangible: the more intangible, the harder it is to evaluate the service at its purchase, increasing a degree of information gap; (3) time lag, and clarity of connection, between the service's consumption and returns to it: the longer the time lag and the less clear the connection, the higher a degree of information gap.

Further, the degree of information gap involved in each service of research institute A is not fixed, either. It changes with some factors external to the service. The factors can be divided into (1) factors specific to the user and (2) factors specific to the relationships between research institute A and the user. Of these, the latter relational factors are considered to have a greater impact upon the degree of information gap involved in the transaction of research institute A's services.

Suppose that the client uses another external source of technical knowledge (say, B). Transactions with B may improve the firm's general capability of absorbing technical knowledge through learning-by-doing, without any additional technical staff. This can reduce information gaps about the use of research institute A's services as well, and particularly when A and B are close to each other in their nature. However, the effect of the use of B's services upon the use of A's services is considered to be small and limited, compared with the influence that the relationship between the user and research institute A exerts. This is evident in the fact that many SMEs rely on business partners (i.e. suppliers and customers) and specialist consultants, and seldom use institutional sources of technical knowledge (Glasmeier et al., 1998). The development of an absorptive capacity through learning-by-interacting with business partners and specialist consultants does not necessarily lead to the use of untried sources like research institutes.

Significant part of the information gap reduction as to A's services is specific to the relationship the user has with A. This is supposed to take place mainly in the following two areas (Table 1).

First, improvement in communication with research institute A reduces type 1 of information gap, rendering the production of services more effective. Learning of each other's idiosyncratic languages and vocabularies smoothes the way to understanding the firm's problems and needs. Also, knowledge of each other (activity, technical strengths and weaknesses, and history) makes the institute's services more effective. The improvement in communication and resultant reduction of information gap are in most part specific to the particular relationship and not transferable to any other sources of technical knowledge.

Second, recognition of an appropriate level of returns to the previous use of research institute A reduces type 2 of information gap, increasing trust in the knowledge provider. As noted earlier, the user's evaluation of knowledge-based services involves difficulties, especially when returns pervade to a wide range of activities and take a long time to appear. Hence, the user often constructs from a number of evidences an estimate of returns that does not necessarily match the exact impact. When the user perceives an appropriate level of returns to the previous use of a service, this reduces an information gap at the next use of the same service. Also, accumulation of perceived returns can produce trust in the competence of research institute A (or particular staff members). This reduces an information gap about the institute's other services that

Table 1
Non-price factors affecting the use of a research institute by SMEs

	Factor	Variable representing the factor
Supply-side	Geographical proximity	Distance
Demand-side	Absorptive capacity	Firm size
		Number of qualified scientists/technologists
	Outward-looking style of management	Number of contacts in other firms, consultancies etc. to discuss technical matters with and seek advice from
Supply–demand interaction specific to the relationship between the firm and the research institute	Ease of communication	The firm's evaluation of the ability of the research institute to communicate with them
	Recognition of an appropriate level of returns to the use	Perceived returns to previous use of the research institute

have not been tried, too. Again, unless the services are standardised across different providers, the reduction of information gap is specific to the relationship with research institute A.

Improvement in communication and recognition of appropriate returns generally take place through repeated transactions over time. When starting to use research institute A's services, the initial basis of communication is fragile. Research institute A's staff and the user firm's staff are often different in their languages and vocabularies, cultures, and goals. Communications between them are likely to initially face difficulties, which diminish over time. Accumulation of perceived returns is also normally a temporal phenomenon. This is particularly true if there is a long time lag between a service's consumption and returns to it.

In sum, a shift in the use of research institute A's service is assumed to take place over time. The smaller information gaps SMEs see with a service, the more likely they are to use the service. Of research institute A's various services, SMEs first use those involving a lower degree of information gap. As they continue to use research institute A, they will experience changes in their relationships with the institute. The relational changes, that is, improvement in communication and recognition of appropriate returns, are likely to reduce the level of information gap across the institute's services. When users see the relational changes reach a certain level (which varies among users), they start using those services they have so far considered to involve too high a degree of information gap. In other words, the use of services involving a higher degree of information gap is assumed to take place only after a period of the use of services involving a lower degree of information gap.

The paper tests this hypothesis under two situations. One is a situation in which a research institute provides services for, and communicates with, individual users on a one-to-one basis. The other is a situation in which a research institute deals with groups of firms formed either formally (e.g. trade associations) or informally (e.g. learning networks) and uses the groups as a channel for collective information exchange and technology transfer. It is argued that the collective network approach of the second situation has advantages over the first one-to-one approach (Kelley and Arora, 1996; Morgan, 1996).[2] The approach not only facilitates inter-firm learning and technology diffusion processes but also tends to attract a greater share of private sector resources. Most importantly in the paper's context, such collective bodies serve their members as a means of reducing information gaps about the use of a research institute (Izushi, 2002). Staying in close communication with a research in-

[2] There are also sceptical views on SME networking. Curran and Blackburn (1994) find among small business owners in the UK a 'fortress enterprise mentality', that is, an extreme reluctance to engage in any behaviour that might lead to a dependence on others. Such competitive instincts are nurtured in many localities and regions, forming a barrier against inter-firm collaboration. While the current growth of inter-firm network initiatives can be traced back to studies that highlight active collaboration among SMEs in a number of regional economies (most notably Third Italy), Harrison (1994) argues that such cases are temporary and exceptional because of the dominant force of large corporations.

stitute, they can express their interests, plans and requests through the collective 'voice' (Hirschman, 1970). This allows them to exert an influence upon the institute's management as pressure groups (Olson, 1965). Since what underlies information gaps is the lack of control over an external source that, with its own goal and culture, may not act in agreement with users, the collective 'voice' reduces information gaps about its services. In a test of the previous hypothesis, it is examined how significant the impact of the length of relationships is under the previous two situations. Given the effect of the collective 'voice', the length of relationships could be expected to be less significant under the second situation. Before undertaking the test, Section 3 provides an account of the methodology adopted.

3. Methodology

The paper examines the use of two local public research institutes in Japan. One is Precision Technology Research Institute serving SMEs in electrical, electronic and precision engineering industry in Nagano Prefecture and the other is Kyoto Municipal Textile Research Institute supporting SMEs engaged in textile manufacture in Kyoto Prefecture. The two areas (Fig. 1) are highly specialised in the particular industries. According to Management and Coordination Agency's *1996 Establishment Census of Japan*, both Nagano Prefecture and Kyoto Prefecture rank first of the country's 47 prefectures in location quotient of the respective industries' establishments relative to the whole manufacturing establishments. Such specialised agglomerations make technology transfer more efficient as they allow targeting and provide significant overall economies of scale accruing to any effort (Storey, 1994). Electrical, electronic and precision engineering industry in Nagano Prefecture employs 120,235 persons (10.9% of the total employment in the prefecture) at 3878 establishments (with an average size of 31 persons per establishment) in 1996. The industry evolved from manufacture of clocks and cameras after World War II, centring round Suwa-Okaya area (i.e. Okaya City, Suwa City and Shimo-Suwa Town). Of the 3878 establishments, 64 are large-scale with 300 employees and over. A majority of smaller businesses operate as subcontractors for large manufacturers including Seiko Epson. Textile industry in Kyoto Prefecture has a much longer history that dates back to the fifteenth century. A total of 66,562 persons (5.2% of the total employment) are employed at 14,117 establishments (with an average size of 5 persons) in 1996. Within Kyoto Prefecture, the industry concentrates in two locations: Kyoto City in its south and Tango Region in its northern periphery. Kyoto Municipal Textile Research Institute serves mainly textile firms in Kyoto City (40,778 persons employed at 6920 establishments). Divisions of labour are highly developed in the industry wherein marketing and product planning functions are mostly situated within wholesale distributors who have no production functions.

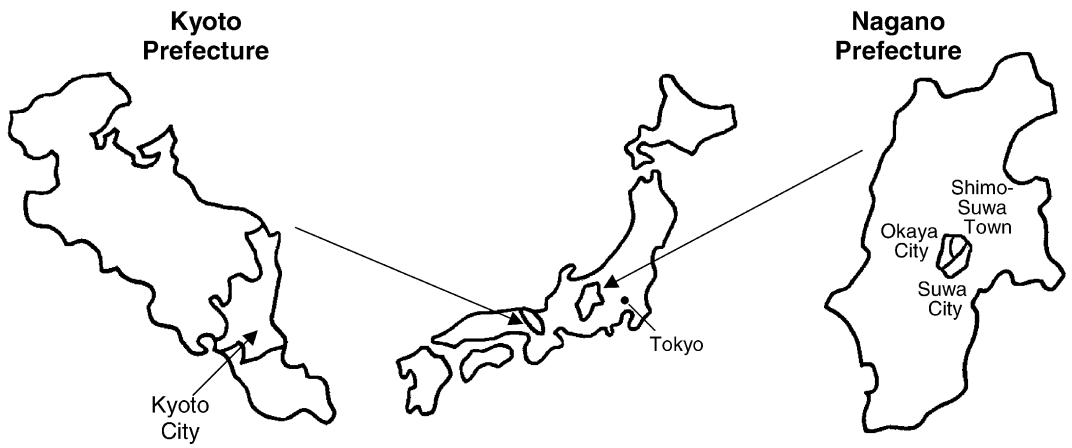

Fig. 1. Location of Nagano and Kyoto.

Unlike the Nagano case, any large-scale manufacturers do not dominate the industry.

Both the industries have received support from Precision Technology Research Institute and Textile Research Institute, respectively, over four decades. Precision Technology Research Institute of Nagano Prefecture was established in Okaya City in 1957 when an imminent rise of the industry was observed in the area. With staff of 42, the institute focuses upon electrical, electronic and precision engineering including optoelectronics and supports businesses throughout the prefecture. The forerunner of Kyoto Municipal Textile Research Institute was founded in 1908 by a local trade association of textile manufacturers and subsequently transferred to Kyoto Municipal Government in 1916. As of 1998, the institute has staff of 38 including 32 researchers and six clerical workers. While undertaking applied and near-market research specific to the respective industries, both the institutes provide firms with technical services at subsidised costs. The technical services include testing, open use of equipment by clients on their own, technical guidance, engineer training, lectures and workshops, study groups, joint research, and commissioned research.[3]

Apart from the difference in industrial sectors focused upon, the two research institutes are in contrast in their approaches to user firms. As mentioned earlier, electrical, electronic and precision engineering industry in Nagano Prefecture has semi-vertically integrated structures wherein SMEs serve large-scale manufacturers as subcontractors. The vertical structures have gradually loosened their grip since the appreciation of yen in the mid 1980s as large-scale manufacturers moved some of their manufacturing capacities overseas. This has given rise to several inter-firm learning activities in the area (Yamamoto and Matsuhashi, 1999). However, such horizontal networking is small in scale and not sectorally-based. Further, no sectorally-based local trade associations exist in the industry. With the exception of six small study groups recently organised, Precision Technology Research Institute provides its services for, and communicate with, user firms on a one-to-one basis. In contrast, trade associations of textile manufacturers play a big role in dealing with Textile Research Institute in Kyoto. Approximately one-third of the textile manufacturers in Kyoto City and its neighbouring towns are affiliated to local trade associations organised by either product or process speciality, facilitating horizontal networking among their members. As its inception being a testing laboratory owned by a trade association suggests, Textile Research Institute has had close relationships with these trade associations. Acting as pressure groups, the trade associations petition the institute for research programmes on specific issues and purchase of equipment. In similar vein, the institute maintains close communication with the trade associations to disseminate research results as well as to study market trends in the industry.

To examine the two research institutes, a questionnaire survey was undertaken, following a pilot survey. A questionnaire was sent to 1219 firms with less than 300 employees in the two prefectures. They include 827 firms engaged in electrical, electronic and precision engineering in Nagano Prefecture and 392 firms engaged in textile manufacture in Kyoto City and its neighbouring towns (including Nagaokakyo, Kameoka, Uji and Joyo) in the south of Kyoto Prefecture. The firms were selected from the commercial database 'Cosmos' published by Teikoku Data Bank. Three in Nagano and four in Kyoto were found to have either moved from their addresses or gone out of business. Of the remaining, 167 firms in Nagano and 97 firms in Kyoto returned the questionnaire (see Table 2 for their profile), yielding response rates of 20.3 and 25.0%, respectively. Managing directors, technology managers or individuals at similar senior management positions completed the questionnaire.

[3] Testing and evaluation services are charged according to the number of units tested as well as types of tests and evaluations. Technical advice and guidance are charged according to the number of hours *kosetsushi* staff members spend with clients for consultation. Charges for joint or commissioned research normally reflect expenses for materials used in addition to some add-on fees.

In general, both the institutes see charges for testing and evaluation services as an indicator of equipment usage and use the revenue figures at the table of negotiation with their local governments about future plans of equipment purchase. According to interviewed firms, fees for testing and evaluation services generally range from 50 to 80% of the private sector counterparts. The gap between *kosetsushi* centres and private-sector providers has been narrowing. In some cases (e.g. when annual service contracts are made with private sector providers), *kosetsushi* centres are found more expensive.

Compared with equipment-based, testing and evaluation services, both the institutes see their R&D activity as public goods and keep lower their fees for R&D-based, 'high information gap' services relative to the costs.

Table 2
Means of the respondents

	Nagano: 167 firms	Kyoto: 97 firms
Distance to the institute (km)	31.8	4.7
Number of employees	54.5	23.4
Number of employees with a science/engineering degree	3.7	0.7
Number of persons in the following organisations to discuss technical matters with and seek advice from		
In suppliers/customers	5.0	2.7
In consultancies	1.2	1.0
In other firms[a]	2.4	0.8
In universities	0.4	0.4
In national research institutes[b]	0.1	–
In the own trade association[c]	–	1.3
Affiliation to a trade association (1 if affiliated and 0 if not)[c]	–	0.9
Number of years since the first use of the institute[d]	16.3	27.8

[a] For Kyoto firms, this excludes contacts in firms affiliated to the same trade association.
[b] There is no national research institute with a department specialised in textile manufacture.
[c] Local trade associations of electrical, electronic and precision engineering firms do not exist in Nagano Prefecture.
[d] This applies only to those firms using the research institutes under examination.

The respondents under-represent firms that are smaller in size, and those opting out of any trade associations in the Kyoto case, due to a sample frame bias existing in 'Cosmos', a known issue with the database published for commercial trade and investment purposes. However, response bias was found statistically insignificant for employment size (and affiliation to a trade association in the Kyoto case). Given the sample frame bias, the data presented later should be considered suggestive rather than conclusive. To complement the questionnaire survey, a total of 53 individuals (38 in Nagano and 15 in Kyoto) were interviewed. These individuals include representatives from the two institutes, user firms in the two prefectures, local government and economic development organisations in Nagano, and trade associations in Kyoto.

4. Empirical assessment

As a literature suggests, whether SMEs use a research institute is to a great extent explained by their proximity to the institute in the Nagano case. Of the respondents, 57.5% use Precision Technology Research Institute. To see what set of variables in Table 2 best account for the use, a binary logistic regression analysis was conducted. Table 3 shows maximum likelihood estimates of logistic regression function for the use of Precision Technology Research Institute (1 if the firm uses the institute and 0 if not). As distance has the largest absolute value (0.27) of standardised estimate for its coefficient, it influences firms' behaviour most strongly. The odds ratio for distance (0.96) means that, the values of the other variables in the function being equal, the odds for the use of the institute (i.e. the probability of using the institute divided by the probability of not using it) decrease by 4% with each additional kilometre in the distance between the firm and the institute. In the estimated function, distance is followed by two variables representing outward-looking style of management (i.e. number of individuals in consulting firms and number of individuals in other firms to discuss technical matters with and seek for advice from) and one variable for absorptive capability (i.e. number of employees). As for the Kyoto case in which 90.7% of the respondents use Textile Research Institute, distance was found less significant in explaining whether firms use the institute. This is considered in part due to the institute's smaller target area in which textile SMEs are highly concentrated. Instead, whether the firm is affiliated to a local trade association was found to be a primary predictor variable, showing that affiliated firms are more likely to use the institute than opting-out firms (Izushi, 2002).

What is revealing in the context of the paper is distinctive patterns found in the use of two groups of

Table 3
Use of Precision Technology Research Institute of Nagano Prefecture: maximum likelihood estimates of logistic regression function

Variable	Coefficient estimate	S.E.	Wald χ^2	Significance	Standardised estimate	Odds ratio
Intercept	0.68	0.38	3.1	0.08		
Distance	−0.04	0.01	16.9	0.00	−0.27	0.96
Contacts in consultancies	0.26	0.12	4.4	0.04	0.11	1.30
Contacts in other firms	0.15	0.08	4.2	0.04	0.10	1.17
Number of employees	0.01	0.004	4.1	0.04	0.10	1.01

Note: backward stepwise selection is employed.

services. The services provided by the two institutes are divided into two groups according to the degree of information gap involved.

Group A: 'low information gap' services:

- product testing and evaluation using the institute's equipment;
- open use of testing and evaluation equipment by users on their own.

Group B: 'high information gap' services:

- technical advice and guidance;
- engineer training;
- lectures and workshops;
- study groups organised by the institute;
- joint or commissioned research.

As the previous literature review suggests, the two groups of services are different in the degree of information gap for the following reasons. First, the services in group A are more tangible as their delivery relies on the use of hardware. Users can see testing and evaluation equipment and form their opinion about how good the equipment is. For service providers, one of the most important ways of providing customer satisfaction is tangible facilities which customers can observe (Zeithaml et al., 1990). User SMEs can easily identify the quality of group A's services with the equipment used. In contrast, it is harder to relate group B's services directly with any equipment. The production of group B's services relies much more on expertise of the institute's staff, rather than its equipment per se. This increases intangibility of group B's services, making it harder to judge their quality in advance. Second, the production of services in group A relies less on communication between the user and the institute. When product testing and evaluation is ordered, the order can carry a small amount of information (e.g. 'can you check if this product passes a test for standards?'). In the case of open use of equipment by the user on its own, communication between the user and the institute is minimal. Compared with these, the production of group B's services relies much more on communication between the user and the institute. Last but not the least, group A's services produce returns in a visible manner immediately. Results of tests and evaluations are given to the user in numbers and charts. The outputs (e.g. 'whether a product passes a test', 'what figures a product shows in specific indices') are what the user expects from tests and evaluations, and they have a clear link to the user's future actions (e.g. shipment of a product, improvement in the areas identified weak). In contrast, group B's services are likely to produce outputs hard to measure and take a long time to recoup the investment. On the whole, the previous differences make the degree of information gap involved in group A's services much lower than that in group B's services. Further, many services in group B, such as joint or commissioned research and engineer training, are more time consuming, involve more uncertainty about their returns, and require more absorptive capacity than group A's services.

These two groups of services show distinct patterns of the usage by the length of the period for which users have used the institute. Table 4 shows those using Precision Technology Research Institute's 'low information gap' services and 'high information gap' services as percent of the total users. The percentages are presented by the number of years since the first use of the institute. Almost all user firms make use of 'low information gap' services irrespective of the length of relationships. In contrast, users of 'high information gap' services are small among those clients using the institute for <5 years. The percentage significantly

Table 4
Users of 'low information gap' and 'high information gap' services of Precision Technology Research Institute as percent of the total

Number of years since the first use	'Low information gap' (%)	'High information gap' (%)
<5	100.0	13.3
5–14	93.9	42.4
15–24	95.5	45.5
≥25	100.0	76.9
≥5	95.6	50.0[a]

[a] The null hypothesis that "the use of 'high information gap' services is the same between those firms using the institute for <5 years and those firms for ≥5 years" is rejected at the significance of 0.002.

Table 6
Clients using 'low information gap' and 'high information gap' services of Textile Research Institute as percent of the total

Number of years since the first use	'Low information gap' (%)	'High information gap' (%)
<5	75.0	25.0
5–14	76.9	69.2
15–24	86.4	72.7
≥25	90.3	80.7
≥5	86.6	76.1[a]

[a] The null hypothesis that "the use of 'high information gap' services is the same between those firms using the institute for <5 years and those firms for ≥5 years" is rejected at the significance of 0.03.

increases as clients use the institute for ≥5 years, and keeps rising as the period becomes long.

The significance of the length of relationships is confirmed by a binary logistic regression analysis. The analysis was conducted to identify a set of variables that best accounts for whether user firms of Precision Technology Research Institute use its 'high information gap' services. The variables in Table 2 were employed as an initial set of independent variables. Table 5 shows the result. Of the three predictor variables selected, the number of years since the first use has the largest standardised coefficient estimate (0.23). This is followed by the number of individuals in other firms (excluding suppliers/customers and consultancies) and the number of individuals in universities to discuss technical matters with and seek for advice from. In other words, how long user firms have used the institute has the largest influence in determining the use of 'high information gap' services. The odds for the use of 'high information gap' services increase by 8% with an additional year of the use. The length of relationships is complemented by the tendency of user firms to discuss technical matters with individuals attached to other firms and universities, the latter of which being a source SMEs are less likely to approach in such occasions than their suppliers and customers. It is also worthy to note that the distance to the institute does not play a significant role in accounting for whether user firms use 'high information gap' services. In other words, physical proximity does not much affect the decision to use 'high information gap' services once firms start using the institute through its 'low information gap' services.

The same patterns of usage are observed among textile SMEs in Kyoto although in a less marked way. Table 6 shows their use of 'low information gap' services and 'high information gap' services provided by Textile Research Institute. As in Table 4, the percentages are presented for each cohort of users by the length of the period since the first use. Differences from the previous Nagano case can be summarised as the following: (a) the percentage of user firms using 'low information gap' services is in the range between 75 and 90%, meaning that 10–25% of clients use 'high information gap' services alone, and (b) the percentage of firms using 'high information gap' services is

Table 5
Use of Precision Technology Research Institute's 'high information gap' services by clients: maximum likelihood estimates of logistic regression function

Variable	Coefficient estimate	S.E.	Wald χ^2	Significance	Standardised estimate	Odds ratio
Intercept	−2.26	0.59	14.6	0.00		
Years since the first use	0.07	0.03	7.8	0.01	0.23	1.08
Contacts in other firms	0.14	0.07	4.0	0.05	0.14	1.15
Contacts in universities	0.67	0.34	4.0	0.05	0.14	1.95

Note: backward stepwise selection is employed.

higher than the Nagano case, and particularly among those firms who have used the institute for 5–24 years. Yet, the following observations are consistent with the Nagano case. First, for each cohort, users of 'high information gap' services are consistently smaller in number than users of 'low information gap' services. Second, users of 'high information gap' services are a minority among those clients using the institute for <5 years. Third, the percentage of clients using 'high information gap' services significantly increases as they use the institute for 5 years and over. Lastly, the percentage of clients using 'high information gap' services grows as clients use the institute longer. In other words, a majority of firms start using the institute with 'low information gap' services and later move on to 'high information gap' services. Compared with the Nagano case, many of the firms start using 'high information gap' services more quickly.[4]

The significance of the length of relationships is again confirmed by a binary logistic regression analysis (Table 7). The analysis found a set of two variables the most effective at accounting for the use: the number of years since the first use and the number of individuals at other firms affiliated to the same trade association to discuss technical matters with and seek for advice from. With similar values of standardised coefficient estimates, the two predictor variables have almost the same impacts. The odds for the use of 'high information gap' services increase by 6% with an additional year of the use of the institute.

One of the underlying factors that induce client firms to use 'high information gap' services is improvement in communication with the institute. Table 8 shows client firms' evaluation of how well Precision Technology Research Institute's staff can communicate with them. When compared with firms using 'low information gap' services alone, those using 'high information gap' services give significantly higher marks on the ability of the institute's staff. This suggests that those users who have reached a high level of effectiveness in communication with the institute's staff feel comfortable enough to use its 'high information gap' services. Also, the use of 'high information gap' services is considered to strengthen the communication because of their communication-intensive nature. As for Kyoto firms using Textile Research Institute, significant differences were not found between those using its 'high information gap' services and those not. This point will be discussed later.

Perceived returns to previous use are another factor that induces firms to use 'high information gap' services. Tables 9 and 10 show what percentage of the client firms benefited from the use of Precision Technology Research Institute and Textile Research Institute respectively during the previous 2-year period. Perceived returns to previous use form expectations for current usage. In other words, the higher the percentage, the higher possibility of gaining benefits firms expect. As the two tables indicate, the percentage of the users reporting benefits is higher among those using 'high information gap' services, compared with the clients using 'low information gap' services alone. This suggests that client firms using 'high information gap' services, which are in general more risky and resource consuming than 'low information gap' services, have gained evidence of a higher success rate from their previous use of the institutes so that they justify their current use of 'high information gap' services.

These show that improvement in communication (for Nagano firms) and perceived returns to previous use (for both Nagano and Kyoto firms) have taken place more evidently with those firms using 'high information gap' services than firms using 'low information gap' services alone. The relational changes

[4] The differences in findings between the two institutes cannot be well accounted for either by the sectors they target or by their charging policies.

First, whether an industry has high or low technology intensity does not account for the observed differences. In general, it is assumed that firms in a high technology industry have a greater innovation capacity than firms in an industry of low technology intensity, and such firms with a greater innovation capacity (e.g. qualified scientists and technologists) are more likely to use external sources like research institutes and universities.

In the case of the present study, SMEs in Nagano Prefecture operate in an industry of higher technology intensity (i.e. electrical, electronic and precision engineering) and on average employ a larger number of graduates with a science/engineering degree than textile SMEs in Kyoto Prefecture. According to the previous assumption, Nagano firms would be more likely to use Precision Technology Research Institute, particularly its 'high information gap' services earlier, which is quite opposite to the findings.

Second, as Shapira (1996) points out, design principles of *kosetsushi* centres are to a great extent standardised across the country. Between Precision Technology Research Institute and Textile Research Institute, no significant differences are found between their charging policies.

Table 7
Use of Textile Research Institute's 'high information gap' services by clients: maximum likelihood estimates of logistic regression function

Variable	Coefficient estimate	S.E.	Wald χ^2	Significance	Standardised estimate	Odds ratio
Intercept	−1.08	0.79	1.8	0.18		
Contacts in the own association	1.50	0.68	4.8	0.03	0.20	4.46
Years since the first use	0.06	0.03	4.6	0.03	0.19	1.06

Note: backward stepwise selection is employed.

Table 8
Clients' evaluation of the ability of Precision Technology Research Institute's staff to communicate with them, compared with the minimum standard they seek in external sources of technical knowledge

	Much worse (%)	Worse (%)	Just as good (%)	Better (%)	Much better (%)
Clients using 'high information gap' services	0.0	5.3	28.9	60.5	5.3
Clients not using 'high information gap' services	6.5	2.2	56.5	32.6	2.2

Note: the means for the two groups of firms are different at the significance of 0.01.

Table 9
Clients benefiting from the use of Precision Technology Research Institute during the previous 2-year period as percent of the total

	Any benefits	Improvement of existing products	Development of new products	Improvement of existing processes
Clients using 'high information gap' services	82.5*	42.5	27.5	30.0**
Clients not using 'high information gap' services	64.6	37.5	16.7	12.5

* Denote that the percentages are different between the two groups of firms at the significance level of 0.10.
** Denote that the percentages are different between the two groups of firms at the significance level of 0.05.

Table 10
Clients benefiting from the use of Textile Research Institute during the previous 2-year period as percent of the total

	Any benefits	Improvement of existing products	Development of new products	Improvement of existing processes
Clients using 'high information gap' services	70.3*	32.8	10.9	18.8**
Clients not using 'high information gap' services	50.0	29.1	0.0	4.2

* Denote that the percentages are different between the two groups of firms at the significance level of 0.10.
** Denote that the percentages are different between the two groups of firms at the significance level of 0.05.

are considered to induce firms to start and keep using 'high information gap' services. As both the relational changes generally take place over time, this supports the finding that the length of relationships is a primary factor to determine whether firms use 'high information gap' services.[5]

[5] As mentioned in footnote 2, the two institutes keep lower the fees for 'high information gap' services relative to their costs, as compared with 'low information gap' services. In spite of this, take-up of 'high information gap' services tends to follow the use of 'low information gap' services. This provides additional support for the finding.

5. Discussion

Interviews with user firms confirm the previously mentioned pattern of usage wherein the length of relationships exerts a significant influence. All interviewed firms with a few exceptions started their use of Precision Technology Research Institute and Textile Research Institute with testing and evaluation services. The services make use of the type of equipment each SME cannot afford to purchase on its own because of high costs and infrequent usage. Also, even if they can undertake tests with their own equipment, firms appreciate the services as a judgement from a third party

intermediary. For instance, when firms have different test results on their products from those obtained at their customers' sites, they ask the institutes for another test to resolve the disputes. The public standing of the institutes adds value to this particular type of usage.

After the initial contact, the use of testing and evaluation services tends to recur. Through repeated transactions, user firms deepen their relationships with staff of the institutes. Unlike private-sector providers specialised in testing and evaluation services, staff of the institutes discuss with users about test results and possible causes of identified problems, using their knowledge which often derives from their research. Such interactions with staff of the institutes allow users to know research areas of the staff and other services of the institutes. Mutual knowledge of the past history of relationships also strengthens the ease of use. The history of the services they have received and the problems they have resolved with the assistance of the institutes provides a clue to solving a new issue as well as an opportunity of collaboration. The initial period in which firms use testing and evaluation services alone serves as a key driver to their enlarging the use to other areas of services involving a higher degree of information gap.

Take-up of 'high information gap' services after an initial learning period happens with both small firms and medium-sized firms although its extent differs. Table 11 shows the percentages of firms using Precision Technology Research Institute's 'high information gap' services by the size of firm as well as the length of relationships. If the length of relationships is divided into '<5 years' and '≥ 5 years', the percentage of firms using 'high information gap' services increases from 0 to 38% for firms with less than 50 employees as well as from 29 to 76% for firms with 50 employees to 299 employees. As reviewed earlier, what prevent SMEs from using knowledge providers include the lack of capacity for searching and utilising knowledge sources and putting knowledge into practice as well as information gaps involved in the transaction. When compared with medium-sized firms, the lack of capacity is likely to be a more significant factor for small firms. As 'high information gap' services tend to be more difficult to assimilate and utilise, the growth of small firms using the services suggests the possibility that they not only reduce information gaps by accumulating first-hand reputations of the institute (Clark, 1995) but also build their capacity for utilising the institute through learning-by-interacting during the initial period.

Table 11
Users of 'high information gap' services of Precision Technology Research Institute as percent of the total by employment size

Number of years since the first use	Employees 1–49 (%)	Employees 50–299 (%)
<5	0.0	28.6
≥ 5	38.3	76.2

Note: the null hypothesis that "the use of 'high information gap' services is the same between those firms using the institute for <5 years and those firms for ≥ 5 years" is rejected at the significance of 0.04 and 0.06 for firms with 1–49 employees and firms with 50–299 employees, respectively (Fisher's exact test).

The Nagano and Kyoto cases also show that the length of relationships is a key driver to the usage of 'high information gap' services whether the institute takes a 'one-to-one' approach or a 'collective network' approach. In the analysis of the Kyoto case (Table 7), it is found that the use of Textile Research Institute's 'high information gap' services is best accounted for by a set of two variables: length of relationships and number of individuals in the same trade association to discuss technical matters with and seek advice from. The second variable can be interpreted as how far firms get their technical concerns and interests on their own association's agenda and make them reflected by the association's request to the institute (Izushi, 2002). The result of the logistic regression analysis suggests that the more the firm is involved in formulating the trade association's 'voice' to the institute, the more likely it is to use the institute's 'high information gap' services. The influence trade associations exert upon the institute allows affiliated firms to reduce information gaps and hence make use of 'high information gap' services in an early period. Further, mediation made by trade associations appears to substitute for close communication between individual firms and the institute. This may to some extent explain why there are not any significant differences between users and non-users of 'high information gap' services in the evaluation of communication with the staff of Textile Research Institute. All these evidence signifies comparative advantages of a 'collective network' approach over a 'one-to-one' approach. Yet, the results of the

analysis in Table 7 suggest that the length of relationships remains a key driver to facilitating the use of 'high information gap' services.

Finally, these findings from the cases of Japanese *kosetsushi* centres are considered highly relevant to US modernisation programmes as well as other 'intermediate' research institutes operating with similar mandates in other industrialised nations.[6] In assessing the generalisability of the research findings, the rest of this section considers differences between *kosetsushi* centres and US modernisation programmes with respect to (1) market for external sources of technical information and (2) operational design characteristics such as range of services and staffing.

Studies suggest that SMEs in some Japanese industries (e.g. automotive, electronics) are embedded in semi-vertically integrated networks and seek for technical information primarily from trading partners (Sako, 1992; Nishiguchi, 1994). This implies a possibility that the findings about the usage of *kosetsushi* centres are unique to the context of the country's market for external sources of technical information. Interviews with users of Precision Technology Research Institute reveal that they use trading partners (and particularly customers) and the institute on different occasions. They often consult with customers when they have technical problems specific to products supplied to the particular customers. On the other hand, they seek assistance from the institute on technical issues not specific to any single customer. Given the division between the two sources, the use of Precision Technology Research Institute might be less frequent than it would be if firms were not situated in semi-vertically integrated structures. However, it is most likely that the significance of the length of relationships remains unchanged. A comparison of the Nagano case and the Kyoto case further supports this. While Nagano firms are often semi-vertically integrated and rely more on customers/suppliers for technical knowledge (see Table 2), Kyoto firms do not have such semi-vertically integrated structures and are more active in horizontal networking through trade associations. In spite of the difference, the length of relationships is identified as a key driver to the shift in usage towards 'high information gap' services in both cases. This suggests that the paper's findings are not dependent on the market context in which *kosetsushi* centres compete with semi-vertically integrated supply chains as sources of technical information.

The other point to be considered is differences between *kosetsushi* centres and many US modernisation programmes in the range of services and staffing arrangements. US modernisation programmes are generally aimed at providing problem diagnostics and off-the-shelf technical solutions. In contrast, *kosetsushi* centres provide services that follow a wider range of progression in terms of information asymmetry (from testing and evaluation services to near-market and applied research) as well as in terms of uncertainty of economic gains and R&D intensity. Further, US modernisation programmes often rely on contracts with independent consultants rather than in-house staff in the delivery of services. In contrast, the use of outside consultants is minimal at *kosetsushi* centres (i.e. limited to the use of a small number of registered advisers, most of whom are retired engineers). *Kosetsushi* staff are also likely to enjoy a longer tenure, virtually guaranteed life-time employment by their local governments.

A closer examination reveals that *kosetsushi* centres are designed to be more robust than US modernisation programmes in developing and retaining relational assets with user firms over time. A great majority of firms start using a *kosetsushi* centre through testing and evaluation services that rely heavily on equipment the centre possesses. Through repeated use of the services, user firms build trust with *kosetsushi* staff and extend the range of services they use from testing and evaluation services to other services involving a higher degree of information gap. In other words, building of relational assets initially relies on the centre's physical capital (i.e. equipment), which is not attached to any particular staff member, and gradually shifts its relational foundation to the centre's human capital (i.e. research staff).

This is somewhat similar to the use of a library. Users of a library are more often attracted by the library's stock of books in the initial instance than by services of its librarians. As users repeat their use of the library, they are likely to find out 'soft' services based on its librarians' expertise and learn how to make more sophisticated use of the library as a source of exploring information and developing knowledge.

[6] Rush et al. (1996) provide several case studies of intermediate research institutes in Europe and Asia.

Such sophisticated use involves high value added by the librarians and does not necessarily rely on books owned by the library.

In similar vein, *kosetsushi* centres are designed to build relational assets with user firms through both its physical capital and human capital. The two kinds of resources of *kosetsushi* centres complement and strengthen each other when developing relationships with user firms. The complementary nature of relation building also often broadens the range of *kosetsushi* staff members whom user firms relate to. Accordingly relational assets are built not only with individual staff members but also with a *kosetsushi* centre's organisation that embodies both physical capital and human capital.[7] This makes it relatively easy for a *kosetsushi* centre to maintain relational assets with user firms even if a particular staff member leaves the centre. The system is further reinforced by the long-term tenure of staff. The learning process of user firms can also go to a long distance as the centres' services range widely from testing and evaluation to joint research. Such a progression in learning is underpinned by *kosetsushi* centres' design that facilitates long-term relationships.

In contrast, the design of US modernisation programmes is less optimised to facilitating long-term relationships with user firms. They make more use of independent consultants rather than in-house staff to deliver services. Contracts with independent consultants can be short-term. Also a turnover rate of in-house staff is likely to be much higher than at *kosetsushi* centres. More importantly, many US modernisation programmes do not offer physical capital-based, 'entry' services that generate repeat use. Lacking interactions that would result from the use of such services, the programmes lose an opportunity of tying personal trust users develop in relation to some particular staff members (including independent consultants) to their organisation and other staff members. This may compound their difficulty developing and retaining relational assets over time. With these design characteristics, US modernisation programmes are less well tuned to facilitating long-term relationships with users and creating demands from technology-followers for services that involve a high degree of information gap. Further, a possible progression of learning within US modernisation programmes is shorter than *kosetsushi* centres as they do not provide such 'high information gap' services as joint research. The lack of a long progression path of learning might render the paper's findings latent within US modernisation programmes.

In short, although labour market conditions (i.e. higher turnover rate) and staffing policy (i.e. higher dependence upon independent consultants) are often considered as key constraints (and advantages in flexibility and adaptability to technological change as well) in US modernisation programmes, they can take more advantage of the SME behaviour found in the present study by adopting some operational design changes. They include: (1) provision of low-barrier, 'entry' services that generate repeat use; (2) a high level of physical capital (i.e. equipment and facilities) in the contents of 'entry' services; and (3) a long progression path of learning within a whole range of services provided.

6. Conclusion

Using a survey data of two Japanese intermediate research institutes called *kosetsushi* centres, the paper tests a hypothesis regarding the length of user–institute relationships as a key driver to change in their usage with respect to types of services. A great majority of SMEs start using the research institutes with those services that involve a lower degree of information gap and produce more immediate effects. As the users improve communication with the institutes and accumulate evidences of returns, they begin to use a wider range of services that include those involving a higher degree of information gap and requiring a greater capacity to assimilate. Although mediation by trade associations helps affiliated firms use 'high information gap' services sooner, the shift towards 'high information gap' services over time is observed whether collective mediation exists or not.

[7] It is found from interviews that while senior engineers of user firms tend to communicate with the *kosetsushi* centres' senior staff at a similar age, the trust they build for the centres is transferred across different generations of engineers within the user firms, and newly recruited junior engineers form relationships with the institutes' junior staff at a similar age. Transfer of institutional trust within user firms also takes place between different product groups who would deal with different members of the *kosetsushi* centres' staff. This suggests that institutional trust occupies an essential part in the bond between user firms and the *kosetsushi* centres.

The paper demonstrates that long-term relationships are a key driver to facilitating organisational learning and convincing SMEs of the use of 'high information gap' services: a proposition that has been frequently presumed but seldom tested empirically in the literature. The likelihood that the use of services shifts towards those containing a higher degree of information gap is partly influenced by the firm's outward-looking style of management (as in the case of Nagano firms) or its involvement in collective mediation between firms and a research institute (as in the case of Kyoto firms). However, repeated transactions over time are found to be one of the most important drivers of the shift, which converts even small firms with a relatively weak absorptive capacity into users of 'high information gap' services. Further, the paper challenges supply-side propositions about the importance of distance in accounting for the use or nonuse of 'high information gap' services. It provides evidence that the likelihood of the usage shift towards 'high information gap' services is under little influence of distance between the user and the institute.[8] These findings are considered applicable to similar programmes in other industrial nations including the US. The paper shows the relevance of its findings by examining the market context of *kosetsushi* centres and their design principles with respect to their services and staffing arrangements.

The paper's findings lends strong support to a proposition set forth by Glasmeier (1999, p.82) and Rush et al. (1996, p.191) about the importance of 'entry' services. Glasmeier argues that industrial modernisation programmes need to offer solutions to rather routine problems that start a long process of building trust necessary for a client to accept more strategic assistance. In similar vein, Rush et al. take notice of testing services as such an 'entry' service in their study of intermediate research institutes in several industrialised nations. As users of a library are often attracted by its stock of books and gradually move on to more sophisticated use that takes advantage of the librarians' expertise, hardware-based testing and evaluation services of *kosetsushi* centres serve as an easy point of entry that gradually leads users over time to more intensive use of research staff's expertise. By combining the use of physical capital (i.e. testing and evaluation equipment) and human capital (i.e. research staff), *kosetsushi* centres maximise and retain relational assets with user firms. Under a casual inspection, the provision of testing and evaluation services by *kosetsushi* centres might appear to be as distraction to their research staff engaged in applied, near-market research. However, it attracts those SMEs that would not otherwise access the institutes and convert a significant part of them into users of 'high information gap' services. Further, it gives the institutes' staff an opportunity to learn needs and problems of wider clientele, which are in turn fed back into their research programmes.

The paper's findings also suggest the need for some degree of policy and institutional continuity on the part of industrial modernisation programmes. What encourages SMEs to use 'high information gap' services is to a great extent specific to their relationships with the provider. The relational assets are not transferable to other providers and can be lost if the provider introduces drastic changes in its operational framework. While industrial modernisation programmes need to adapt their organisations and delivery schemes to new needs and thus avoid the 'perverse policy syndrome' (Bennett et al., 1994), they should also pay attention to the balance between renewal and continuity in terms of their institutional framework and staffing so that benefits of relational assets can be maximised.

[8] This rings well with the suggestion of Bennett et al. (2000, p.827) that trust-based relationships (which would facilitate the use of 'high information gap' services) and distance are not strongly statistically interrelated.

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References

Aoyama, Y., 1999. Policy interventions for industrial network formation: contrasting historical underpinnings of the small business policy in Japan and the United States. Small Business Economics 12 (3), 217–231.

Beise, M., Stahl, H., 1999. Public research and industrial innovations in Germany. Research Policy 28 (4), 397–422.

Bennett, R.J., Robson, P.J.A., 1999. Intensity of interaction in supply of business advice and client impact: a comparison of consultancy, business associations and government support initiatives for SMEs. British Journal of Management 10, 351–369.

Bennett, R.J., Wicks, P., McCoshan, A., 1994. Local Empowerment and Business Services: Britain's Experiment with Training and Enterprise Councils. UCL Press, London.

Bennett, R.J., Bratton, W.A., Robson, P.J., 2000. Business advice: the influence of distance. Regional Studies 34 (9), 813–828.

Charles, D., Howells, J., 1992. Technology Transfer in Europe: Public and Private Networks. Belhaven Press, London.

Clark, T., 1995. Managing Consultants: Consultancy as the Management of Impressions. Open University Press, Buckingham.

Commission of the European Communities, 1994. Research and Technology Management in Enterprises: Issues for Community Policy. Office for Official Publications of the European Communities, Brussels.

Curran, J., Blackburn, R., 1994. Small Firms and Local Economic Networks: The Death of the Local Economy? Paul Chapman, London.

Dodgson, M., Bessant, J., 1996. Effective Innovation Policy: A New Approach. International Thomson Business Press, London.

Feller, I., 1993. What agricultural extension has to offer as a model for manufacturing modernization. Journal of Policy Analysis and Management 12 (3), 574–581.

Feller, I., 1997. Manufacturing technology centers as components of regional technology infrastructures. Regional Science and Urban Economics 27 (2), 181–197.

Feller, I., Nelson, J.P., 1999. The microeconomics of manufacturing modernization programs. Research Policy 28, 807–818.

Feller, I., Glasmeier, A., Mark, M., 1996. Issues and perspectives on evaluating manufacturing modernization programs. Research Policy 25 (2), 309–319.

Fuellhart, K., 1999. Localization and the use of information sources: the case of the carpet industry. European Urban and Regional Studies 6 (1), 39–58.

Gallouji, C., 1997. Asymmetry of information and the service relationships: selection and evaluation of the service provider. International Journal of Service Industry Management 8 (1), 42–64.

Gittell, R.J., Kaufman, A., 1996. State government efforts in industrial modernization: using theory to guide practice. Regional Studies 30 (5), 477–492.

Glasmeier, A.K., 1999. Territory-based regional development policy and planning in a learning economy: the case of 'real service centres' in industrial districts. European Urban and Regional Studies 6 (1), 73–84.

Glasmeier, A.K., Fuellhart, K., Feller, I., Mark, M.M., 1998. The relevance of firm-learning theories to the design and evaluation of manufacturing modernization programs. Economic Development Quarterly 12 (2), 107–124.

Harrison, B., 1994. Lean and Mean: The Changing Landscape of Corporate Power in the Age of Flexibility. Basic Books, New York.

Hassink, R., 1997. Technology transfer infrastructures: some lessons from experiences in Europe, the US and Japan. European Planning Studies 5 (3), 351–370.

Hirschman, A.O., 1970. Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and States. Harvard University Press, Cambridge, MA, USA.

Hitchens, D.M.W.N., O'Farrell, P.N., Conway, C.D., 1994. Business service use by manufacturing firms in Mid Wales. Environment and Planning A 26 (1), 95–106.

Holmstrom, B., 1985. The provision of services in a market economy. In: Inman, R.P. (Ed.), Managing the Service Economy: Prospects and Problems. Cambridge University Press, Cambridge, MA, USA, pp. 183–213.

Izushi, H., 2002. 'Voice' approach of trade associations: support for SMEs accessing a research institute. Environment and Planning C: Government and Policy 20 (3), 439–454.

Joly, P.B., Mangematin, V., 1996. Profile of public laboratories, industrial partnerships and organisation of R&D: the dynamics of industrial relationships in a large research organisation. Research Policy 25 (6), 901–922.

Kelley, M.R., Arora, A., 1996. The role of institution-building in US industrial modernization programs. Research Policy 25 (2), 265–279.

Luria, D., Wiarda, E., 1996. Performance benchmarking and measuring program impacts on customers: lessons from the Midwest Manufacturing Technology Center. Research Policy 25 (2), 233–246.

Mackun, P., MacPherson, A.D., 1997. Externally-assisted product innovation in the manufacturing sector: the role of location, in-house R&D and outside technical support. Regional Studies 31 (7), 659–668.

MacPherson, A., 1991. Interfirm information linkages in an economically disadvantaged region: an empirical perspective from metropolitan Buffalo. Environment and Planning A 23 (4), 591–606.

Mason, G., Wagner, K., 1999. Knowledge transfer and innovation in Germany and Britain: "intermediate institution" models of knowledge transfer under strain? Industry and Innovation 6 (1), 85–109.

Morgan, K., 1996. Learning-by-interacting: inter-firm networks and enterprise support. In: OECD (Editor), Networks of Enterprises and Local Development: Competing and Co-Operating in Local Productive Systems. OECD, Paris, pp. 53–66.

Nishiguchi, T., 1994. Strategic Industrial Sourcing: The Japanese Advantage. Oxford University Press, New York.

O'Farrell, P.N., Hitchens, D.M., 1990. Producer services and regional development: key conceptual issues of taxonomy and quality measurement. Regional Studies 24 (2), 163–171.

Oldsman, E., 1996. Does manufacturing extension matter? An evaluation of the Industrial Technology Extension Service in New York. Research Policy 25 (2), 215–232.

Olson, M.J., 1965. The Logic of Collective Action: Public Goods and the Theory of Groups. Harvard University Press, Cambridge, MA, USA.

Rosenberg, N., 1982. Inside the Black Box: Technology and Economics. Cambridge University Press, Cambridge, MA, USA.

Rothwell, R., Dodgson, M., 1991. External linkages and innovation in small and medium-sized enterprises. R&D Management 21 (2), 125–137.

Rush, H., Hobday, M., Bessant, J., Arnold, E., Murray, R., 1996. Technology Institutes: Strategies for Best Practice. International Thomson Business Press, London.

Sako, M., 1992. Prices Quality and Trust: Inter-firm Relations in Britain and Japan. Cambridge University Press, Cambridge, MA, USA.

Shapira, P., 1992. Modernizing Small Manufacturers in Japan: the Role of Local Public Technology Centers. Journal of Technology Transfer (Winter), 40–57.

Shapira, P., 1996. Modernizing small manufacturers in the United States and Japan: public technological infrastructures and strategies. In: Teubal, M., Foray, D., Justman, M., Zuscovitch, E. (Eds.), Technological Infrastructure Policy: An International Perspective, Kluwer Academic Publishers, Dordrecht, pp. 285–334.

Shapira, P., 2001. US manufacturing extension partnerships: technology policy reinvented? Research Policy 30 (6), 977–992.

Shapira, P., Roessner, J.D., Barke, R., 1995. New public infrastructure for small firm industrial modernization in the USA. Entrepreneurship & Regional Development 7, 63–84.

Shapira, P., Youtie, J., Roessner, J.D., 1996. Current practices in the evaluation of US industrial modernization programs. Research Policy 25 (2), 185–214.

Storey, D.J., 1994. Understanding the Small Business Sector. Routledge, London.

US Congress Office of Technology Assessment, 1990. Making Things Better: Competing in Manufacturing, OTA-ITE-443. US Government Printing Office, Washington, DC, USA.

Yamamoto, K., Matsuhashi, K., 1999. Networking in an industrial area characterized by agglomeration of SMEs. Hosei University Economic Review 66 (3/4), 85–182.

Zeithaml, V.A., 1981. How consumer evaluation processes differ between goods and services. In: Donnelley, J.H., George, W.R. (Eds.), Marketing of Services. American Marketing Association, Chicago, pp. 186–190.

Zeithaml, V.A., Parasuraman, A., Berry, L.L., 1990. Delivering Quality Service. Free Press, New York.