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Abstract: Co-operation is one way for companies to complement their own resources with those of other, and thus to benefit from skills possessed by other organisations. Innovation is also stimulated by encounters of different skills. Here we view co-operation as a particular learning strategy. The objective of the studies presented here was to study the effects that co-operation within the areas of R&D and skills development have on a company's productivity, the occurrence of co-operation in Swedish business and regional differences. Our study is one of the few that are based on a large body of empirical data, comprising approx. 1,000 company responses, and that aim to draw general conclusions.

The results of the analyses show that co-operation has a positive impact on a company's productivity. However, this does not mean that all forms of co-operation lead to high productivity. Relationships that extend over large geographical areas, both within and outside Sweden, are highly important. Yet it can also be important for a company to have a base within its own region. The effect on productivity is between four and five per cent. It is also important that co-operation is focused on a small number of actor groups, and the most important actors are customers and suppliers. The study also shows that small companies engage in less co-operation.

There are also differences in patterns of co-operation between different types of regions, and companies in small regions engage in co-operation to a lesser extent. Co-operation also turns out to be linked to differences in regional economic growth, especially co-operation with only a few actor groups.

Introduction

In a world of growing international competition, changing customer requirements and increasing acceleration of the pace of technical innovation, a company's ability to compete and survive is becoming increasingly dependent on the skills of its employees and its ability to predict change, to adapt to new circumstances, and to create new solutions, products and production processes. The causes and forces behind growth must, therefore, be sought to a growing extent within the company itself. In research into the areas of management and innovation alike, heavy emphasis is being placed on skill development within the company. A company can acquire knowledge from outside sources, such as by recruiting employees with special training, purchasing consulting services or participating in forms of co-operation with other companies. Knowledge can also be created within the company as a result from formal training programmes, but also from organising work in such a way as to help employees develop their skills on the job.

A study entitled FLEX-1, conducted by NUTEK in 1995, has shown that company strategies which place emphasis on a decentralised form of structuring work and on the development of skills have a positive impact on factors such as company productivity. [NUTEK 1996] A couple of years later, a new study – FLEX-2 – was initiated, and designed to take additional learning strategies into account as well. One of these learning strategies was co-operation. We have a reasonably good understanding of how co-operation works between individual companies and within particular collaborative projects, since many of the studies that have been conducted are "case" studies or studies of specific sectors. The NUTEK study, however, is one of only a very few that are based on a large volume of empirical data, and that aim to arrive at some general conclusions regarding the significance of co-operation with other

partners to a company's level of productivity.

In the present paper, we will report on some of the results of our ongoing research into co-operation. The aim of the particular part of the study that is described herein was to examine the occurrence of co-operation and its impact on productivity. In addition to providing an overall picture of co-operative patterns found within the business world in Sweden, we also analyse the presence of co-operation in different sized companies and within the various sectors. In addition, results from a different study in which regional differences were analysed will also be presented. In this regional report, we have examined the ways in which learning strategies differ between companies in different regions, and we have asked whether these differences might be linked to the fact that different regions show differing levels of growth. In this presentation, the focus of our analysis will be limited to co-operation, even though alternative learning strategies are also of considerable importance.

The data

Within the framework of the FLEX-2 project, data was collected that was based partly on information for the year 1997 gathered from telephone interviews and questionnaires distributed by post, and partly on economic and employment data provided by Statistics Sweden for the years 1990–1997. The initial data set consists of a random selection of a total of around 5,600 workplaces, most within the private sector, but some within the public sector as well. The selection and collection of data was carried out by Statistics Sweden.

The analyses of co-operation and regional differences are based on a subset of FLEX-2 workplaces within the private sector and having at least 20 employees. The size of this set

amounts to roughly 2,300 workplaces. Of these, 79 per cent participated in the telephone component of the FLEX-2 survey, while the proportion of workplaces that also answered the questionnaire amounted to 58 per cent. Since not all of the workplaces answered all the questions, we have chosen in this report only to analyse those workplaces that returned fully completed questionnaires, a total of about 1,000 workplaces. We have checked whether this group deviates from the net set in any essential areas, and have found that it does not. The unit of analysis is the workplace, but for the sake of simplicity, we will use the term "company" henceforth.

Why is co-operation with others important?

A number of explanations can be found in studies on economics for why co-operation strengthens a company's ability to compete and to develop. One explanation is that interaction between different partners stimulates innovation and product development activities, since new knowledge tends to arise in the border area between established areas of skill. Co-operation also means that several different partners share the costs and risks that are a part of any attempt to innovate. In addition, technical innovations that are supported by several different companies have a greater chance of gaining acceptance. [Ekstedt et al. (1994), Håkansson (1989), Johannisson and Lindmark (1996), Larsson (1998) and Gustavsen and Hofmaier (1997)]

Another explanation is that co-operation leads to reduced transaction costs. In this case, what is meant by transaction costs are the costs involved in identifying an adequate partner, entering into agreements and ensuring that these agreements are adhered to. Through co-operation, a company can build up trust in other partners, which facilitates the exchange of information and experience. [Johannisson and Lindmark (1996)]

Yet another explanation is that co-operation creates opportunities for specialised companies to become more flexible in terms of customer requirements. The rise in global competition have led many companies in Sweden to specialise their activities. Companies are producing fewer and fewer components themselves, while, at the same time, more and more customers are demanding complete products, as opposed to individual components. In order for companies to meet these demands, they are forced to enter into co-operative arrangements with other suppliers. This phenomenon is referred to in the literature as "flexible specialisation". [Ekstedt et al. (1994)]

How do we measure co-operation?

We have attempted to measure co-operation by asking questionnaire respondents to specify which areas of co-operation they participate in and who their particular partners are. One of the areas of co-operation we have studied, and on which we will focus our analysis, is the co-operation within the area of research and development (R&D), as well as skills development, i.e. developing relations or knowledge networks.

In many earlier studies, the objective has been to differentiate between informal and formal co-operation. However, it has not been concluded that informal co-operation is any better or worse than formal co-operation. Indeed, different forms of co-operation have been found to be more or less suitable for different areas of co-operation and different partners. For this reason, our definition of co-operation encompasses the exchange of both ideas and experience, as well as a general agreement to conduct joint activities, i.e. both informal and more formal type of co-operation.

As regards the various partners with whom companies might choose to co-operate, we have decided to distinguish between customers, suppliers, other companies, colleges and universities, other public-sector authorities and other organisations. We have also observed the geographical dimension by requiring the respondents to indicate whether the partners are found within or outside their own geographical region. (The definition of region is the own minicipality and the nearby municipalities.) This information allows us to study several aspects of the issue, including the nature of the co-operation with individual partners, the number of partners with which a company co-operates, and the geographical distribution of the network.

Causality

It is desirable to be able to draw conclusions on causal relationships in order to determine the significance of co-operation. This means that the analysis must be able to show that co-operation does not only show the same variations as the studied effect but also have a causal relation to it, i.e. that the strategy has been implemented prior to the outcome. One method is to measure the outcome at a later point in time than the explanatory factor. Our information on the enterprises' co-operation patterns applies to the situation in 1997. Experience gained from other studies indicates that co-operative relations often are based on long-term relations. As a result of this we consider that we can draw conclusions on the *significance* or *influence* of co-operation on financial performance.

Co-operation among Swedish businesses

Several studies have shown that the most common and most important partners with whom a company engages in co-operation are the company's customers and suppliers, i.e. actors within the system of production. Co-operation is built on relationships, and contact with

customers and suppliers is maintained automatically in conjunction with the company's general business activities. Developing co-operative relationships with others is more difficult and thus somewhat less common. The particular partners with whom the companies included in our survey co-operate are listed in *table 1*.

Our study also shows that customers and suppliers are the most common partners with whom companies co-operate. Then follows co-operation with other companies and other organisations. The fact that the relative share of co-operation with other companies and organisations turned out to be quite high in this study might be due to the fact that these categories comprise numerous sub-groups as well. The "other companies" group, for example, comprises consultants, other companies within the same groups and competitors. Several studies on networking actually distinguish between these sub-groups, in which case the level of co-operation with the various individual sub-groups is not as high.

Table 1. Percentage of companies that co-operate with the respective partners.

Co-operative partner	**R&D and skills development**	**Co-operative partner**	**R&D and skills development**
Customers and suppliers		**Colleges and universities**	21
– within the region	42	– within the region	9
– outside the region	34	– outside the region	
Other companies		**Public organisations**	
– within the region	33	– within the region	15
– outside the region	29	– outside the region	7
High schools		**Other organisations**	
– no division according to region	12	– no division according to region	38

Research has indicated that geographical proximity facilitates personal contacts and stimulates co-operation. At the same time, the degree of specialisation within business has forced companies to go outside their own region to look for suitable partners. It is evident from *table*

1, however, that co-operation within a region is more common that co-operation across regions.

Co-operation with few groups of partners most common

Another way to describe co-operation is by studying the number of co-operative partners. Some companies have networks consisting only of their customers and suppliers. Other companies co-operate with educational institutions and, for example, trade organisations. In this section, we will describe a number of different groups of partners with whom companies co-operate. Starting with the individual partners, we have created four separate groups, each united by a set of common denominators. Customers and suppliers are both involved in the production system, and thus form one group. Other companies also constitute a group. The third group consists of public authorities, including colleges and universities, high schools and public offices. Finally, the fourth group consists of other organisations. *Table 2* shows that the share of companies that only co-operate with one or two groups of partners amounts to 53 per cent, while the share of those who co-operate with three or four groups of partners comprises 29 per cent.

Table 2. Percentage of companies that co-operates with few or many groups of partners.

	R&D and skills development
No co-operation	18
1–2 groups of partners	53
3–4 groups partners	29
Total	*100*

The geographical distribution of the networks

Company networks can also be described based on whether the partners with whom a given

company co-operates are located within or outside the company's own region. The significance of co-operative relationships with partners located within a close geographical proximity has been emphasised in numerous contexts. At the same time, studies show that relationships extending over long geographical distances are often more important to a company's ability to innovate than are relationships with partners located nearby the company. The share of companies that co-operate only with partners within their own region amounted to 34 per cent. A smaller portion, 18 per cent, co-operate only with partners located outside their own geographical region. The share of companies that co-operated with partners located both within and outside their own region amounted to 29 per cent.

Table 3. Percentage of companies that co-operate with partners only within their own region, only outside their own region and both within and outside their own region.

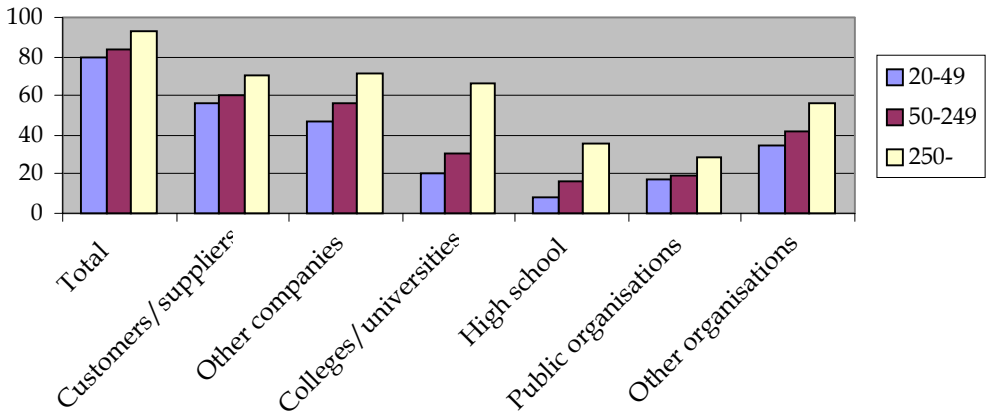
	R&D and skills development
No co-operation	18
Only within the region	34
Only outside the region	18
Both within and outside the region	29
Total	*100*

Small companies co-operate less

In *chart 1*, the figures for co-operation in the areas of R&D and skills development are broken down by company size: 20–49 employees, 50–249 employees and 250 or more employees. The table shows that the larger the size category, the greater the portion of companies that engage in co-operation – regardless of the kind of partners involved. The difference is greatest in the area of co-operation with colleges and universities. For example, we can see that almost 70 per cent of companies with 250 or more employees co-operate with colleges and universities. The figure for companies having between 50 and 249 employees is approx. 30

per cent. For companies having between 20 and 49 employees, the figure is approx. 20 per cent. The fact that co-operation with colleges and universities is more common among larger companies has also been shown in other studies. In a study on the mechanical engineering industry, Larsson (1998) explains this as, in part, a consequence of small companies not having the time required to build up relationships with colleges and universities. A further explanation discussed by Larsson involves the differences in the kinds of formal skills possessed by smaller companies, on the one hand, and colleges and universities on the other. Communication with colleges and universities can be hampered by a scarcity of company employees not having college-level training, meaning that few of these employees speak the "same language" as that spoken by potential counterparts at the colleges and universities. Neither are small companies able to take advantage of employees who maintain informal contact with the educational institutions where they studied.

Chart 1 *Percentage of companies that co-operate in the areas of R&D and skills development, in total and with different partners, broken down by company size.*



It is also evident that the larger the size category, the greater the number of groups of partners that participate in the company's network. The proportion of companies that co-operate with more than two groups of partners is just over 60 percent among the largest size category, and almost 25 per cent among companies having 20–49 employees. Moreover, the networks of

smaller companies are often more limited geographically, meaning that co-operation is carried out to a greater extent with partners located within the company's own region.

Service companies have local networks

Differences between sectors are not as clear as those between size categories. The definition of sector that we have used assumes a division of Swedish business into seven categories, based on the companies' relative use of production factors. The five sectors involved in this particular study are knowledge-intensive industry, knowledge-intensive services, labour-intensive industry, labour-intensive services and capital-intensive services.

In general, it can be concluded that co-operation with the various partners is often lowest among companies within the capital-intensive services sector. We can also see that the level of co-operation with colleges and universities is considerably higher among knowledge-intensive companies than among the other categories. If we look at the number of groups of partners, it is evident that knowledge-intensive companies co-operate with a greater number of groups of partners than do companies within the other sectors. With respect to the geographical distribution of company networks, there are clear differences between the industry and service sectors. The proportion of companies that co-operate only with partners within their own region is considerably higher within the service sectors. This is due in part to the fact that service production is, by nature, a more local affair.

Effects on the company's productivity

In addition to studying the occurrence of co-operation within Swedish business, we are also interested in looking at the added value that is created in terms of value added per employee, i.e. increased productivity, when companies engage in co-operation with external partners.

Our analyses of the impact of co-operation on productivity are based on a model taken from classical economic theory. Productivity is a function of several factors, including capital, the educational level of the labour force, company size and the sector to which a company belongs. In order to study and distinguish the added value created in terms of value added per employee, indicators for co-operation must be included in the equation, in addition to other more traditional factors that are generally considered to contribute to growth. The model also includes other learning strategies that were examined in the FLEX-2 project. In this way, the impact of co-operation on productivity is regardless of differences in the level of skills development, form of work structure and level of IT maturity. The model used here is explained in detail at the end of the report.

The relationship between co-operation and productivity is examined in three separate analyses. First we look at the relationship between the geographical distribution of the network and the level of productivity. We then examine the relationship between the number of different groups of partners with which a company co-operates and the level of productivity. Finally, we look at the relationship between the particular partners with which a company co-operates and the level of productivity. All of the results are presented in *table 4*.

The results of the regressions demonstrate in summary that it is the particular type of network that a company has that is important, not merely whether a company has one. If we look at the geographical dimension, we see that companies that co-operate with partners both within and outside their own region or only with partners outside their region show have on average a 4–5 per cent higher level of productivity than companies that do not co-operate at all. However, it is also evident that companies that only co- operate with partners within their own region

have a somewhat lower level of productivity than companies with no co-operative arrangements at all. The difference is not large, just over 1 per cent, but it is still significant.

Analyses of the number of groups of partners show that companies that co-operate with few groups of partners have a higher level of productivity than companies with no co-operative arrangements at all. On the other hand, it is not possible to determine any difference in productivity levels between companies that co-operate with many different groups of partners and those who do not co-operate with other partners at all.

In common with much other research, our study shows that co-operation with customers and suppliers is most important. Companies that co-operate with customers and suppliers show increased productivity levels of 3.8 per cent and 4.8 per cent, respectively. Co-operation with other organisations also has a positive effect on productivity. The difference between companies that co-operate with other organisations and those who do not is just over 1 per cent.

Those who co-operate with other companies, high schools and public-sector partners, on the other hand, show lower levels of productivity than those who do not co-operate. In the case of public-sector authorities, the difference is almost 12 per cent. Since the study concerns the levels of productivity and not changes in these levels, it is not possible to interpret our results to mean that co-operating with public-sector partners leads to lower productivity. One possible explanation for the figure is that companies that already have low levels of productivity initiate co-operation with public-sector partners – a move that could be an

expression of a need for support. In fact, we have seen that companies that co-operated with public-sector partners in 1997 achieved in general lower growth during the period 1995–1997. In conclusion, it should be noted that the effect of co-operation with colleges and universities is positive, but not significant.

Table 4. The effect of various co-operation indicators on productivity levels in terms of value added per employee.

Co-operation indicator	**Effect on productivity**
Geographical spread	
Only within the region	-1,4%*
Only outside the region	4,0%
Both within and outside the region	4,6%
– compared to companies with no co-operation	
Groups off partners	
Few groups of partners	1,3%*
Many groups of partners	(-) ins
– compared to companies with no co-operation	
Individual co-operative partners	
Customers	3,8%
Suppliers	4,8%
Other companies	-2,7%
Colleges and Universities	(+) ins
High schools	-2,8%
Public authorities	-11,9%
Other organisations	1,4%

Note. (-)ins = insignificant negative connection (+) ins = insignificant positive connection.

In summary, it is evident that, in business in general, the best strategy is to have a network either both within and outside the company's own region or only outside the region. At the same time, it is important to focus on the number of different groups of partners. The significance of having partners both within and outside a company's own region is an aspect that SIR has also emphasised in a report entitled *Närhet och vida nätverk (Closeness and wide networks)* [Rapport 1999:112].

Regional differences

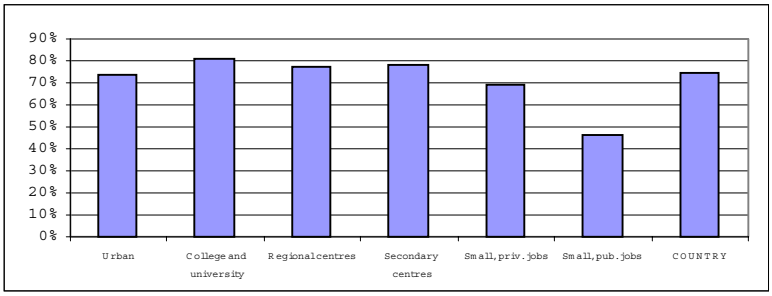
Regional differences are looked at in another part of the study. To carry out these analyses, it was necessary to operate with different regional divisions. To begin with, we have made use of local labour-market regions known as LA regions. Local labour-market regions are areas within which employees can live and work without having to commute long distances between home and work. The division is based on commuter statistics from Statistics Sweden, and includes a total of 81 LA regions in Sweden. In the other regional division system, LA regions are grouped on the basis of similar basic production conditions. This produces six different groups that we have called regional families. The regional families thus consist of a number of LA regions having similar production conditions with respect to population and education, the number of entrepreneurs and the proximity to larger towns as well as colleges and universities. The families can be named based on the character of the LA regions they contain. We thus end up with urban regions, college and university regions, regions containing regional centres, regions containing secondary centres, small regions with a predominance of private-sector jobs and small regions with a predominance of public-sector jobs.

We have then analysed the problem using two different approaches. We begin by comparing the companies' patterns of co-operation among the different regional families, i.e. among regions with differing conditions. We then examine whether or not co-operation can help explain why LA regions within the same regional family, i.e. regions with similar conditions, show different levels of growth.

Differences between regional families

The object of the first analysis is to create a picture of how differences between patterns of co-operation are linked to differences in regional environment, with respect to the basic production conditions present in the different regional families. This has been done by comparing the companies' patterns of co-operation in the areas of R&D and skills development across the different regional families.

Chart 2 Presence of co-operation in the areas of R&D and skills development.



The clearest difference that appears when we study the average values in *chart 2* is that companies in small regions with a predominance of public-sector jobs engage in co-operation to a lesser extent that the remaining regional families. However, structural differences between regions also affect the chart. We have thus continued and performed an analysis in which the effects of company size, sector and specific industry were controlled. We used the urban regions as a reference group, which means that the effects described can be interpreted as deviations on the part of the other regional families from the norm set by the urban regions. Small regions with a predominance of public-sector jobs continue to show a significantly lower level of co-operation within the areas of R&D and skills development. In addition, there is a tendency for companies in the college and university regions to co-operate more than the urban regions within this areas.

The differences in the nature of the co-operation, however, are greater. If we examine the geographical distribution of the co-operation, we see that companies in small regions tend to co-operate with partners located either outside or both within and outside their own region. Urban regions thus engage in a more locally oriented form of co-operation.

The other aspect of the nature of the companies' co-operation is the question of whether companies co-operate with few or many groups of partners. Here we can note that companies in the college and university regions and companies in regions containing secondary centres seem to focus on co-operation with fewer groups of partners.

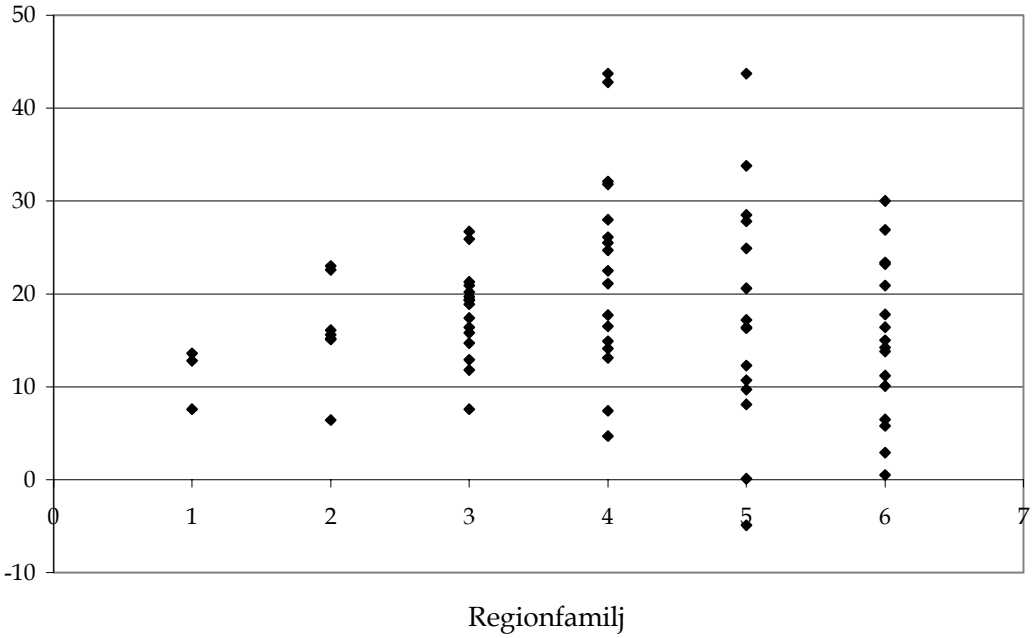
Co-operation is linked to differences in regional growth.

In the second analysis, we leave the comparison between regional families and the significance of different regional environment. This analysis is instead based on the fact that, regardless of similarities in the regional environment with regard to basic production conditions, there are differences in regional economic growth. What is it that makes some regions more successful than others, even though they share similar production conditions? The analysis presented below aims to determine whether differences in companies' patterns of co-operation can be linked to differences in economic growth between regions sharing similar production conditions. Put somewhat differently: are the patterns of co-operation found in companies located in LA regions with high growth different from those found in companies located in comparable LA regions with low growth.

The analysis of the differences in growth between LA regions was performed on each of the following three regional families: college and university regions, regions containing regional centres and regions containing secondary centres. The urban regional family consists of only three LA regions (Stockholm, Malmö and Gothenburg). This means that the number of observations is too small. We have therefore chosen to exclude this family from the study. As regards the two regional families with small regions, the number of companies included in the study are too few which can lead to uncertain evaluations. We have therefore also chosen to exclude these families from the second analysis. In the first instance, it is the differences between regions with low versus high levels of economic growth, despite their sharing similar basic production conditions, that are of interest. The regional families themselves, and the differences between them, are not of primary interest in this analysis. What is essential here is that they comprise homogeneous units with regard to production conditions.

In *chart 3*, we can see that growth levels vary considerably, despite the fact that the LA regions share similar production conditions. If it were production conditions alone that determined the differences in economic development between regions, then the LA regions within each family should be gathered around a common point. This does not appear to be the case, however, which provides some room for alternative explanations. Our hypothesis is that the differences in growth that cannot be attributed to different production conditions depend in part on regional differences in the companies' patterns of co-operation.

Diagram 3 Economic growth within the regional families during the period 1993–1996.



Note. Growth is measured as relative change in value added per employee. Each dot in the figure represents one LA region.

In the analyses, we have controlled for the same factors as in the first analysis, i.e. the results apply regardless of differences in company size, sector and industry.

The results show that co-operation within the areas of R&D and skills development contribute significantly to growth in two of the three regional families. On the other hand, we found no clear pattern between co-operation within or outside a company's own region. When we examined the significance of co-operation with many versus few groups of partners, we found that companies in growth regions tend to exhibit co-operation limited to one or only a few groups of partners.

Summary

In summary, we can say that co-operation has a positive impact on a company's productivity. However, this does not means that all forms of co-operation lead to high productivity. The results show that relationships that extend over large geographical areas, both within and outside Sweden, are highly important. Yet it can also be important for a company to have a base within its own region. However, co-operation should be focused on a small number of groups of partners, and the most important partners are customers and suppliers. We have also shown that smaller companies engage in co-operation to a lesser extent, and when they do engage in it, they do so with partners located within the company's own region.

We conclude that patterns of co-operation are different in different types of regions. Companies in university regions are those who engage in co-operation most, while companies in small regions do so least. Companies in urban regions engage in more locally oriented co-operation, which is natural given the options available within large markets.

Co-operation is linked to differences in regional economic growth. In those regions where companies engage in co-operation, and then with only a few groups of partners, we see better economic development.

Model specification - Robust regression

net_va 97 = $\alpha+\beta_{1\text{-}10}X+\beta_{11}$in9597 $+\beta_{12}$d_sk9597 + β_{13}staff97 + β_{14}staff^{2}97$+\beta_{15}$staff9697 + β_{16} univ97 $+\beta_{17}$ retent $+\beta_{18}$ brplant + β_{19} workpl$+\beta_{20}$ subc $+\beta_{21}$ subc2$+\beta_{22}$obj4 $+\beta_{23}$season + β_{24} kap int $+\beta_{25}$ inv$+\beta_{26}$exp $+\beta_{26}$ d_va9597 + β_{27} d_worg $+\beta_{28\text{-}32}$ sector$+\beta_{33\text{-}34/38}$Y$+\varepsilon$

net_va97	net value added/employee 1997
X	group of indicators for other learning strategies: work organization, competence devolopment, wagesystem and ICT 1997
in9597	innovations during 1995-1997 as part of turnover
sk9597	% change in number of skilled employees (skilled=university degree) 1997
staff97	number of employees 1997
staff297	(number of employees 1997) ^{2}
staff9697	% change in number of employees 1995-1997
univ97	proportion of skilled employees 1997 (skilled= university degree)
retent	retention rate 1997
brplant	if workplace is a branch plant 1997
workpl	if more than one workplace in the company 1997
subc	subcontractor to mainly one customer 1997
subc2	subcontractor to several customers 1997
obj4	participated in the EU Structural Fund program Objective 4
season	high degree of seasonal employment variation
kapint	capital intensity 1997
inv	the ratio of new investement to value added 1997
exp	if workplace exports more than sector median 1997
d_va9597	% change in value added/employee 1995-1997
d_worg9597	change in work organisation 1995-1997 towards higher degree of responsibility
sector	group of five sector definitions
Y	three different groups of indicators for co-operation, described in the paper, used in separate analysis
ε	residual

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