The Odd Role Of Proximity In Knowledge Relations

- High-Tech In The Netherlands

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The odd role of proximity in knowledge relations - High-tech in The Netherlands

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Abstract

In contrast to findings in other countries, and surprisingly in view of the literature, high tech economic activity in the Netherlands is not spread geographically according to either relevant labour market characteristics or because of localized agglomeration effects. Instead, statistical analysis shows that the Netherlands is an urban field, and that the knowledge infrastructure is the only variable to significantly explain high-tech presence through the Netherlands. By analysing the same relations for younger firms, we are able to make a rather strong case about causation.

Keywords

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The odd role of proximity in knowledge relations
- High-tech in The Netherlands

Introduction

Due to their continuous R&D efforts, high-tech firms are allegedly highly competitive and grow fast in terms of employment and output (Geroski et al. 1993). Both their R&D efforts and rate of growth constitute a relative comparative advantage for countries where these firms and sectors are located and thus boost national economic growth. Some regions accommodate more high-tech firms than other regions. Despite efforts by regions to attract high-tech firms, the number of success stories is rather limited. Apparently, regional characteristics matter and cannot be easily modified. This is an observation that is true not only of high-tech firms. An important strand of research in the field of economic geography analyses the regionalized economic activity. The regional accumulation of knowledge and the knowledge spillover occurring locally are important topics of such research (cf. Krugman 1996; Martin 1999). In the literature, three elements are emphasized: characteristics of the regional labour market, agglomeration externalities, and, more recently, characteristics of the regional knowledge *infrastructure*. The latter is a more recent elaboration of the two former. Agglomeration effects and the local labour market combined is, of course, known as the industrial district argument developed first by Alfred Marshall. For high-tech firms in particular, as we will show, prosperity hinges on the ability to create and sustain a competitive regional knowledge base.

In this paper we empirically assess the extent to which these three elements explain the spread of firms in high-tech industries through the Netherlands. Some studies have found that, in a technical sense, clusters of high-tech firms cannot be said to exist in the Netherlands (Hoen 2001; Wever & Stam 1999; Swann 1999). We study the *tendency* to cluster; although there are no clusters, there is a concentration of high-tech firms in particular regions rather than other (see Figure 1). We do not study the effects of clusters. As it turns out, the Dutch case is different from other cases described in the literature on a number of counts. The differences are significant at least for policy purposes, but also contribute to the theoretical discussion in the field of economic geography about the role of, particularly, knowledge institutes in regional economic development. To anticipate on the results to some extent, the Dutch case may show that, where physical distance is deemed

less important a factor for location choices, *cognitive* distance becomes all the more important (cf. Nooteboom 2000). In this contribution, this third element which is thought to be increasingly important is included by looking at how the effects of the knowledge infrastructure on the geography of high-tech economic activity. We show that, indeed, material reasons for the spread of economic activity through the Netherlands, at least for high-tech, become less important, indicating that the Netherlands is indeed an 'urban field'. More importantly, however, we point to a development that other regions & countries may expect, where the importance of physical distance in explaining geographical clustering of economic activity may diminish, but social or cognitive distance remains and may even become more important. We will elaborate this point to some extent.

2 Location factors

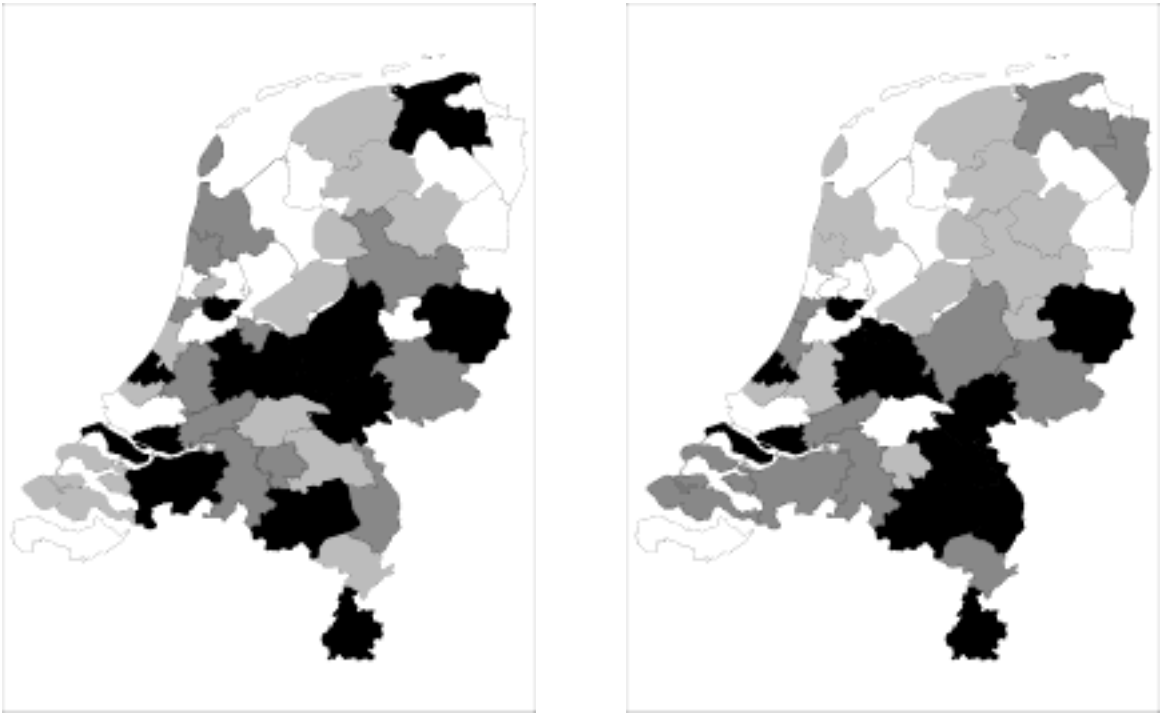
Economic activity tends to spread unevenly geographically. It should, therefore, not come as a surprise that firms in high-tech industries in the Netherlands are not evenly spread across the country (see Figure 1). The literature generally recognizes three factors on the basis of which firms decide where to locate themselves. Two of these are in line with Alfred Marshall's (1952) industrial district argument. These arguments are quite well understood now and need little elaboration. Marshall has argued that the local labour market may have particular characteristics that make it attractive for firms to set up shop. Depending on the type of products made and the production process, employees with particular skills and knowledge may be required. Assuming that the labour market is not perfect and may be fragmented regionally as well as according to skills & knowledge, firms may not scatter evenly as one would expect in the perfect market of neoclassical economics. A second factor Marshall discusses is agglomeration externalities. Suppliers to or buyers (customers) of a firm may be concentrated in a region. Particularly in case of high transport costs, agglomeration effects may be strong. In what is by increasing numbers of observers called an (emerging) 'knowledge' economy, these location factors may differ somewhat from the situation that Marshall studied in the late 19th and early 20th Century.

In a knowledge economy, the first factor may take on a different role. Different characteristics of potential employees in the region may become important. The need for employees to respond adequately to the economic and technological dynamism has, notably, increased the demand for employees with a formal education. Professionalisation and a need for objective criteria for selection of future employees designate the eminence of the regional labour market as a genuine location factor for this type of industry (Malecki

1991; Weiss 1995). In high-tech industries, more particularly, there is a need for employees who have an education in engineering at, for instance, the university level. De Grip & Willems (1996) show that Dutch high-tech firms indeed employ more professionals relative to medium- and low-tech firms.

Figure 1: Location pattern of high-tech firms (A) and total high-tech employment (B), by Corop region

A. Number of high-tech firms B. Total high-tech employment



Source: Calculations based on data available from Marktselect plc, 2002.

Agglomeration externalities are or might be different in a knowledge economy as well. In addition to Marshall's industrial districts argument, agglomeration can offer a favourable environment for the innovating firm in which to create and sustain its knowledge base. As distance hinders the exchange of tacit knowledge (Jaffe 1989), the regionally bound stock of tacit knowledge increasingly becomes a source of competitive advantage of the region (Maskell & Malmberg 1999). Moreover, proximity fosters collaboration (Fritsch & Schwirten 1999), which creates relations of trust among economic actors within the agglomeration (Harrison 1992). Hence agglomerations not only offer the advantages of Marshalls 'traded linkages', but possibly also those more elusive ones of 'untraded interdependencies' (Storper 1997). As Hägerstrand (1967) showed for Europe, innovations

tend to be introduced in major cities, and than spread across the urban hierarchy. More recently, it has been empirically shown that innovative activities tend to be concentrated in agglomerated milieus for the U.S (Audretsch & Feldman 1996), the U.K. (Baptista & Swann 1998) and France (Carrincazeaux et al. 2001). As such, agglomerations are alleged breeding places for innovations (Brouwer et al. 1999). Close geographical proximity may thus economise on communication and interpretation costs involved in the creation of new knowledge. We show that proximity to a knowledge institute or university of technology matters to high-tech firms. The creation of new knowledge, of course, does not take place in a social or cognitive vacuum.

To some extent, and in some cases, the possible benefits of agglomeration are more visible and less ephemeral. For firms in high-tech industries, particularly, the role of knowledge creating and diffusing institutes such as universities and non-academic research centres, both private and public, could also play an important role in understanding regional economic differences (e.g., Florax 1992). In line with other research, we conceive of (non) academic research institutes as the constituents of the regional knowledge infrastructure and is a separate location factor, especially for firms in high-tech industries. Joint research projects, spillover of research undertaken at these institutes and informal exchanges of (tacit) know-how are their main contributions to the regional knowledge base. As these effects are regional, firms in high-tech industries might benefit from knowledge spillovers if and when they locate close to knowledge institutes. Jaffe (1989), for instance, provides evidence for knowledge to spill over from university research to industrial R&D efforts (see also Audretsch & Feldman 1996; Mansfield & Lee 1996; and Anselin et al. 1997). For Germany, the same holds for universities that engage in applied sciences (Engel & Fier 2000) as well as for non-academic research institutes (Fritsch & Schwirten 1999; Sternberg 1999). For our purposes it makes sense, from a theoretical point of view, to separate knowledge infrastructure from the more general agglomeration effect. Our focus on high-tech industries points in this direction. The course that modern economies in general take towards a knowledge economy is a more general argument in favour of including the knowledge infrastructure as an explanatory variable in our analysis.

The different patterns for the geographical spread of the firms in high-tech industries as compared to employment in these firms (Figure 1a and 1b, respectively) offers important additional clues about the odd role of proximity in knowledge relations.

3 The model

We use the OECD definition for high-tech industries. When on average firms in an industry spend at least 4.5 percent of total sales on research and development the industry is considered high-tech. For high-tech industries the creation and use of new knowledge is relatively important. Industries that are included in the definition are pharmaceutics, office equipment, computers, electronic devices, communication devices, scientific instruments and aerospace. The definition proposed by the OECD is not the only one, and has several drawbacks (cf. Kleinknecht 2000). For instance, it is a definition that focuses on the level of the industry. Firms in industries that the OECD does not recognize as high-tech could spend more than 4.5 % of revenue on R&D - intra branch differences with respect to R&D intensity may be considerable. Statistical information to establish the extent to which an industry is innovative, such as that used by the OECD, tends to underestimate innovation in the service industries. The classification that the OECD proposes is based on R&D inputs only, whereas R&D output measures are more direct proxies of innovativeness. However, the branches designated as high-tech by this OECD definition are classified as such by most alternative definitions as well. Moreover, this definition is most common in scientific research; using it here makes our study comparable to other studies and thus our results can be interpreted more readily.

In our model, we test whether the three sets of regional factors discussed in section 2 (labour market characteristics, agglomeration externalities and knowledge infrastructure) can explain the spread of high-tech activity in the Netherlands, explaining the pattern in Figure 1. Malecki (1991) emphasized the need for employees with a strong technical background. We therefore use two indicators for the regional labour market. Those who have a university degree (master) or a degree from a polytechnic for vocational training (bachelor) in a field of the natural science on the one hand, and those who have one of these degrees in a different field of study. We use data provided by Statistics Netherlands for these indicators.[3] Given that there is a legal obligation in the Netherlands to attend school until the age of 16, and few children leave school without a high school diploma or equivalent, this is a useful indicator that allows for discrimination between the different regions. The data we have for the labour market is particularly rich and allows for a close scrutiny of the significance of this factor for the geographical spread of high-tech economic activity throughout the Netherlands. Our hypothesis, deriving from the literature, is that the

3 Enquête beroepsbevolking (CBS 1999).

higher the proportion of BA's and MA's – both technical and non-technical – in the labour force of a region, the more likely it is that high-tech firms will locate there.

Recent research has rejected the relevance of agglomeration economies for the Netherlands, when the density of linkages between spatially clustered firms is used as an indicator of agglomeration (Heijs & Schmitz 2001). When looking at innovation, this is not an appropriate indicator for agglomeration. Agglomeration economies enhance the local knowledge base, which is only very partially included in an approach that where a 'traded' linkage-density parameter is used (Malmberg & Solvell 1997). Instead of measuring linkage density, we test whether agglomerated regions accommodate more high-tech firms relative to less agglomerated regions. We use Manshandens (1996) agglomeration index[4] as an indicator for agglomeration economies, distinguishing five ordinal degrees of agglomeration. Other scholars in the field have used this index as well (Poot & Kleinknecht 1992). With our third factor, we are able to capture some of the specific tendencies that Heijs & Schmitz (2001) are after, albeit in a more focused way.

Our third hypothesis is that the regional knowledge infrastructure, measured by the number of knowledge institutions in Corop regions,[5] is conducive to high-tech economic activity in a region. In particular we test whether the presence in a region of a university, a university of technology and non-academic research institutes (for agricultural, medical, scientific and societal research) makes a difference in terms of high-tech activity. The Netherlands has 4 universities of technology in Delft, Enschede, Eindhoven and Wageningen, and a further 11 universities without such a clear focus on technology and the natural sciences. Obviously, the regional impact of knowledge institutes depends on size of the institute. To account for size differences, the presence of knowledge institutes is weighted by their size in terms of numbers of employees. Comparing the results from the model we develop here with an earlier study we have published (Van der Panne & Dolfsma 2001) indicates that the availability of more detailed information on this count is highly valuable. Such data is often not available for use in statistical analyses. Marktselect, a private firm, offers data collected from Chambers of Commerce that is highly detailed. The exact number of firms is now known – Statistics Netherlands' data rounds the number of firms off to units of 5. Statistics Netherlands' data is drawn from a survey from the total number of firms, which is then extrapolated; the data we use is likely for this reason to be

4 The Manshanden index categorizes the Corop regions into five degrees of agglomeration according to the logarithm of the regional population density.
5 These highly detailed data are provided by a private firm, Marktselect b.v. (2000).

more useful for statistical purposes. For each firm, more information is available. Not only size of the firm in terms of numbers of employees, but also industry code and - importantly- year when the firm was founded. Such information is also available for the knowledge institutes.

We analyse both the dependent and the explanatory variables at the regional level. The most appropriate level of aggregation for the specific Dutch context is the Corop level, distinguishing 43 regions that are relatively homogeneous in economic terms. A different way of demarcating geographical areas is by postal codes. Not all of the data we require is (easily) available on this aggregation level, however. The rationale behind the postal codes is different from that of the Corop classification, and it is not obvious that postal code areas are more homogenous in relative terms than Corop regions are. The more aggregated level of analysis of the Corop means that statistical relations are less likely to be significant than in the case of a more disaggregated level of analysis. Any statistically significant relations observed will be stronger for a lower level of analysis. In addition, as the Corop level is the prevailing level of analysis in Dutch research on economic geography, using the data makes our analysis more comparable to other studies.

The data we use allows for an ordinary least squares technique to be used. This offers, of course, results that are most readily interpretable. We estimate two models, one where the number of high-tech firms in a region is the dependent variable (see Figure 1a), and one where high-tech employment in a region is to be explained (see Figure 1b). Both models are relevant: whereas the first is more likely to indicate reasons for any firm in a high-tech industry to select a location, the second takes size differences into account and may therefore indicate growth potential. The explanatory variables relate directly to the factors deemed to be important in the theory. Hence, we estimate the following models at the Corop level:

$$Y_{1,2} = \alpha + \beta_1 (\text{share of bachelors and professionals in the regional labour market}) + \beta_2 (\text{share of technicians in the regional labour market}) + \beta_3 (\text{agglomeration economies}) + \beta_4 (\text{non-academic knowledge institutes}) + \beta_5 (\text{university}) + \beta_6 (\text{university of technology}) + \mu$$

Where: Y_1 = number of high-tech firms in Corop region (Fig. 1A), and
Y_2 = total high-tech employment in Corop region (Fig. 1B)

Table 1 presents the results of our analysis. Some of these are not particularly noteworthy, but a number of them are. Section 4 not only discusses the results of each of these models, but also compares the two to understand some of the dynamics of high-tech economic activity throughout the Netherlands.

Table 1: Two models explaining the location of high-tech activity

		1. Number of high-tech firms (fig 1A)		2. Total high-tech employment (fig 1B)	
		Beta	t-value	Beta	t-value
Labour market	Technicians	-6.78	-1.21	-134.15	-0.78
	Bachelors and professionals	0.04	0.03	-2.68	-0.07
Agglomeration economies	Agglomeration index	3.49	0.07	1066.87	0.66
Knowledge infrastructure	Research institutes	0.06	7.17**	0.77	2.9**
	University	-5.6	-0.25	189.65	0.27
	University of technology	89.08	2.88*	2451.85	2.56*
R-squared		0.69		0.32	

* significant at 5% level **significant at 1% level

4. Results

One should, of course, be careful interpreting the map shown earlier. The figures present a number of things that are striking, also from a policy perspective. The economically active Rotterdam region does not have much high-tech to show for; its main sector is transport and the chemical industry. Little value added is generated in these industries. The southeast again proves to be a region where technology-intensive firms locate (Wintjes 2001). It remains to be seen if the Twente-region, a central-eastern corop region bordering Germany with a university of technology in the city of Enschede, can reconvert itself from a low tech region strong for a long time in textiles et cetera into a high-tech region. The region is characterized by a few larger firms in high-tech that are daughters of other firms doing most of the research (Ministry of Economic Affairs 1997). Indeed, comparing maps A and B shows which regions have relatively smaller high-tech firms, the central Veluwe and northern Groningen regions being cases in point. Vice versa, regions with relatively many bigger high-tech firms show up where Corop regions in Figure 1B have a darker shade of grey than in 1A.

Our analyses in Table 1 present results that are in some ways not surprising. Agglomeration economies do not play a role in explaining the location of high-tech. The

coefficients are positive, but not significant. This links up with the findings for the labour market. The proportion of professionals or technicians in a region even has a negative effect on the presence of high-tech activity in that region. This is noteworthy, even though the coefficients are not significant in a statistical sense. The findings for agglomeration and labour market combined confirm earlier conclusions –from studies that have a slightly different focus– for the Netherlands that it is an 'urban field' (Heijs et al. 2001). Brouwer et al (1999) find, however, that the degree of urbanization is positively correlated with the probability of announcing new products in specialist trade journals. This seems largely due to the use of a different indicator of innovation used by Brouwer et al.[6] Although the indicator they use is valuable for many purposes, it is not generally available across countries and sectors, and therefore little used. Other studies indicate that labour market factors are an important factor discriminating between the attractiveness of different regions for different kinds of economics activity (e.g., Malecki 1991, Weiss 1995), and so the Netherlands stand out in this respect. Observations about the Amsterdam region – a region with a relatively large number of high-tech firms and substantial high-tech employment as Figure 1 shows – corroborate our results about the labour market: a third of the labour force in Amsterdam does not live in that region and must commute to and fro (Van der Vegt et al. 2000).[7] Despite roads and public transport systems that are increasingly perceived of as congested, it is not an impediment for labour to commute. The most recent figures available, Van der Vegt et al. (1995), do indicate that in the 1988-1993 period there has been an increase of 'higher technicians, mathematicians and natural scientists', a category that seems to coincide with one of our indicators for the labour market, in the Amsterdam region. Considering that the Amsterdam region does not have a university of technology, this seems to indicate a high willingness to move, corroborating our findings that the labour market factor is not significant. A similar argument holds for agglomeration.

The knowledge infrastructure of a region does make a significant difference. The significantly positive effects of the presence of knowledge institutes is not surprising, given Winter's (1984) argument about high-tech economic activity being science-based. We have tried to delve deeper into what it is about the knowledge infrastructure that is attractive for high-tech firms to locate in one region rather than the next. Universities without a clear

[6] We refer to Kleinknecht (2000) for a discussion of the advantages and disadvantages of the different ways of measuring innovation.

focus on technology and the natural sciences do not make much of a difference. This contrasts with international findings. Universities of technology do have an effect. Apparently, universities of technology tend to stimulate the location of small high-tech firms.

Non-academic knowledge institutes have the strongest effect on the location of high-tech in the Netherlands. This finding contradicts partly with Engel & Fier (2000), who observe that regions with non-academic research institutes do not accommodate more high-tech start ups. We show in Table 2 in the next section that knowledge institutes are located in regions with relatively more young high-tech firms. The category of universities focusing on applied (natural) sciences that Engel & Fier use is different from the category of universities of technology that we use. For the German context, the kinds of universities that Engel & Fier distinguish are in between the polytechnics and the universities of technology in the Netherlands.

5. Discussion: causation

Statistical significance is not synonymous to scientific significance (cf. McCloskey & Ziliak 1996). In order that we stand on firmer ground claiming that the pattern for the spread of high-tech activity through the Netherlands can indeed be explained by referring to the presence or absence of either of the three variables we use, we will present some additional tests. The data we have allows us to discriminate between the age of firms, allowing us to disentangle the process of cumulative causation that underlies geographical clustering. Is economic activity located somewhere because of the specific characteristics of the region, or does the region appear to have attractive characteristics (partly) as a result of the firms that are located there? Assuming that the decision to start a firm at a specific location is a rational one, where all the important costs and benefits are weighed, it makes sense to study the clustering of the younger firms. We have regressed the model presented earlier for firms of the ages of 3, 5, and 10 years; we have regressed both for the number of high-tech firms as well as for high-tech employment. We only present the findings on the number of high-tech firms as the dynamics on this indicator can be assumed to be more pronounced. In addition, we present results for 3- and 10-year-old firms. After 3 years, firms in the Netherlands are not entitled anymore to any tax breaks that are meant to

[7] The Amsterdam region is a region of high economic activity, although not growing as fast as other regions in the Netherlands as well as elsewhere in terms of value added (SEO 1997; Van der Vegt et al. 1995).

encourage entrepreneurship.[8] Three years is thus an important threshold. Ten years is another threshold as during that period a knowledge base or absorptive capacity of some kind can be assumed to be established. Subsidiaries of foreign firms in the Netherlands, for instance, irrespective of sector, move to a different location in the Netherlands within a number of years after they are first established in order to take advantage of the knowledge infrastructure they find on the new location (Wintjes 2001). This new location is typically in general the south-east of the Netherlands.

Table 2: Explaining the spread of young high-tech firms

		3. Number of high-tech firms (3 year old)		4. Number of high-tech firms (10 year old)	
		Beta	t-value	Beta	t-value
Labor market	Technicians	-0.82	-0.68	-3.71	-1.24
	Bachelors and professionals	0.06	0.22	-0.05	-0.07
Agglomeration economies	Agglomeration index	-0.03	0.01	-6.03	-0.2
Knowledge infrastructure	Research institutes	0.01	5.21**	0.03	6.28**
	University	-0.86	-0.17	-3.05	-0.25
	University of technology	13.0	1.94*	50.67	3.05**
R-squared		0.55		0.64	

* significant at 10% level **significant at 5% level

A general finding is that the older the firms in high-tech industries in the Netherlands, the more the knowledge infrastructure matters. Unsurprisingly, universities that do not offer a focus on technology and the natural sciences are still clearly not a relevant element. The consistency of the findings presented in Table 2 with those of Table 1 indicates that there is a strong case to be made about the causality of the presence of a relevant knowledge infrastructure on the choice of a high-tech firm to locate somewhere. Labour market and agglomeration effects still do not play a role.[9]

6. Concluding remarks

Of the three factors recognised in the literature –agglomeration, labour market and knowledge spill-over–, we find the first two to be insignificant in explaining the spread of high-tech economic activity through the Netherlands. Labour market characteristics are

[8] Dutch policy to stimulate innovation is mostly of the generic type, with tax measures playing a significant role (Ministry of Economic Affairs, 2002).

[9] Employment by high-tech firms of ages 3 and 5 years (not shown here) is related to the presence of a technically educated labor market. The relation is weak, however.

irrelevant, and the insignificance of agglomeration indicates that the Netherlands are indeed an urban field. Our findings are robust, and are noteworthy for another finding: the importance of the proximity of knowledge institutes. Although there is a lot more institutional thickness to be added to this analysis (Martin 1999), we show that some elements in the knowledge infrastructure seem to be more important than others. Particularly universities of technology have a positive impact on the activity of high-tech firms in a region. We have strong indications of causation, as we are able to test the general findings for the groups of firms of a more recent origin. The same pattern emerges. Younger firms in high-tech industries too tend to locate close to universities of technology in particular.

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