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Spatial Localization of Knowledge-Transfer Channels and Face-to-Face Contacts: A Survey of the Jena University-Industry Linkages

Thomas Sauer
Matthias-W. Stoetzer
Andrea Gerlach

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Thomas Sauer
Matthias-W. Stoetzer
Andrea Gerlach

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Andrea Gerlach

Fachhochschule Jena, Fachbereich Betriebswirtschaft
Carl-Zeiss-Promenade 2, 07745 Jena
Tel.: 03641.205 550, Fax: 03641.205 551

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Spatial Localization of Knowledge-Transfer Channels and Face-to-Face Contacts: A Survey of the Jena University-Industry Linkages

Matthias-W. Stoetzer, Thomas Sauer and Andrea Gerlach*

Department of Business Administration, University of Applied Sciences Jena

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Abstract

In this paper we examine the knowledge-Transfer Channels of the universities and public research institutes in Jena. The empirical study is based on a survey of 297 personal interviews with researchers of both types of organisations. Our study focuses on three questions: (a) The importance and multitude of existing transfer channels, (b) their geographic distribution and (c) the importance of face-to-face contacts. With regard to the first question the analysis reveals some shortcomings of the usual channels considered in many empirical studies. Above all, informal transfer channels play an important role and in addition the multitude of transfer channels at hand turns out to be large. These outcomes suggest a very cautious interpretation of the claimed influences of transfer mechanisms like patents, joint publications and so on. As to the regional distribution of the linkages our results confirm the relevance of geographical proximity. A substantial part of the relevant transfer co-operations concentrate on the city and region. Finally, we examine the idea that "distance matters" is due to the necessity of face-to-face contacts. By means of asking the researchers directly we found the puzzling result, that knowledge-transfer rests significantly upon personal contacts, but that this does not imply a bias towards geographical proximity.

JEL Classification: O31; 032; R12

***All: University of Applied Sciences Jena, Department of Business Administration, Carl-Zeiss-Promenade 2, 07745 Jena, e-mail: Matthias.Stoetzer@fh-jena.de, Thomas.Sauer@fh-jena.de, Andrea.Gerlach@fh-jena.de**

1. Introduction

Alfred Marshall already pointed out in 1919 the necessity of close university-industry linkages as a mean of national economic prosperity.[1] In so far the growing efforts in economic and science policy to use universities and public research organisations as nucleus and source of economic development has old and prominent roots. In addition, Friedrich August von Hayek in 1945 stressed the fact that the use of knowledge dispersed among the individuals in a society is at the heart of the functioning of every economic system.[2] So, creation and transfer of knowledge is a fundamental prerequisite of economic development. With regard to the spatial dimension Michael Polanyi in 1958 introduced the concept of tacit-knowledge, which is relevant for explaining the importance of regional proximity in the process of knowledge transfer.[3]

The paper provides an empirical analysis as to the university-industry linkages for the universities and other public research organisations (institutes) in the city of Jena. In fact, the probably oldest study in Germany of the economic and social value of a university for the community where it is located dates from the year 1611 and explores the relations of the university and city of Jena (Sagittarius 1611).[4]

The paper is organised as follows. Section two surveys the related literature with regard to basic empirical findings and fundamental theoretical reasoning in the context of spatially bounded knowledge transfer. Section 3 reviews the literature with special reference to knowledge transfer channels and develops the hypotheses to be tested. The following section 4 describes the design and data base of the empirical study, while section 5 presents the empirical results. Finally, section 6 draws conclusions for further research.

2. Basics of the empirical and theoretical background

An important result of the economic analyses of the competitiveness of nations and firms is the emergence of the region as a basic “intermediate” phenomenon shaping and influencing economic competitiveness and development. The analysis of the knowledge impacts of universities in this context usually refers to the seminal article by Jaffe (1989) proving a significant effect of university research on corporate

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1 „...the small band of British scientific men have made revolutionary discoveries in science; but yet the chief fruits of their work have been reaped by businesses in Germany and other countries, where industry and science have been in close touch with one another.“ (Marshall, 1920, p. 548)

2 “The various ways in which the knowledge on which people base their plans is communicated to them is the crucial problem for any theory explaining the economic process, and the problem of what is the best way of utilizing knowledge initially dispersed among all the people is at least one of the main problems of economic policy – or of designing an efficient economic system.” (Hayek 1945, p. 520)

3 See Polanyi, 1958 and his famous expression “We can know more than we can tell” (Polanyi, 1967, p. 4).

4 He titled his book: „Study of the great happiness of cities where there are universities” (own translation).

patents. In this line of econometric studies different indicators of university knowledge output are used in order to detect a positive correlation with an indicator of the regional level of economic activity (e.g. innovations or economic growth). Up to now, several publications of this type corroborate the idea of a positive influence of universities.

A number of these studies of university-industry linkages refer to Germany[5] and to others countries as well. Here only selected results are discussed.

Seeber (1985) provides an early empirical study for Germany. Despite his simple descriptive statistical analysis his methodology is interesting because he uses a balanced matched sample approach of German cities with and without universities.[6] He compares their development from 1957 to 1982 and reveals that as to the GDP per capita and the level of unemployment the cities with universities show a substantial better development. A recent example of such an econometric study is Mueller (2005). She finds that regional economic growth at the level of the German districts depends on university-industry linkages. The regional level of these relations is measured by the amount of grants given from the private sector to universities. But this relationship seems to be fragile: The influence of research conducted in universities on regional economic growth is less distinctive. In fact, a number of papers come to the conclusion that it is not possible to detect any firm evidence of regional knowledge spillovers of universities. Bröcker examines the growth of employment in 87 regions in Germany from 1970 to 1982 and rejects the hypothesis that public research has a positive impact (Bröcker 1989, p. 205).
Florax (1992) in his very detailed study found no knowledge impacts of Dutch universities on industrial investments at the regional level over the period 1977-1984.[7] Broström and Lööf (2006) refer to the industry side of the university-industry linkages in Sweden. Using matching techniques and a dataset of 2071 Swedish firms their findings suggest that in case of large manufacturing firms university collaboration has a positive influence on the innovation and patenting activity of large manufacturing firms. But in contrast, there is no such influence as to the service firms´ innovation output.

Such kinds of econometric analyses of university-industry linkages are a suitable tool for generalization and detection of average effects but have a basic limitation: The exact nature and causal structure of these linkages remain unclear.

First, it is an open question whether the linkages are related to the demand or supply side of universities. As to the demand side the expenditure of a university has

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5 See Bode (2004), Bröcker (1989), Edler/Schmoch (2001), Franke (2002), Fritsch/Schwirten (1998), Funke/Niebuhr (2000), Keilbach (2000), Nerlinger (1996), Niebuhr (2000), Sternberg (1998). Döring/Schnellenbach (2006) provide a survey of the literature – not only of findings as to Germany.

6 Each of these two samples comprises 29 cities.

7 This very detailed study tries to give a comprehensive analysis of the very different ways how universities influence regional economic development. Based on a thorough theoretical and econometric analysis he already detects in 1992 the so called „absorptive capacity“ problem (Florax 1992, p. 290). Nevertheless, his study is rarely cited in the literature.

multiplier effects on regional income and employment. In addition, also investments may be induced by regional accelerator effects. So findings as to regional economic growth might be attributed to macroeconomic demand-side effects and not to knowledge transfer as a supply-side effect.

Second, also the supply side effects alone consist of a multitude of different possible linkages. This is the problem of the exact "channels" of the know-how-transfer assumed. For instance, it is possible to link "number of patents" of firms and "research universities" at the regional level. But a positive correlation does not provide useful information on what kind of knowledge has flown, by what kind of means and from whom to whom.

The proper linkages are for sure complex, as to their scope, scale and working mechanisms. Their scope is a problem because of the limited availability of data as to linkages besides patenting, publishing and licensing agreements. Their scale is a problem due to the fact that not only the simple existence of a linkage but the intensity of the knowledge transfer should influence the relevant outcomes like number and quality of innovations, economic growth and so on. The unknown mechanisms of university-industry linkages turn out to be a problem because of open questions of the direction of causality, interdependencies of these channels, substitution possibilities and complementarities with a variety of other influencing factors, e.g. absorptive capacity, mismatch of social norms and characteristics of knowledge fields to name only three.

The spatially bound impact of universities in general and university-industry knowledge flows in particular is explained by means of the concept of tacit knowledge.[8] Yet this concept suffers from unclear meanings and lack of coherent definition (Boschma 2006, Gertler 2003). Broekel and Binder (2006) provide an alternative explanation of the spatial bias of knowledge flows. They develop a behavioural model and argue that actors with bounded rationality will have a regional bias with regard to their information search activities. But besides the tacit knowledge or the behavioural concept it seems reasonable to assume that in any case direct personal contacts "face-to-face" are a key element explaining the regional bias of knowledge flows.[9] A hypothetical scenario illustrates the relevance of face-to-face contacts. Suppose that there are no kinds of mobility costs of any kind due to the maintenance of face-to-face contacts. In this scenario every person is always without costs and immediately able to "beam" itself to any other place in the world. In this scenario the traditional meanings of "regional bias" vanish. Still there would be a bias in the information search activities because of personal relations resulting from "knowing each other" based on face-to-face interactions. But this would be a pure social bias due to social proximity not regional proximity (cf. for the terminology Boschma 2006).

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[8] The regional impact of the expenditure effects can easily be attributed to the spatial structure of the demand and regional import propensity (see Florax 1992, p. 88-96).

[9] To refer to the "..inherent spatiality of human action" (Broekel/Binder 2006, p. 20) or the "regional identity" (p. 17) is not a satisfactory alternative to the "face-to-face" argument.

So, in the literature the spatial limitation of knowledge transfer processes rests on two assumptions. Above all, there exists a need of face-to-face contacts. In addition, personal mobility is associated with costs (e.g. direct travel costs, loss of time, and inconvenience of transportation modes) and these costs are – even with modern transportation infrastructures – not negligible. Only the need of face-to-face contacts together with the costs of personal mobility explains the significance for the spatial bias of knowledge flows.

3. Transfer Channels: Review of selected empirical results and hypotheses of our own approach

Recent comprehensive empirical studies of university-industry linkages covering a wide range of different types of know-how-transfer channels are Schartinger et al. (2001), Arvantis et al. (2006), Goddard/Isabelle (2006) and Hughes (2006).

The study of Schartinger et al. (2001) deals with the various forms of interaction between universities and firms. They identify 16 types of transfer channels and include 9 different types of them in their survey based on data for 39 Austrian universities. The authors found that universities use a variety of channels for knowledge interaction with firms. Furthermore, a large number of scientific disciplines at the universities exchange knowledge with almost all sectors of the economy in the process of innovation.
Arvantis et al. (2006) explore the different forms of knowledge and technology transfer activities of Swiss science institutions at the level of a single institute or department. They distinguish between 19 different types of linkages and in addition 3 traditional forms (patents, licensing and spin-offs). Based on about 200 observations they find that human capital oriented forms are the most important followed by informal types of knowledge transfer.
Goddard and Isabelle (2006a) present results for public research organisations in France. Their analysis rests on a survey of 130 public laboratories. It turns out that licensing and patents are less common channels for knowledge transfer than joint research contracts, informal exchanges, conferences or research consortia.

These three studies all rely on questionnaires that refer to the departments or faculties as unit of observation. With the exception of Schartinger et al. (2001) they share their limitation to such sciences traditionally taken for granted as transfer-oriented (e.g. natural sciences, engineering and medical sciences) with most of the existing empirical analyses. In both respects these kind of studies lead to problems.

The focus on scientific disciplines traditionally assumed as transfer-oriented alone seems to be self-evident but has several shortcomings. First, analyses excluding departments of economics and business administration are hardly justified; taking into consideration the fact that in many cases the economic value of an innovation does not depend on its sophisticated technology but instead on its market success. This clearly requires including the knowledge transfer of business administration, economics and legal studies even if they lack of technological innovations (or patents

and licenses). Second, departments of humanities and social sciences might very well contribute in various ways to the so called soft factors responsible for regional economic prosperity; e. g. by ameliorating the public service, education, creativity and so on.[10] Thus it might be misleading to focus the "usual suspects" alone and to exclude any scientific discipline a priori.

A detailed investigation of transfer channels has to adopt a methodological approach focusing on the acting individual. Knowledge transfer and innovation processes depend on the actions of individuals. So, the development and working of the transfer channels bases on the behaviour of the individual scientists involved. To ask the dean of a university faculty as to the transfer channels will lead to biased answers following strategic policy considerations. In addition, even in the case of unbiased answers the head of a faculty often misses the detailed information as to the different transfer activities of the faculty members. And this is especially true with regard to informal transfer activities and linkages without flows of funds. Finally, the professor at a university is almost free in his research including transfer activities. So, as to the universities the obvious unit of observation has to be the individual professor. For the institutes the situation is somewhat different and more complicated. Here the freedom of research including transfer activities might be rather limited for the individual scientist and very much depending on the nature, organisation and social norms of the specific institute under scrutiny. The range of possible transfer behaviour can be much like at the universities, e.g. for the Max-Planck Institutes, or strictly determined by the internal hierarchy and the "market" and the "customers" for the research institutes in the field of applied research with their budget depending nearly totally on industrial research contracts.

Hughes (2006) presents the results of an empirical study based on firms as units of observation in the US and the UK. His sample consists of 1149 matched firms in each of the two countries. He identifies 12 types of channels contributing to innovative activities of the firms. The outcomes show that there exists a great variety of interrelationships and possible patterns of interaction between a university and the regional industry. Patenting and licensing are among the least frequently cited interactions and a comparative analysis reveals that the quality of linkages distinguishes the US from the UK. In this context the term quality refers to the relevance of informal contacts and internships.

To sum up, the existing literature points out the importance of other types of knowledge transfer and collaboration besides licensing and patenting (see also Cohen et al. 1994 for the US and Kauffeld-Monz 2005 for Germany).

The aim of our study is to disentangle the notions "university-industry linkage" and "knowledge-spillovers" as a first step towards an empirical micro-foundation of knowledge-transfer processes. We focus on transfer channels involving face-to-face contacts and exclude channels like publications, patents and licenses, but not the

[10] Concepts like "localized learning" (Malmberg/Maskell 2006) and even more pronounced "creative class" (Florida 2004) have in common that they are "broad" concepts insisting on the multitude and variety of influencing factors.

personal activities which might lead to them as results. In addition, we do not take into consideration the flows of graduates (and PhDs) leaving the universities. The simple reason is that by asking the scientists (professors) we would not be able to gather reliable information as to their spatial scattering.
Thus our empirical analyses deals with three hypotheses:
The first hypothesis is that there exists a multitude of transfer channels with great relevance for the scientists. The study tries to identify what kinds of transfer channels are used and what can be said as to their relative importance.
Second, regional distribution of the transfer channels is put under consideration. Here the hypothesis put forward is that in line with the majority of the empirical findings the importance of knowledge transfers should decline with growing spatial distance.
Third, the role of face-to-face contacts leads to the hypothesis that the necessity of this type of personal contact should have a constraining impact on the spatial distance of transfer partners.

4. Design and data base of the empirical analyses

The reliability of survey as well as interview results could suffer from a number of deficiencies, such as communication barriers and answer bias, influence of the interview situation, personality of the interviewer and so on. The design of the questionnaire and the interviews takes some of these possible deficiencies into consideration.

The empirical study is based on personal interviews with closed but rather detailed questions in order to catch the supposed inherent complexity and the multitude of channels in the knowledge transfer processes. Overall 15 different types of knowledge transfer channels involving personal contacts were identified in the literature and by means of pre-tests. So the pre-selection effect of referring only to four or five types should not lead to biased results. These types of transfer channels were explained and defined so that different wordings should not influence the answers.[11] In order to identify in a more precise way the importance of this different types of knowledge transfer the questions comprise the intensity of the use of these channels on a 6-point scale (Likert-scale-type). In addition, a question as to the most relevant transfer channel is included. The vague meaning of “importance” or “relevance” is standardized because it is measured in relation to the time allocated by the individual scientists for his transfer activities. In addition, the regional distribution, the different transfer partners, the motives and problems of transfers were part of the survey. So the questionnaire includes 29 questions and a considerable amount of definitions in order to clarify meanings. The resulting complexity made it necessary to use personal interviews as the method of gathering the necessary information despite its high costs.[12]

[11] For instance the questionnaire contains a type called “Final papers of students studies”. These can be Master theses, Bachelor theses, Diploma theses or any other type of student scientific writings at the end of the graduate or undergraduate studies.

[12] These interviews were realized as face-to-face interviews. Only in a very limited number of interviews at the institutes telephone interviews were used.

The data used in this study were collected in the course of a survey among the two universities and 12 other public research organisations – called institutes - in the city of Jena. The survey took place in two waves, firstly the universities in 2004/2005 and secondly the public research institutes in 2006. 174 completed interviews took place at the universities and 123 interviews at the institutes. The survey is almost representative as to the professors at the universities.[13] With regard to the institutes three of them refused to participate, therefore the interviews are limited to scientists of nine institutes.

5. Results

5.1 Types and significance of transfer channels

The results as to the types of transfer channels are presented in table 1 and 2. The central question concerns statements about the types of transfers in general. Table 1 shows the transfer channels of the scientists at the universities and the institutes in Jena. The relative importance of these channels is measured on a 6-point scale with a range of zero, i.e. not at all used, to five, which means that this type of transfer channel is very frequently used by the individual scientist consuming a lot of his time.

(Insert table 1 here)

The empirical findings are that the average importance does not reveal dominating types of transfer activities. Only a group of “entrepreneurial” transfer channels (founding of ones own firm, activity as general manager, promotion of spin-offs) play a minor role. Table 1 also indicates that informal channels are relevant: The most important transfer channel for the universities with an average importance of 2.2 is the “personal activity not bound by contract”. Comparing the universities with the institutes shows a different structure of importance.[14] But even in this case the “personal activity not bound by contract” with an average importance of 2.4 has rank number two of all transfer types. Also other transfer channels not covered by many of the existing empirical studies turn out to be important, e.g. “workshops/colloquiums/conferences” and “final papers”. Table 1 reveals a second outcome of the survey: All these channels are used, i.e. for universities and institutes the relevant transfer linkages cover a wide range of activities.

So the empirical findings are that the most important and in addition several other relevant transfer channels are hard to identify: They leave no money or paper trails and for that reason are neglected by econometric studies relying on indicators like

[13] See Sauer/Stoetzer/Gerlach (2006) for details.

[14] Both types of public research organisations have some obvious differences, e.g. due to the fact that institutes do not have own students. Therefore, the types of channels asked in the questionnaire were not completely identical. A forthcoming paper will focus in detail on the differences between these groups of public research organisations.

patents, citations and funds. Furthermore the survey confirms the idea that the analysis of knowledge transfer activities that is limited to one type of indicator has profound shortcomings.

5.2 The most important transfer channel

In order to substantiate the relative significance of different transfer channels the scientists were asked as to their most important transfer activity (see table 2). At the universities 25.6% declare joint research and publication projects and 15.6% research and development assignments as the most important activity. But even in this case 11.3% of the scientists answer “personal activity not bound by contract” to be the most important transfer activity.

(Insert table 2 here)

University-industry linkages resulting in publications (namely “Joint research and/or publication projects”) and flows of funds (namely “R&D assignments”) appear to be only for 41.2 % of the university scientists and for 38.6 % for scientist of the public research institutes the most important transfer types. This corroborates the hypothesis that a multitude of transfer channels has to be considered to give a complete picture of the knowledge transfer processes.

5.3 Spatial destinations of the transfer activities

The second important question relates to the geographical distribution of university-Industry Linkages. Table 3 depicts the findings. It shows that for the universities 24.2 % of all of the “Joint research/publication projects” take place in Jena, i.e. the city of Jena and the neighbouring districts. In case of the institutes these are 31.7 % of this transfer type – almost one third. An overview of table 3 confirms that there is a strong spatial bias of the transfer activities in favour of Jena: In virtually all of the rows Jena is found on the first or second place as to the relative allocation of transfer activities. This outcome holds for the universities and for the institutes. One exception is the transfer channel “Temporary transfer of scientists”. Here the international dimension dominates for both types of public research organisations.

(Insert table 3 here)

Two objections that might explain this local bias have to be discussed. First, the local concentration of transfer activities might rest on the fact that potential transfer partners – as to the field of research - for the scientists in Jena can only (or at least predominantly) be found in Jena. That means, the local bias just reflects the mismatch of the scientific disciplines of the public research organisations in Jena with recipients in regions outside Jena. This explanation has to be rejected. The scientific disciplines of the universities and institutes in Jena cover the broad range of scientific fields (from sociology and medicine to engineering and physics) that can be found at almost all universities in Germany, Europe and the world.

Second, as to the strong local and regional focus of transfer activities presented above it might be argued that this is a very specific result that can not be generalized to other universities in other cities. The reason could be missing traffic infrastructures in Jena: Scientists would have to look out for transfer partners in Jena because of mobility barriers.[15] But considering the convenient highway and railway connections of this region on one side and the lack of an international airport on the other side it seems reasonable to conclude that Jena has a traffic infrastructure quite similar to the average situation of most of the universities in Germany. If there really exists a difference of transport possibilities compared with other cities in Germany it is in favour of the city of Jena.

So, the hypothesis that distances matter is confirmed by the regional distribution shown in table 3. There is a high probability that the regional distribution of transfer activities in Jena is not due to very specific external infrastructure constraints or a specific portfolio of scientific disciplines.

5.4. The relevance of face-to-face contacts and their significance for the spatial bias of transfer activities

The need of face-to-face contacts is the theoretical foundation of the tacit-knowledge-concept. The survey directly asked for the relevance of personal face-to-face contacts on a 6-point Likert-type scale ranging from zero (not at all necessary) to five (permanent contact necessary). With regard to the universities 60 % of the scientists claim that a very frequent or permanent personal contact is necessary during the transfer process (see table 4). In case of the institutes this finding is even more pronounced. Here 61 % underline the relevance of very frequent or permanent personal face-to-face contacts. For both public research organisations only about 6 to 7 % believe that for their own transfer activities there is no need (0) of or a very limited frequency (1) of personal face-to-face contacts necessary.

(Insert table 4 here)

These empirical facts of the survey lead to an average intensity of personal contacts of 3.65 for the universities and 3.61 for the institutes (see table 5). Due to the skewed distribution it is reasonable to look at the median instead of the average. In this respect the great importance of personal face-to-face contacts results in a median of 4 (universities and institutes) compared with the maximum of 5. This confirms the high importance of personal face-to-face contacts for the diverse activities concerning knowledge transfer in general.

(Insert table 5 here)

Finally, the survey design allows tackling the crucial question of the prominent role of personal face-to-face contacts as the factor limiting the geographical distribution of

[15] This conclusion bases on the premise that frequent personal face-to-face contacts are necessary during the knowledge transfer process. This is discussed below.

transfer linkages even in times of videoconferencing and a high personal mobility because of fairly good traffic infrastructures. Whether the spatial proximity of the transfer partner goes hand in hand with a need of frequent face-to-face contacts is put under consideration by means of a correlation analysis. It links the variable “Need and frequency of face-to-face contacts” to the variable “Localisation of transfer activities in Jena”. It puts forward the hypothesis that a high need of face-to-face contacts entails an increasing probability to work with transfer partners in Jena. For that reason a positive correlation coefficient is expected. Table 6 shows the Spearman rank-correlation of these two variables.

(Insert table 6 here)

The results do not fit to the hypothesis very well. Concerning the universities most of the correlations have a positive sign but statistical significance could be observed only in the case of three exemptions: Personal activities not bound by contract (or “informal activities”), education services for firms and institutions and the offer of workshops, colloquiums, conferences. The latter two results are not surprising, because education services and conferences heavily rely on personal face-to-face contacts by definition. The only interesting result is that the informal transfer channel of personal activities not bound by contract is significantly positively related to such direct kind of contacts.

As to the institutes the signs of the correlation coefficients for most of the transfer channels are negative, i.e. a high need of face-to-face contacts is slightly accompanied by a low percentage of transfer relations with partners in Jena. The only significant exemption is the founding of one’s own firm or institution. This kind of transfer activity draws heavily on personal face-to-face contacts.

Several tentative explanations of this result emerge, three technical ones and one more fundamentally one: First, the meaning of “personal face-to-face contacts” was missed by the scientists. Second, the simple analysis of these two variables might be misleading because other influencing factors disguise the correlation: a multivariate analysis is necessary. Third, the number of cases is rather low for some transfer channels. This leads to problems of detecting existing correlations. Fourth, personal face-to-face contacts are necessary but because of convenient communication and transportation possibilities they do not influence the geographic distribution of transfer channels.[16]

If this last argument is true there is a strong need for an alternative theory explaining the fact that a rising number of transfer activities is regionally concentrated (Broekel/Binder 2006, Gertler 2003). The findings suggest the need for a more differentiated theoretical explanation. An important element of such a theory could be the distinction of the search process for a transfer partner on one side and the

[16] Schartinger et al. also found that distance is no barrier for knowledge transfer demanding personal interactions (2002, p. 324). She explains this outcome with the fact that her study is limited to Austria – a nation with limited geographical extension.

transfer process itself on the other side. As to the transfer process the need of face-to-face contacts does not entail a local bias because transport costs are negligible. But in order to start a transfer activity a search process for relevant partners is necessary. Here the face-to-face contacts of everyday life become important and lead to a local bias. Or put in another way, personal face-to-face contacts might be necessary because of social proximity not because of cognitive proximity – in contrast to the assumption of, for example, Boschma (2006). This idea is supported by the finding of a principal component analysis (yet with the data of our university survey alone) that such core transfer activities as PhD theses, R&D assignments and joint research and publication projects load on the same principal component termed "research oriented transfer activities" as the informal activities not bound by contract.[17]

6. Concluding remarks

The study presents empirical findings for the innovation system in Jena and deals with three questions: The importance and variety of existing transfer channels, their geographic distribution and the importance of face-to-face contacts. With regard to the first question the analysis reveals some shortcomings of the usual channels considered in many empirical studies. First, informal transfer channels play an important role and second the multitude of transfer channels at hand turns out to be large. These outcomes suggest a very cautious interpretation of the claimed influences of transfer mechanisms like patents, joint publications and so on. In addition there is evidence that it is not possible to analyze the knowledge transfer channels between universities and firms by including only one channel. That means as to the methodology used the large degree of complexity and the profound fuzziness of university-industry linkages emphasize the need of great caution in interpreting the outcomes of econometric analyses. This applies obviously to the ad-hoc interpretation of correlations that miss any direct link (e.g. regional economic growth and existence of universities). But this is also true when using indicators of the knowledge transfer processes that clearly cover only a tiny fraction of the channels at hand.

As to the regional distribution of the linkages we confirm the relevance of spatial proximity. A substantial part of the relevant transfer co-operations concentrate on the city of Jena and the neighbouring districts.

Furthermore, we examine the idea that "distance matters" because of the necessity of face-to-face contacts. By means of asking the researchers the empirical findings underline that knowledge-transfer rests upon direct personal contacts. Finally, we offer tentative statistical analysis with respect to the relation of geographical distance and personal contacts. In this respect the results point out the need of further clarifications as to the theoretical explanations of local university-industry linkages and impacts.

[17] We will check this finding for public research institutes as well.

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Table 1: Average importance of transfer channels

Type of channel	Universities	Institutes
Joint research and / or publication projects with firms / institutions	2.1	3.2
R & D assignments by firms / institutions	1.8	2.0[1)]
Personal activity not bound by contract	2.2	2.4
Final papers of students	1.5	1.7
Education services for firms / institutions	1.6	1.2
Personal activity bound by contract (e.g. consulting)	1.1	0.3
Inspection orders / advisory or expert opinions for firms / institutions	1.5	1.2
Student projects (e.g. seminars)	1.2	0.8
Ph. D. – Theses	1.1	1.5
Offering workshops / colloquiums / conferences	1.8	1.5
Founding of ones own firm / institution	0.3	0.1
Activity as general manager / chief excecutive	0.7	0.2
Internships of students	1.1	2.0
Promotion of spin-offs / start-ups	0.5	0.2
Temporary transfer of scientists	1.1	1.4
	N = 172	N = 122

1) R&D Assignments in the field of basic research only.

Table 2: Most important transfer channels

Type of channel	Universities %	Institutes %
Joint research and / or publication projects with firms / institutions	25.6	27.9
R & D assignments by firms / institutions	15.6	10.7[1)]
Personal activity not bound by contract	11.3	6.6
Final papers	8.8	4.1
Education services for firms / institutions	7.5	1.6
Personal activity bound by contract (e.g. consulting)	5.6	0.8
Inspection orders / advisory or expert opinions for firms / institutions	5.0	4.9
Student projects	3.8	1.6
Ph. D. – Theses	3.8	6.6
Offering workshops / colloquiums / conferences	3.8	1.6
Founding of ones own firm / institution	3.1	0.0
Activity as general manager / chief executive	1.9	0.0
Internships	1.3	3.3
Promotion of spin-offs / start-ups	0.6	0.0
Temporary transfer of scientists	0.6	0.8
	N =160	N = 122

1) R&D Assignments in the field of basic research only.

Table 3: Regional Distribution of transfer channels

Type of channel		Jena %	Rest of Thuringia %	Rest of Germany %	International %
Joint research / publication projects	Universities	24.2	10.7	44.8	20.3
	Institutes	31.7	9.6	35.0	23.2
R & D assignments	Universities	28.5	13.7	43.6	13.2
	Institutes[1)]	37.5	8.5	32.5	21.6
Personal activity not bound by contract	Universities	25.8	12.9	42.8	18.8
	Institutes	21.4	10.0	37.1	31.1
Final papers	Universities	32.3	21.8	35.7	9.0
	Institutes	87.0	2.9	7.8	2.4
Education services	Universities	34.2	21.6	35.3	8.8
	Institutes	78.0	6.5	12.3	3.2
Personal activity bound by contract	Universities	30.0	10.2	49.7	10.1
	Institutes	24.1	20.0	31.4	24.5
Inspection orders / advisory or expert opinions	Universities	14.1	21.3	56.2	8.4
	Institutes	27.6	11.1	30.6	31.9
Student projects	Universities	38.6	20.1	33.9	7.5
	Institutes	86.1	6.8	4.9	2.4
Ph. D. – Theses	Universities	35.8	12.4	41.1	10.6
	Institutes	79.6	1.4	15.2	3.7
workshops / colloquiums / conferences	Universities	38.5	12.0	30.2	18.1
	Institutes	60.4	9.2	18.2	13.4
Founding of ones own firm	Universities	45.6	7.2	40.6	6.7
	Institutes	45.0	6.4	44.3	4.3
Activity as general manager / chief executive	Universities	37.0	19.2	40.6	3.1
	Institutes	66.0	19.0	11.0	4.0
Internships	Universities	36.0	12.2	37.4	14.3
	Institutes	91.9	3.2	2.3	2.5
Promotion of spin-offs / start-ups	Universities	59.2	17.4	20.4	3.0
	Institutes	90.0	5.0	5.0	0.0
Temporary transfer of scientists	Universities	26.1	8.0	31.4	34.3
	Institutes	13.1	2.8	25.3	58.8

1) R&D Assignments in the field of basic research only.

Table 4: Intensity of personal contacts

Frequency of personal face-to-face contacts needed		Universities %	Institutes %
None	0	1.9	2.5
	1	3.8	5.0
	2	11.5	7.6
	3	22.4	23.5
	4	30.1	37.0
Permanent	5	30.1	24.4
		100.0 %	100.0 %

Table 5: Average and median intensity of personal contacts

	Universities	Institutes
Average	3.65	3.61
Median	4	4
	N = 156	N = 119

Table 6: Rank correlation coefficients for the frequency of face-to face contacts and

Type of channel	Universities	Institutes
Joint research and / or publication projects with firms / institutions	0.18	- 0.04
R & D assignments by firms / institutions	- 0.10	0.08[1)]
Personal activity not bound by contract	0.20*	0.08
Final papers	0.03	0.07
Education services for firm / institutions	0.25*	- 0.04
Personal activity bound by contract	0.15	- 0.13
Inspection orders / advisory or export opinions	0.05	0.15
Student projects	0.04	0.07
Ph. D. – Theses	0.18	- 0.11
Offering workshops / colloquiums / conferences	0.24*	- 0.04
Founding of ones own firm / institution	0.00	0.89*
Activity as general manager / chief executive	0.29	0.04
Internships	- 0.04	- 0.04
Promotion of spin-offs / start-ups	0.08	- 0.11
Temporary transfer of scientists	- 0.03	- 0.11
	N = 156	N = 119

Spearman rank correlation coefficients
* Significant at the 5% - level
1) R&D Assignments in the field of basic research only.

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