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**Knowledge Spillovers as a Central Element  
in Theories about Knowledge-Based Regional  
Development: Advancement in Theory  
and Obstacles for Empirical Research**

*Peter Franz*

February 2010

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# **Knowledge Spillovers as a Central Element in Theories about Knowledge-Based Regional Development: Advancement in Theory and Obstacles for Empirical Research**

## **Abstract**

As scientists and policymakers tend to interpret changes in the economy as a trend towards an increasingly knowledge-based economy, their recommendations and strategies for regional economic development frequently contain elements how to intensify the knowledge flows in the region concerned. Knowledge flows come into existence from intentional action, but also in an unintended way as externalities or knowledge spillovers. This paper reviews the ways regional and urban economics has dealt with the concept of knowledge spillovers. Knowledge spillovers are defined within a conceptual framework that points out different uses of knowledge in economics. The concept's operationalisations in diverse empirical studies are systematised and discussed. After a critical review of the current state of research, policy strategies aiming to intensify knowledge spillovers are classified. The paper concludes with an outlook on promising new approaches to research knowledge spillovers and on the elaboration of more efficient policy strategies.

Keywords: knowledge spillovers; tacit knowledge; codified knowledge; transfer mechanisms; related variety

JEL classification: D83, R11, R12

# **Wissens-Spillover als zentrales Element in Theorien zur wissensbasierten Entwicklung: Fortschritte in der Theorie und Hindernisse für die empirische Forschung**

## **Zusammenfassung**

In dem Maße, wie Ökonomen und Politiker den wirtschaftlichen Wandel zunehmend als Trend zu einer wissensbasierten Ökonomie interpretieren, fließen in ihre Politikempfehlungen und politischen Strategien zur wirtschaftlichen Entwicklung auch Vorschläge ein, die eine Intensivierung von Wissensströmen zum Ziel haben. Wissensströme können sowohl durch intendierte Aktion zustande kommen als auch in Form nicht-intendierter Wissens-Spillover auftreten. Dieser Beitrag vermittelt im Überblick, in welcher Weise sich bisher Regional- und Stadtökonomien mit dem Konzept der Wissens-Spillover theoretisch und empirisch befasst haben. Als Ausgangspunkt für die Begriffsbestimmung von Wissens-Spillover dient ein konzeptioneller Rahmen, der die Dualität von Wissen als privates und als öffentliches Gut abbildet. Im Anschluss daran werden verschiedene Operationalisierungen des Konzepts der Wissens-Spillover systematisiert und diskutiert. Nach einem kritischen Blick auf den gegenwärtigen Stand der empirischen Forschung werden verschiedene Politikstrategien klassifiziert, die das Ziel verfolgen, Wissens-Spillover zu intensivieren. Der Beitrag schließt mit einem Ausblick auf vielversprechende neue Forschungsansätze und formuliert Voraussetzungen für effizientere Politikstrategien im Bereich der Wissens-Spillover.

Schlagworte: Wissens-Spillover, implizites Wissen, kodifiziertes Wissen, Transfermechanismen, related variety

JEL-Klassifikation: D83, R11, R12

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# **Knowledge Spillovers as a Central Element in Theories about Knowledge-Based Regional Development: Advancement in Theory and Obstacles for Empirical Research**

## **1 Introduction**

„If one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas” (Marshall, 1890, p.271). In spite of this recognition of Marshall at the end of the 19<sup>th</sup> century the attention economists pay to knowledge as a potential factor for growth is a rather recent phenomenon. After the findings of Marshall concerning the advantages of spatial proximity for the expansion of certain industries – embracing inter alia knowledge flows between the industrial actors – the orthodoxy of neoclassic constrained the economists’ view to capital, labour, and land as the basic factors of production. Scientists from other disciplines studying economic activities, like geographers, were less locked in the neoclassic view and focussed their research to processes of knowledge diffusion (Hägerstrand, 1967; Pred, 1977). Since the rediscovery of the importance of industrial clusters for regional growth and the realisation that an economy’s knowledge base gets more and more important for its ability to innovate scholars in regional, urban and innovation economists have begun to research knowledge creation and knowledge exchange more carefully. From the 1980s on this research has contributed to a refined understanding of the role of knowledge for innovation and production

This paper cannot screen the whole new stock of this knowledge-centred research, but will concentrate on recent advances in research concerning knowledge spillovers as a special kind of knowledge diffusion. Knowledge spillovers are considered to be the least intended and therefore least manageable kind of knowledge flows. From features like these difficulties can be expected in trying to include knowledge spillovers into knowledge-based development strategies. On the other hand, as scientists and policymakers increasingly tend to interpret changes in the economy as a trend towards a knowledge-based economy, their recommendations and strategies for regional economic development frequently contain elements how to intensify the knowledge flows in the region concerned.

The paper is structured as follows: In the first section the basic concepts of knowledge and knowledge spillovers will be clarified and various dimensions of the knowledge concept relevant for economics will be discussed. In the second section different phases

in empirical research concerning knowledge spillovers will be outlined and structured. The third section turns to implications for knowledge-based development strategies that can be deduced from the findings in section two. Section four concludes and points to diverse research gaps referring to mechanisms enabling knowledge spillovers.

## **2 Economically Relevant Dimensions of Knowledge and Knowledge Spillovers**

Since the early attempt of Machlup (1980) an increasing number of concepts, dimensions and typologies have been introduced by economists with respect to knowledge. Tacit vs. codified knowledge, knowledge as a private good vs. knowledge as a public good, knowledge vs. information or knowledge vs. human capital are just the most frequently discussed differentiations and polar dimensions in this research process. In accordance with Döring and Schnellenbach this paper defines “knowledge as comprising all cognitions and abilities that individuals use to solve problems, make decisions and understand incoming information” (2006, p. 377).

This definition contains the implicit assumption that knowledge becomes only effective and economically relevant, when it is accessed and processed by human mind (Witt, Brökel, and Brenner, 2007, p.3). As preconditions for using a piece of knowledge the respective actors need to have access to it (e.g. lend or buy a book or attend a lecture) and they must dispose of a certain absorptive capacity (Cohen and Levinthal, 1989) that allows them to understand the information and to interpret its context and meaning.

These processes of learning (individual level) and knowledge diffusion (aggregate level) imply a model of communication with senders or transmitters of knowledge on one side and recipients on the other side. Whereas the actions of reading a book or listening to an audio tape can be classified as a mode of indirect interaction, because the original knowledge could be codified and stored on a medium, attending a lecture belongs to the mode of direct communication with transmitter and recipient coupled in a face-to-face situation (Witt, Brökel, and Brenner, 2007, p. 3).

In the case of tacit knowledge, where knowledge is not or cannot be codified, the transmission of knowledge can only take place by means of direct communication. In a few cases the holder of tacit knowledge may not even be able to verbalise his knowledge. This reduces the knowledge transmission process to learning-by-watching, i.e. face-to-face-situations with non-verbal communication.

A further relevant dimension of knowledge refers to the distinction between knowledge as a public and knowledge as a private good. Knowledge can only take the characteristics of a public good if it can be codified and thus be potentially accessed by all users (first public good criterion of non-excludability). But this is only a necessary



precondition and not a sufficient one. With the exception of published scientific knowledge as an (almost) pure public good many cases exist where the use of the knowledge will change its value and therefore hurt the second public good criterion of non-rivalry (ibid.).

Within the conceptual framework developed so far knowledge spillovers can be specified with respect to the public-private and the codified-tacit dimensions of knowledge (cf. Table 1). Knowledge spillovers only occur in cases, where knowledge is communicated *unintentionally*. In the case of knowledge as a public good, i.e. presented in a codified way and made accessible for the public, this spilling over process is intended. In the case of knowledge as a private good the carrier of the respective knowledge may either try to keep it secret and to gain profits from its use, or may either try to sell it on the market. As a rule the latter option only becomes possible when the knowledge has been codified. Spillovers from knowledge as a private good occur (1) when its carrier makes use of it (e.g. a new especially productive mode of logistics) and other ones (persons, firms) watch this use and become able to imitate this use.<sup>1</sup> Frequently successful imitation requires a period of reverse engineering (cf. Table 1). Spillovers from knowledge as a private good also (2) take place in cases where codified documents, e.g. descriptions of patents stored in the diverse patent offices, reveal important hints to the patent-protected knowledge for agents equipped with adequate absorptive capacities.

In the case of tacit knowledge the carrier of the respective knowledge can also be observed in face-to-face situations and learning-by-watching as a mode of knowledge spillover may occur. When the carrier of tacit knowledge will be hired by a firm in order to use this knowledge and to combine it with pieces of knowledge already available within the hiring firm, the acquisition takes place by (intended) exchange on the (labour) market and not by a spillover channel. The diverse dimensions of and relations between the diverse knowledge modes discussed so far are compiled in Table 1.

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<sup>1</sup> This mode of learning-by-watching in case of a private good takes place primarily as watching in distance, whereas in case of tacit knowledge learning-by-watching will be typical in face-to-face situations.

Table 1:  
Modes of knowledge and of knowledge acquisition

	Codified knowledge as ...		Tacit knowledge
	Public good	Private good	
<b>Acquisition by market</b>	-	Purchase of patents, licenses, software R&D assignments	Employment of bearers of tacit knowledge Cooperation with bearers of tacit knowledge
<b>Non-market acquisition</b>	Learning by means of texts and software Graduation in public schools and universities	Spillovers by means of... Reverse engineering Learning-by-watching Reading patent descriptions	Spillovers by means of ... Learning-by-doing Learning-by-watching Learning-by-interacting

Source: Franz (2004, p.112).

In theories of regional growth succeeding the neoclassical theory of growth knowledge spillovers play a crucial role. In their view a region A endowed with small technological knowledge advantages in comparison to a region B will extend these advantages continually over time. This comes true by means of gains in productivity and the market success of innovative products. According to theory one reason for this more dynamic growth in region A can be traced back to knowledge spillovers occurring more frequently between the firms within the region. After a certain span of time and a number of growth-enforcing (region A) and growth-restraining (region B) feedback loops the two regions A and B will move on diverging paths of economic development (Franz, 2004, p.111). In the long run the regions adjacent to the successful growing region A will gain by knowledge spillovers transgressing the region's border. Thus the new growth theories understand knowledge spillovers as positive externalities. This perspective opens up new political options, because regions can be screened according to their institutional settings being more or less favourable for knowledge spillovers taking place. Before dealing more intensely with this political dimension, the next section will examine how this theoretical assumption has been translated in and supported by empirical research.

### 3 Knowledge Spillovers in Empirical Research: Operationalisations and Findings

The following paragraphs address a variety of different research efforts to explore knowledge spillovers in the regional context. The summary in condensed form in Table 2 (for other classifications of knowledge spillover channels and mechanisms cf.

Audretsch and Feldman, 2004; Johansson, 2004) shall help to keep track of these various research designs.

Table 2:

Hypothesised transmission modi of knowledge spillovers and their operationalisation in regional economics and in innovation economics

<p><b>Operationalisation focused on ...</b></p> <p><b>Innovation input</b>  <i>Public R&amp;D expenditures</i> ⇒ stimulate private R&amp;D investment, patent applications and entrepreneurship in the region  <i>Private R&amp;D expenditures</i> ⇒ increase number of patents and innovations in the region</p> <p><b>Innovation output</b>  <i>Patent applications</i> ⇒ frequently take place in spatial proximity of recent patent applications in the same industry  <i>Patent citations</i> ⇒ frequently relate to other patents applied in the same region  <i>Product innovations</i> ⇒ frequently come true in regions endowed with universities, businesses engaged in R&amp;D, and highly qualified workforce</p> <p><b>Capital and product flows</b>  <i>Foreign direct investment and trade flows</i> ⇒ Diffusion of new technologies and technological processes at the locations of subsidiaries, customers and suppliers</p> <p><b>Availability of specialized human capital</b>  <i>Star scientist at universities</i> ⇒ Business clusters of spin-offs and subsidiaries of MNE in spatial proximity</p> <p><b>Exchange channels of codified knowledge</b>  <i>Comparison between location of a publication and location of citations of the publication</i> ⇒ Measure a) for intensity of knowledge flows between regions and b) for importance of diverse centres of knowledge production  <i>Co-authorship of publications according to the authors' workplace location</i> ⇒ Measure a) for the spatial concentration of knowledge production and b) for intensity of knowledge flows between regions  <i>Number of publications in refereed journals</i> ⇒ High quality of the codified knowledge in the region supports activities aiming at innovations in the region</p> <p><b>Exchange channels for tacit knowledge</b>  <i>Region as location of internationally renowned consulting firms</i> ⇒ opportunities to access tacit knowledge for businesses in the region  <i>Accessibility of airports with intercontinental flights</i> ⇒ a high number of connections increases the probability for interregional face-to-face exchange of carriers of tacit knowledge  <i>Frequency of trade fairs and exhibitions in the region</i> ⇒ opportunities for face-to-face exchange of tacit knowledge  <i>Frequency of science-business-relations in the region</i> ⇒ opportunities for face-to-face exchange of tacit knowledge</p> <p><b>Degree of knowledge correspondence between transmitter and receiver</b>  <i>Related variety</i> ⇒ for optimal productivity growth of firms new workforce must have slightly deviating skills from the firm's knowledge base</p>
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Source: Author's compilation, based on Franz (2004, p.114).

The introduction of knowledge spillovers in regional economics as a theoretical construct adds a further case to the story ‘easy theorising – difficult conversion into empirical research’. A couple of years ago Krugman stated in his seminal work on ‘Geography and Trade’: “Knowledge flows are invisible; they leave no paper trail by which they may be measured and tracked...” (1991, p. 53). So in a first attempt empirical studies exploring knowledge spillovers concentrated on paper trails of codified knowledge becoming visible and countable in form of patent citations (cf. Jaffe, Henderson, and Trajtenberg, 1993). Patent data allow comparing the location of the patentee with the locations of those persons citing the patent. This informs and about the spatial reach of knowledge spillovers and spatial spillover patterns in different technologies. Jaffe, Henderson, and Trajtenberg (1993) found in their study that patent citations of younger patents appear in spatial proximity to the patentee’s location. In case of older patents the pattern is much more scattered. From this finding can be concluded that spatial proximity is relevant for the diffusion of new codified knowledge, but not relevant for the diffusion of established knowledge.

A relatively similar methodology consists in comparing the geographical locations of co-patentees of patents and of co-authors of scientific publications. The detected spatial patterns also can be interpreted as knowledge flows. Concerning knowledge spillovers this method is of limited use, because co-authorships stand for planned cooperation, co-patents stand for R&D contracts and not for unintended knowledge flows. So this method has established in studies about networks and R&D cooperation (cf. Stolpe, 2002; Fritsch and Franke, 2004; Graf, 2006; Fritsch et al., 2007).

Further studies are focussed to the influence of public universities and research institutions on industrial innovation activities. With respect to this Jaffe (1989) could proof that the intensity of university research in a region is weakly, but positively correlated with the number of patents applied for in the same region. Another study covering 194 Standard Metropolitan Statistical Areas (SMSAs) in the US found a positive correlation between the amount of R&D expenditures in the private sector and in the public science institutions (Bania, Calkins, and Dalenberg, 1992). European studies with a similar research design (Goddard and Isabelle, 2006; Fritsch and Slavtchev, 2007) come to comparable findings.

Apart from these approaches exploring the diffusion of knowledge codified in form of patents and publications there exist further studies with a focus on the spatial relations between persons as carriers of highly specialised knowledge and the locations of firms belonging to diverse industries. Frequently the locations of biotech firms in the US are close to universities where star scientists teach and research in biotechnology (Audretsch and Stephan, 1996; Feldman, 2000). This high spatial correlation can be interpreted in the way that the economic exploitation of cutting edge technologies still requires flows of tacit knowledge besides the stock of codified knowledge. Gittelman

(2006) refines this research in comparing the US biotechnology sector with that in France.

Another category of empirical studies is based on the assumption that knowledge is not only embodied in persons, but also in technological products and processes. With this assumption in mind since 1990 a variety of studies tested if the numerous foreign direct investment (FDI) in the former socialist economies in Middle and Eastern Europe helped to produce knowledge spillovers from the new and/or modernised plants of multinational enterprises (MNE) to the domestic industries lagging behind in technological expertise and equipment (Branstetter, 2005; Girma, 2005; Günther, Stephan, and Jindra, 2008; Jindra, Giroud, and Scott-Kennel, 2009).

Can cities be discriminated according to the opportunities they offer for the exchange of tacit knowledge? This question has been explored by urban researchers like Lever (2001). He differentiated three dimensions for the term 'opportunities': (a) a city's endowment with business oriented services, especially consulting firms, (b) the number of flight connections offered by the city's airport(s) as well as the number of trade fairs and exhibitions in the city region, and (c) the number of firm start-ups implying that a high dynamics will help firm networks coming into existence.

The empirical studies cited up-to-now have in common that they infer from statistically significant correlations between variables at the aggregate level to the amount of regional knowledge transfer between firms or between firms and universities (cf. Hanson, 2000, p.481). A crucial deficit of these studies consists in the fact that they do not allow to identify the exact mechanisms of knowledge spillovers, as Glaeser et al. also note concluding their own study: "As a final point, however, we recall that our evidence on externalities is indirect, and many of our findings can be explained by a neoclassical model in which industries grow where labor is cheap and demand is high" (1992, p.1151). Audretsch and Feldman (2004) enforce this critical view pointing to the habit of economists to treat knowledge spillovers formally within a knowledge production function, introduced by Griliches (1979). This formal treatment leaves the nature of transfer channels as a black box (Döring and Schnellenbach, 2006, p.389).

The exploration of the variety of situations where knowledge spillovers emerge requires more (field) research at the micro level. So can knowledge spillovers be detected only by means of sociological micro-studies as already argued by Arrow (1962) and 30 years later by Krugman (1991)? In the meantime some case studies and some studies with small samples exist (cf. Simmie, 2002; Caniels and Romijn, 2005). But studies like these are stuck in the micro-macro dilemma how to deduce from certain cases to the whole city or region.

A number of years have passed since the statement of Glaeser et al. (1992) and for a large number of empirical studies researching knowledge spillovers this 'verdict' still holds true. In recent years some promising advances have been made by some scholars

with access to data files containing detailed information about personal attributes of the workforce in a country or a region. These features of the data sets allow at least partially to overcome the micro-macro dilemma mentioned above, and to specify more precisely conditions favourable for the emergence of knowledge spillovers. Boschma, Eriksson, and Lindgren (2009) analysed the effects of labour mobility on the productivity of Swedish firms. The data allowed comparing the similarity of the human capital embodied in the firms' workforce and in the new in-migrating employees. The authors found the largest productivity effects in cases where the skills of the newcomers were slightly different from the firm's established knowledge base. Negative productivity effects could be observed in cases of high similarity as well as in cases of complete divergence (Boschma, Eriksson, and Lindgren, 2009, pp.182ff.). The theoretical background of these findings is the hypothesis that knowledge spillovers will predominantly emerge in cases when the newly combined knowledge bases show a kind of 'related variety' (Frenken, Van Oort, and Verburg, 2007; Boschma and Iammarino, 2009). The new political options this new type of research reveals will be discussed in the following section.

#### **4 Implications for Strategies of Knowledge-based Development**

A discussion of knowledge spillovers within the political domain has to take into consideration that strategies can be aimed at their prevention as well as their stimulation. The institution of private property rights supports the status of knowledge as a private good. It's most important instrument is the patent law that tries to ensure that inventors and innovating firms can earn temporary surplus profits from their innovative endeavours. Political activities directed at property rights normally take place at the national level and not at the regional level. This paper is not the adequate place to go deeper into regulation aspects of individual property rights, but it should be pointed to a discussion in innovation economics if there is a loss in economic growth when protection of property rights becomes too strict and prevents (growth enhancing) knowledge spillovers (cf. Jaffe and Lerner, 2004; Acs and Sanders, 2008; Block, Thurik, and Zhou 2009).

In cases where knowledge is conceived as a public good, knowledge spillovers are valued as desirable phenomena: They help to diffuse new knowledge on more and unplanned transfer channels. For regional policy this accelerated diffusion is especially useful in cases when the application of new technologies helps firms to become more productive and/or develop new products. Though at a first glance it seems to be a paradox that unplanned and not intended knowledge spillovers can become a policy target, their economically promising aspects have led in the past to a variety of political strategies at the regional level. This variety is in stark contrast to the lack of precise

understanding of the spillover mechanisms (Maier and Sedlacek, 2005, p.1). The strategies can be classified into three categories:

- (1) Instruments trying to reduce the spatial distance between firms in a region as potential transmitters and receivers of knowledge. All policies supporting business clusters can be subsumed to this category, including the erection of technology, industry and science parks.
- (2) Policies to locate knowledge generating institutions in a region. The installation of universities, research institutions and the attraction of private R&D labs belong to this category of political measures. Universities simultaneously impart established knowledge to their students (human capital production) and create new knowledge by research.
- (3) Policies aiming at the intensification of knowledge flows. Measures as the setting up of offices for knowledge transfer, the opening of schools for extended vocational training or the stimulation to establish network relations between business and science in a region belong to this category. A further subcategory can be seen in the strategy to enrich a region's endowment with exchange nodes where people can meet and get stimulated by the presentation of technologically new products and new ideas.

#### **Ad (1):**

One of the rationales for practising cluster policies is the assumption that spatial proximity of firms belonging to the same industry or to complementary industries is a sufficient precondition for the emergence of knowledge spillovers. The positive experience of a few showpiece clusters (Silicon Valley, Route 128/Boston, Cambridge/UK) led to copies of these 'best practise' models all around the world. Some cluster policies also are connected with the building up of technological infrastructure, as for instance the case in biotech and nanotech parks, or incubators for the media industry. Decisions like these are based (a) on the (more or less) founded conviction (presumption of knowledge) that the selected technologies will become future growth carriers. They are also based (b) on expectations of the operating units that the common use of the technology would lead to local network and spillover effects between the involved firms.

Lacking success of these cluster policies by transferring 'best practises' indicates that policy recommendations must be substantiated on base of more complex and more context-specific theoretical approaches. Up-to-date innovation activities require combinations of knowledge available within and from outside of the region, and much depends on the firms' capabilities to get access to extra-regional knowledge sources. Wishful thinking that the emergence of *localised* knowledge spillovers alone would suffice to stimulate local economic growth has proven as too simplistic (Bergman and

Schubert, 2004). The question ‘How can firms get access to and use external knowledge resources?’ (Arvanitis and Woerter, 2006) might be a more adequate starting point for the development of strategic policy recommendations in comparison to the request to enlarge a local cluster by merely adding firms and employees.

**Ad (2):**

Research in regional economics has shown that since the 1980s the existence of universities in a region is generally positively correlated with regional economic growth (Jaffe, 1989; Goldstein and Renault, 2005). However, these findings on the aggregate level do not inform about the channels and mechanisms how these knowledge and human capital producing institutions stimulate economic growth. Some intervening factors seem to influence the relations between science and industry in a region: Favourable are certain complementarities between the disciplines researched and taught at the university and the predominating industries. In this context the universities’ profiles in the natural and engineering sciences is especially important. In regions with a clear profile of (a) specialised industr(y)ies frequently the location of research institutes with cognitive proximity to the specialised industry is an obvious instrument.

Another intervening factor on the industry side is the absorptive capacity of its R&D employees and departments. The effectiveness of this limiting factor can be studied at the case of the transformation of the post-socialist economy in Eastern Germany, where regional knowledge diffusion from the universities into the private sector suffered from the destruction of the collective combines with their large R&D departments and the subsequent predominance of small firms after 1990 (Graf, 2006; Fritsch et al., 2007; Fritsch and Slavtchev, 2007). This means that in regions with a private sector featured by low absorptive capacities the first policy step, i.e. to locate a university or a research institute in the region, should be accompanied by subsequent steps aiming at the communicative qualification of potential network partners. Measures of this kind already belong to the third category of measures differentiated above.

**Ad (3):**

As the diverse political instruments subsumed to category (3) lay stress on the function of places as exchange nodes, they seem to be more appropriate for city regions and less for rural and peripheral regions. In cases where the measures involve the building of expensive public infrastructure (e.g., trade fair complexes, convention centres), its feasibility depends on the capabilities of a number of municipalities to cooperate. A less expensive strategy with a stronger symbolic content consists in the stimulation of network relations between carriers of differing knowledge and capabilities. Recent evaluations of specific network stimulating programmes have shown that financial support that is granted to network initiatives in the context of a competitive call for



tenders, is suited to activate regional networking potentials (Eickelpasch, Pfeiffer, and Pfirmann, 2004; Eickelpasch and Fritsch, 2005; Kauffeld-Monz and Fritsch, 2008).

In recent years among the number of studies in regional economics supporting policy strategies falling into category (3), the ‘creative class’ approach (Florida, 2002) has become very prominent. In its core Florida’s approach is a human capital theory of regional development, enriched with sociological findings about preferred life-styles of younger academics (Franz, 2004). With respect to knowledge spillovers Florida’s approach is rather explicit, because he describes a kind of ideal urban information exchange scenario: Information exchange is intensified in urban places showing a high diversity regarding to age, nationality, ethnicity and sexual orientation, and offering opportunities where carriers of technological, economical and artistic (‘bohemians’) creativity can meet (2002, p.30ff.). The empirical evidence for this approach is mixed (Nathan, 2007; Boschma and Fritsch, 2009), but the dimension ‘diversity of creativities located in a city’ seems to hold as an appropriate predictor for urban economic development in the long run (Falck, Fritsch, and Heblich, 2009). Adding ‘in the long run’ is important, because it is easy to find examples where cities with an excellent human capital endowment perform economically poorly (e.g., the German capital Berlin: ‘Poor, but sexy!’). Another controversial topic derives from the policy implication in Florida’s approach to attract (talented) people first - and jobs will follow. There is an ongoing debate about the causal connection between both factors in urban and regional economics (cf. Glaeser, 2005).

## 5 Summary and Conclusions

This paper has started with the venture to differentiate important dimensions of knowledge (private – public; codified – tacit) in the economic context, to root the notion of knowledge spillovers within this conceptual framework (Table 1), and to elaborate the preconditions for knowledge flows coming into existence. In section 3 the various trials to operationalize the knowledge spillover concept for empirical research were screened and the deficits in these research endeavours were identified. Especially studies with a background in regional economics still suffer from the habit to conclude from positive correlations between variables at the meso or the macro level that knowledge spillovers at the micro level exist. Research deficits like these still interfere with intentions to derive sound policy strategies from those studies. In section 4 the diverse policy strategies aiming at an increase of regional knowledge spillovers were classified into three categories: (1) Instruments trying to reduce the spatial distance between firms in a region as potential transmitters and receivers of knowledge, (2) policies to locate knowledge generating institutions in a region, and (3) policies trying to produce an environment favourable for more intense knowledge flows. The efficiency of many strategies suffers from the widespread handicap that they represent mere copies of best

practises applied in other regions. The mentioned deficits in research as well as in policy serve as a point of departure for the following concluding remarks.

Knowledge-based economies cannot only be characterised by a growing importance of scientific and/or technological knowledge shaping economic activities, but also by increasing intensities of knowledge flows between the acting units. Part of this knowledge flows come into existence without any intention and in spite of trials to protect knowledge in order to reap profits from its application. In regional economics these knowledge externalities or spillovers were taken into consideration theoretically since the late 19<sup>th</sup> century. It lasted more than half a century until scholars of this domain started to explore knowledge spillovers empirically. Soon it became obvious that their methods, for the most part applied at an aggregate level, could not catch the working mechanisms and transfer channels of knowledge spillovers. More openness towards interdisciplinary research and the inclusion of studies at the meso and the micro level seem to be the key steps for future progress in research.

Newly available data sets can help to refine existing approaches by introducing more intervening variables as for example ‘related variety’. From these possible gains in theoretical precision perhaps more difficulties in formulating policy recommendations may result. The era of recommending ‘one-size-fits-all’ policies or just copying best practises seems to be past (Asheim, Boschma, and Cooke, 2009). It becomes imaginable that the new analytic instruments will disclose such a variety of differences of regions’ profiles with factors intervening in (localised) knowledge spillovers that it will prove impossible (or too expensive) to propose a strategy tailored to a specific region. Instead, policies at other levels may turn out to be more effective. The question ‘How can firms get access to and use external knowledge resources?’ has not necessarily to be answered by a local or regional policy approach. Diverse indicators give hints that the political actors are confronted with the task of a complex multi-level-policy where networking skills become essential. The goal could be to develop ‘collaborative advantage’ for the region (Lynn and Salzman, 2006; Franz, 2007).

The preoccupation with policy recommendations deducible from empirical research bears the risk to overlook the ambivalent nature of the knowledge spillover concept. This ambivalence already appears in the duality of defining knowledge in economics as a private as well as a public good. In the first sense it may be justified to intervene politically in order to prevent knowledge spillovers; in the second sense strategies to support knowledge transfer may be put on the agenda. Or, at the firm level: “While (firms, P.F.) obviously would like to appropriate relevant knowledge spilling over from other firms, they have an incentive to protect their own stock of knowledge against competitors” (Döring and Schnellenbach, 2006, p.388). This ambivalence will even continue in new research and new policy designs urgently needed.

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