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Abstract

It is widely recognised that knowledge and highly skilled individuals as "carriers" of knowledge (i.e. knowledge spillover agents) play a key role in impelling the development and growth of cities and regions. In this paper we discuss the relation between the mobility of talent and knowledge flows. In this context, several issues are examined, including the role of highly skilled labour for regional development, the features that characterise knowledge spillovers through labour mobility, the key factors for attracting and retaining talent as well as the rise of "brain gain" policies. Although the paper deals with highly skilled mobility and migration in general, a particular attention will be paid to flows of (star) scientists.

1 Introduction

In the past years, there has been a growing recognition that knowledge and highly skilled individuals as "carriers" of knowledge are a key driving force for regional development, growth and innovation (Lucas 1988, Romer 1990, Glaeser 2004, Florida 2002a, 2005a). Given the importance of well-educated people for regional dynamism, the geography of talent and the mobility patterns of the highly skilled class are increasingly attracting the attention of both academic scholars and policy agents. The central purpose of this paper is to shed some light on the relation between the mobility of talent and knowledge flows. We refer to talented individuals who transfer knowledge from one place to another by means of their mobility as "knowledge spillover agents". Although the paper deals with highly skilled mobility and migration in general, a particular attention will be paid to flows of (star) scientists. Understanding the precise character, spatiality, and temporality of this phenomenon is essential for explaining regional growth patterns and uneven development.

Based on a review of different strands of literature and recent insights from regional economics, concepts about innovation and knowledge interactions, and migration studies we will investigate the following questions:

- What is the role of highly skilled labour for regional development and growth? To what extent and in which ways do star scientists contribute to the innovation performance and dynamic development of cities and regions?
- Which features characterise the geography of knowledge spillovers through labour mobility in general and movements of star scientists in particular?
- Which factors are essential for attracting and retaining the highly skilled class? Which determinants shape the migration and location decisions of talented scientists?
- Finally, what are the policy implications which result from the rise in importance of knowledge spillover agents for the development and growth of cities and regions?

In the remainder of this paper we will review the most important findings concerning the issues raised above and map out an agenda for further research.

2 The role of highly skilled labour for regional development and growth

In the past two decades a considerable body of work has enhanced our understanding of the critical role played by human capital and talent in spurring regional development, innovation and growth. Highly qualified people and human talent are acknowledged to be an essential economic asset and a source of creative power in science, technology and business (Straubhaar 2001; Solimano 2005).

The new growth theory (Romer 1990) formally highlights the connection between knowledge, human capital, and economic growth. Drawing on the insights of this conceptional work, Lucas (1988) has put forward the argument that the spatial concentration of (skilled) labour generates strong external economies (or in his words "external human capital"), and that these externalities increase productivity and growth. In the meantime there exists a large number of empirical studies providing evidence for the strong relationship between well-educated people and the performance and growth of cities and regions (Eaton and Eckstein 1997, Black and Henderson 1999, Glaeser et al. 1995, 1998, 2000, 2004; Glendon 1998, Glaeser and Saiz 2004; Rodriguez-Pose and Vilalta-Bufi 2005).

Looking specifically on high-technology or knowledge-based sectors, it has been shown that a flexible labour market and highly-qualified personnel play a central role for the emergence and dynamics of high technology industries (Keeble and Wilkinson 2000). A survey of Californian biotechnology companies, for example, has revealed that the availability of qualified workers is a key factor determining the location of these firms (Audretsch 2003). Florida's recent work on the creative class (2002a, 2002b, 2005a, 2005b) supports the above raised issues, as it also identifies human capital as the driving force behind regional development. His research indicates that the economic geography of talent exerts considerable effects on the location of high-technology industries and regional incomes. Although Florida's creative class approach has been criticised sharply for a variety of reasons (see, for example, Glaeser 2004; Lang and Danielsen 2005; Peck 2005; Boyle 2006; Hansen et al. 2005; Markusen 2006; Scott 2006), his basic ideas on the significant role played by skilled labour for regional economic dynamism continue to be highly influential, both in the scientific and policy community.

Star scientists as driving forces of regional high-tech development

What are the contributions of highly qualified scientists to the innovation performance and dynamics of cities and regions? Already 40 years ago, Horowitz (1966) analysed the economic effects of the regional distribution of scientific talent and concluded that areas which are rich in scientific talent can derive subsequent economic benefit while those which are poorly endowed with scientists suffer economic loss. More recently, in a series of articles Zucker and her colleagues showed for the rapidly advancing science and technology area of biotechnology that star scientists making major discoveries play an important role, influencing the use of the new technology by firms (Zucker and Darby 1996, 2001, 2006; Zucker et al. 1998a, 1998b, 2002, Darby and Zucker 2001, 2006a). Zucker and Darby (1996) and Zucker et al. (1998) introduced the concept of biotechnology stars based upon productivity measured by the number of articles written through the 1990s which reported a genetic-sequence discovery. Direct involvement of these stars proved to be a major factor in determining which firms were ultimately major winners in biotechnology (Zucker et al. 1998, 2002; Zucker and Darby 2001).

In a recent paper Zucker and Darby (2006) extend the concept of star scientists to all areas of science and technology. They demonstrate that the number of stars in a U.S. region or in one of the top-25 science and technology countries has a consistently significant and quantitatively large positive effect on the probability of firm entry in the same area of science and technology. Their main result is that the number of star scientists and engineers active in a region or country has uniformly very significant (at the 0.001 significance level) and positive effects on the probability of a firm entering in all six science and technology areas investigated. These findings lead them to conclude that the stars themselves rather than their potentially disembodied discoveries play a crucial role in the formation or transformation of high-tech industries, emphasising their embodied knowledge, insight, taste and energy. The physical presence of star scientists, thus, matters, as it has an impact on the formation and transformation of high-tech firms. The evidence provided by Zucker and Darby (2006) strengthens the case for the importance of the work of these extraordinary individuals for the economic development of regions and nations. Given the crucial role played by talent in general and star scientists in particular in fuelling regional dynamics, their mobility patterns and location decisions turn out to constitute essential issues which deserve closer attention.

3 Labour mobility as a key mechanism of knowledge spillovers and knowledge transfer

The main aim of this section is to unravel the linkages between the mobility of highly skilled labour and knowledge transfer. In order to capture the relevance of that issue, it seems to be useful to "embed" the reflections on it within the more general academic discussion about knowledge flows. In the last years, the nature and geography of knowledge flows have become an important research topic in regional studies (see, for example, Bathelt et al. 2004; Gertler and Levitte 2005; Gertler and Wolfe 2006; Maskell et al. 2006; Tödtling et al. 2006; Tödtling and Trippl 2007, Trippl and Tödtling 2007). A key argument which has been raised in the recent literature on the mechanisms of knowledge flows and knowledge circulation is that it is not only market transactions and networking which matter for the exchange of ideas and expertise. There seems to be a widespread consensus that also spillovers constitute an important type of and specific channel for knowledge transfer and that these externalities have a positive impact on innovation and growth (Breschi and Lissoni 2001a, 2001b; de Groot et al. 2001; Bottazi and Peri 2003; Greunz 2005; Maier and Sedlacek 2005; Eckey et al. 2005; Abdelmoula and Bresson 2006).

Knowledge externalities are complex in nature as they can take very different forms. There are, for example, spillovers through the reading of scientific literature and patent specifications (Jaffe 1989; Jaffe et al 1993), through informal contacts (Feldman 2000), through observation and monitoring of competitors (Malmberg and Maskell 2002) or through spin-offs (Keeble and Wilkinson 2000, Tödtling et al. 2006). The mobility of highly skilled personnel (or the transfer of human capital) represents another core mechanism for the spilling over of (embodied) knowledge (Arrow 1959; Matusik and Hill 1998; Argote and Ingram 2000; Rosenkopf and Almeida 2003; Moen 2005; Döring and Schnellenbach 2006).

In the following our focus is exclusively on the mobility of highly qualified workers as a specific type and manifestation of knowledge spillovers. We refer to talented individuals who transfer knowledge from one place to another by means of their mobility as "knowledge spillover agents". To understand the precise character, spatiality, and temporality of this phenomenon is essential for explaining regional growth patterns and uneven development.

3.1 The geography of knowledge spillovers through mobile labour

The movement of highly-skilled workers between local firms, universities and other organisations is regarded to constitute a central mechanism of regional collective learning and localised knowledge transfer (Saxenian 1994, Henry and Pinch 2000, Keeble 2000, Lawton Smith and Waters 2005), underpinning the dynamic development of high-technology clusters. Mobile highly-skilled researchers, scientists, engineers and managers are important "carriers of knowledge" (Lorenz 1996) on the local labour market, leading to an enhanced transfer of embodied expertise and a deepening and broadening of the regional pool of knowledge.

Labour mobility, however, is not restricted to the local or regional levels. On the contrary, the international migration of labour has become an important form of globalisation (see Table 1 and Table 2) in recent years (Beaverstock 2002; Willis et al. 2002; Global Commission of International Migration 2005; Freeman 2006; Taylor 2006).

Table 1: Stocks of foreign labour force in selected OECD countries (percentages)

	1995	2000	2004
Luxembourg	52,4	57,3	62,0
Switzerland	18,6	17,8	20,6
Austria	9,9	10,5	11,9
Belgium	8,3	8,6	9,1
Germany		8,8	9,1
Norway	2,5	4,9	6,6
Spain	0,8	2,5	6,3
Italy	1,7	4,0	6,0
France	6,2	6,0	5,6
Ireland	2,9	3,7	5,5
Portugal	1,8	2,0	5,5
United Kingdom	3,4	4,0	5,2
Sweden	5,1	5,0	4,9
Denmark	3,0	3,4	3,9
Netherlands	4,0	3,9	3,8
Czech Republic	2,2	2,0	2,1
Finland		1,6	1,9
Hungary	0,5	0,8	1,4
Korea	0,3	0,6	1,0
Japan	0,1	0,2	0,3
Slovak Republic	0,2	0,2	0,1

Source: OECD (2006)

Table 2: Foreign-born persons with tertiary attainment in OECD countries, circa 2000, as a percentage of all residents

Country	Total „net“ foreign-born persons with tertiary attainment*	Country	Total „net“ foreign-born persons with tertiary attainment*
Luxembourg	33,5	New Zealand	0,2
Australia	26,5	Japan	-0,4
Canada	20,4	Korea	-1,0
Switzerland	16,4	Italy	-1,2
United States	12,7	Netherlands	-1,2
Sweden	8,8	Czech Republic	-2,3
France	8,0	Hungary	-3,8
Spain	4,2	Germany	-3,9
Portugal	4,1	Finland	-4,6
Belgium	3,7	Mexico	-5,6
Norway	3,2	Poland	-7,6
Greece	2,7	Ireland	-8,1
Turkey	1,2	Slovak Republic	-11,9
United Kingdom	1,0	*Average (simple)*	*3,3*
Austria	0,5	*OECD zone*	*6,0*
Denmark	0,3		

* Total “net” foreign-born persons with tertiary attainment = (Immigrants from other OECD countries – Emigrants to other OECD countries) + Immigrants from the rest of the world

Source: OECD (2006)

Particularly interesting for the purpose of this paper is the increase of the global mobility of highly skilled managers, scientists, and engineers[1] (Iredale 2001; OECD 2005). There is a growing global competition for talent and highly qualified people (Mahroum 2001, Cervantes and Goldstein 2006). Over the last two decades a global “migration market for skills” (Salt 2005) has emerged. The main driving forces of this trend are a growing demand in advanced countries for IT and other skills in science and technology as well as the emergence of more selective immigration policies that favour highly skilled migrants (Cervantes 2004, Salt 2005).

International migration and mobility of people are powerful mechanisms for the global diffusion of cutting-edge scientific, technical and managerial knowledge (Bunnel and Coe 2001; Coe and Bunnel 2003; Williams 2007), contributing to scientific excellence and underpinning innovation in

[1] Although the focus of our paper is on the migration of highly skilled, we agree with Williams (2006) who argued that every migrant and not only the highly educated one is a knowledge carrier, exhibiting a potential to transfer knowledge to others.

traditional high-tech centres such as the USA (see, for example, Alarcon 1999, Saxenian 1999, Stephan and Levin 2001) and impelling the emergence of new dynamic agglomerations of knowledge-based industries. Several Asian regions represent interesting examples in this respect (Sternberg and Müller 2005, 2007). Saxenian (2002, 2005, 2006) shows that the development of IT industries in Taiwan, India and China has been considerably accelerated by highly-skilled engineers, who retuned to their home countries after having studied and worked in the United States. This talent, she argues, is increasingly reversing the "brain drain" phenomenon (see also Section 3.2), by working or creating new companies in (and, thus, transferring technology entrepreneurship to) formerly peripheral regions. Another important issue raised by Saxenian is that foreign-educated venture capitalists increasingly invest in their home countries, thus, transferring first-hand knowledge of the financial institutions of the new economy to peripheral regions. This leads us to examine in more detail the character of knowledge flows through mobile talent.

3.2 Directions of knowledge flows and spillovers through movements of highly skilled workers

Several authors have argued that knowledge spillovers through mobile talent are far from being one way flows but tend to be more multi-directional in nature (Meyer et al. 2001; Ackers 2005a), leading to a sharing of the benefits of skilled migration between sending and receiving countries and regions (see, e.g., Fromhold-Eisebith 2002; Wickramasekara 2002; Meyer 2003; Regets 2003). These insights stress the need to go beyond a strict dichotomy between "brain drain" and "brain gain" when assessing the consequences of international migration of highly skilled workers. Several terms such as "international brain exchanges" (Salt 2005) or "brain circulation" (Saxenian 2000) can be found in the literature as denominations for this phenomenon. The trend towards circulation is strongly linked to the changing temporality of skilled labour migration, which is about a shift from longer-term to shorter term mobility (Koser and Salt 1997; King 2002). As Williams et al. (2004, p. 28) put it: "Longer-term migration has increasingly been replaced by more diverse, shorter-term flows, so that it is more apposite to refer to circulation and mobility than to migration".

The return of highly qualified people to their home countries represents an important example in this context (see also Section 3.1). The cases of India, Taiwan, Israel and Eastern Europe clearly show that such return flows of talent can even constitute an economic development strategy in its own right (Saxenian 2002, 2003, 2005; Cervantes and Goldstein 2006).

Recent academic work has demonstrated that the sending countries or regions might also benefit from their "knowledge migrants" (Ackers 2005a) even if they do not return. Highly relevant in this context is the rise of diaspora networks which connect skilled expatriates with their country of origin, alleviating the negative effects of the loss of highly qualified persons for the sending area (Meyer 2001, Ackers 2005b; Gill 2005).

A study carried out by Agrawal et al. (2003) identified the existence of knowledge spillovers from the receiving region to the sending one. Agrawal and his colleagues have developed a model of knowledge spillovers that rests on social relationships between inventors. In this model, geographical proximity is crucial for the emergence of social ties, but the authors allow for the possibility that social ties endure even after individuals have become separated. Based on an analysis of patent data, Agrawal et al. (2003) found strong evidence in support of the enduring social capital hypothesis: social ties that promote knowledge transfer persist even after formerly co-located individuals are separated. Thus, at the regional level, there is a spillover from the region that receives the employee to the region that lost the employee.

Similar findings have been presented by Corredoira and Rosenkopf (2005), who analysed the mobility of technical employees among firms in the U.S. semiconductor industry between 1980 and 1995. They show that a firm experiencing a loss of an employee is more likely to cite the firm receiving the mobile employee. Interestingly, the authors found that this effect is stronger for firms that are geographically distant than for firms that are spatially proximate. To summarise, the "circulation phenomenon" manifests itself in a variety of ways and seems to be to some extent "decoupled" from the physical presence of talent.

Although high-skilled international migration has gained considerably in importance, its economic and other effects are under-researched and remain poorly understood (Regets 2001; Coleman and Rowthorn 2004). A notable exception is, for example, the work of Ottaviano and Peri (2005, 2006) and Peri (2006) who show empirically for the USA that the inflow of foreign-born workers is associated with economic gains. Regets (2001) has compiled a list of likely outcomes of skilled migration, differentiating between sending and receiving countries (see Table 3). However, only few of these factors are – as he admits – well established empirically.

Table 3: Possible global and national effects of high-skilled international migration

SENDING COUNTRIES: POSSIBLE NEGATIVES • "Brain drain": lost productive capacity due to at least temporary absence of higher skilled workers and students • Less support for public funds for higher education	**RECEIVING COUNTRIES: POSSIBLE NEGATIVES** • Decreased incentives of natives to seek higher skills • May crowd out native students from best schools • Language and cultural barriers between native and immigrant high-skilled workers • Technology transfers to possibly hostile countries
SENDING COUNTRIES: POSSIBLE POSITIVES • Increased incentives for natives to seek higher skills • Possibility of exporting skills reduces risk/raises expected return of personal education investments • May increase domestic return to skills • knowledge flows and collaboration • Increased ties to foreign research institutions • Export opportunities for technology • Return of natives with foreign education and human capital • Remittances and other support from diaspora networks	**RECEIVING COUNTRIES: POSSIBLE POSITIVES** • Increased R&D and economic activity due to availability of additional high-skilled workers • Knowledge flows and collaboration • Increased ties to foreign research institutions • Export opportunities for technology • Increased enrolment in graduate programs/keeping smaller programs alive
POSSIBLE GLOBAL EFFECTS • Better international flow of knowledge • Better job matches • Greater employment options for workers/researchers • Greater ability of employers to find rare/unique skill sets • Formation of international research/technology clusters (Silicon Valley, CERN) • International competition for scarce human capital may have net positive effect on incentives for individual human capital investment	

Source: Regets (2001)

3.3 Understanding scientific mobility

Highly skilled migrants are far from being a homogeneous group. On the contrary, there are marked differences between professions regarding, for example, their propensity and motivations to move abroad (Mahroum 2000a; Iredale 2001, see also Section 4). Scientists and academics tend to be more mobile than talent belonging to other highly skilled categories (Meyer et al. 2001), indicating the significance of an increasingly global research labour market (Ackers and Gill 2005). The enormous imbalances in the geography of such flows and the resulting uneven distribution of scientific capabilities have become a key issue of policy debates in many countries and regions (Gill 2005). In Europe, for example, the ongoing loss of scientists to the United States is a matter of constant concern (Morano-Foadi 2005). Generally, scientific mobility, or – as Meyer et al. (2001) put it – "scientific nomadism" is regarded to be a normal phenomenon in the academic world and often a precondition for progression in science careers, entailing international flows of scientific knowledge. Laudel (2003, p. 215) noted that "the interorganisational mobility of scientists has always been an important functional requirement for science. Scientists 'on the move' bring their knowledge to other places, acquire new knowledge in the new place and thus promote new combinations of knowledge. This is especially important in knowledge is not communicated through other channels like publications ... Since some kinds of knowledge are circulated in science by scientists who travel around, scientists' interorganisational mobility constitutes one of the most important knowledge flows in science."

Scientific migration and mobility, however, are a highly complex phenomenon. A sound understanding of its impact requires more than simply enumerating emigrants, immigrants and returnees. The effects of scientific mobility critically depend on factors such as the skill levels involved and the temporal character of such movements (see also Ackers and Gill 2005). Recent research also indicates that mobility patterns differ enormously within the academic or scientific sector between disciplines, scientific specialities and countries (Ackers 2005a, Laudel 2005).

A key finding of recent studies and analyses concerns the significance of the "qualitative dimension" of scientific migration. In other words: It is not only the quantity but also the quality of flows that matters (see, for example, Ackers 2005a). In terms of regional and national development, it seems to be obvious that movements of the most brilliant and brightest scientists have the greatest impact. Salt (1997, p. 22) noted that "the departure of a few top-level specialists in certain sectors of basic research could lead to the collapse of national scientific schools". In this context Mahroum (2003) points to the attraction of global centres of excellence. These centres have a "magnetic" and multiplying effect drawing star scientists who play an essential role in subsequent recruitment: "They tend to go where the best facilities are, and their reputation attracts the best young talents" (Mahroum 2003, p. 2).

Laudel (2005) points explicitly to the role of the "scientific elite" in recruiting the next generation of star scientists, emphasising the autocatalytic character of "elite production". The elite, she argues, is spatially concentrated in a few places "where young scientists are selected and guided into fruitful research areas. This increases the likelihood that those scientists will later become members of the elite themselves" (Laudel 2005, p. 380). Using bibliometric methods she also found that elite migration is partly field-specific and, even more interestingly, that migration occurs more among potential elites rather than among established elites.

3.4 Star scientists, knowledge flows and regional development

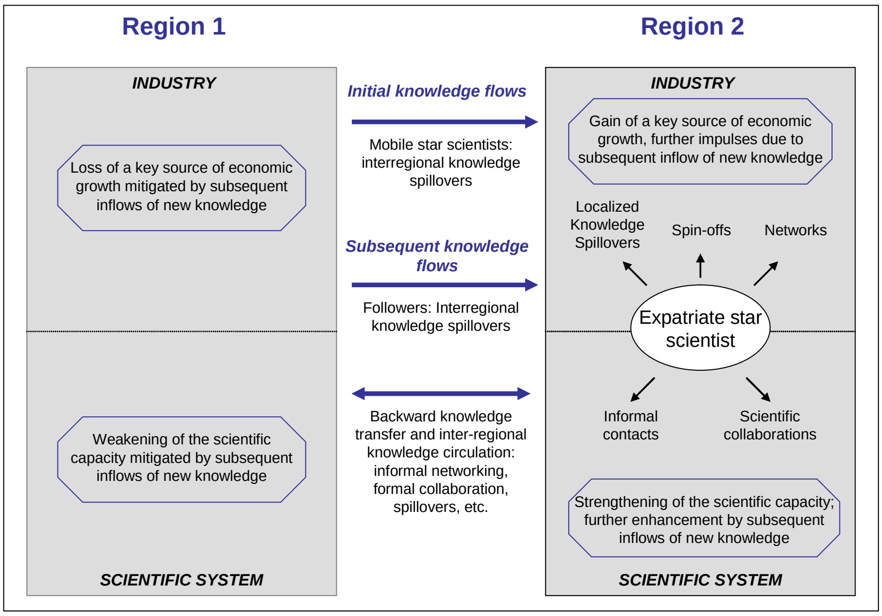
The issues raised above enable us to be more specific about the nature of knowledge flows which result from the mobility of highly skilled people and to reflect upon their impact on regional development. Focusing on movements of talented scientists we propose a model of knowledge circulation that goes far beyond a simple and unidirectional transfer of knowledge (see Figure 1).

The model suggested in this paper recognises that mobile star scientists can give rise to a large variety of interregional and local knowledge flows and it explicates important types in this respect. In the following we intend to discuss in a more comprehensive way the issue of interregional knowledge interactions induced by the movement of talented scientists and to draw first conclusions about their impact on regional development and innovation.

Interregional knowledge interactions due to the mobility of star scientists

In order to unravel the multitude of interregional and international knowledge interactions which can be related to mobile star scientists, our model draws a distinction between "initial knowledge flows" and "subsequent knowledge flows". The model is, therefore, dynamic, and this allows for capturing the complexity of the phenomenon dealt with here.

Figure 1: Knowledge link model



Source: Own compilation

- The movement of a star scientist from Region 1 (sending region) to Region 2 (receiving region) is inextricably linked to an interregional spilling over of knowledge. To take into consideration only this first effect, however, is oversimplified and would imply to ignore the large variety of knowledge flows that is potentially set off by the mobile scientist. To put it differently, the initial interregional knowledge spillover effect that is due to the movement of a star scientist could entail a range of further knowledge interactions between the sending and the receiving region.

- These subsequent knowledge flows emphasised above can take different forms. Other talent from Region 1 might follow the star to Region 2, thus, generating a further series of knowledge spillovers from the sending to the receiving area. These “followers” can include, for example, members of the former research team of the star scientist or also talented students.

- Furthermore, there are strong reasons to assume that the star maintains his or her relationships to the academic and industrial world of the sending region, releasing a backward transfer of knowledge or the establishment of linkages promoting the interregional circulation of expertise. There are various manifestations which can make their appearance in this context, such as scientific or R&D co-operations or more informal contacts promoting the exchange of expertise and ideas.

Mobile star scientists, therefore, can pave the way for an intense interregional and international exchange of knowledge and competences. They play an important role for the establishment of "knowledge infrastructures" which are pivotal for gaining competitive edge in the contemporary economy. Mobile stars could be regarded as important "creators of knowledge roads" between regions, along which other talent can drive and knowledge can move easily, tying distant areas together.

Scientific and economic impacts of the mobility of star scientists

In our model we differentiate between effects on the economy and effects on the scientific system in both the sending and receiving region. Before doing so, it should be alerted that the strength of the effects is dependent on the scientific and economic specialisation and the knowledge bases of the respective area, its absorptive capacity as well as the duration of time the star stays in the region.

- Arguably, there is a strengthening of the science base in the receiving region and correspondingly a weakening of scientific capabilities in the sending region due to the movement of the star scientist. This initial effect is reinforced if the "follower phenomenon" is quantitatively and qualitatively strong. The existence of mechanisms for backward knowledge transfer and interregional knowledge circulation, however, can mitigate the problem, leading to "scientific gains" for both the sending and the receiving region. The latter will in particular benefit from the immigration of the star scientist, if his or her knowledge diffuses locally. This requires an embedding of the star into the local or national scientific community, brought about by the formation of research co-operations, informal relationships and other types of scientific collaboration with local colleagues.

- Dealing with the economic impact of the mobility of star scientists, it seems to be reasonable to argue that the sending region looses a key source of innovative dynamism, whereas in the receiving region the arrival of the star might imply positive impulses for the local industry. Provided that the star scientist does not cut all ties to his or her former home region, an interregional circulation of knowledge can set in, stimulating creativity and economic development in both the sending and the receiving area. Examining in more detail the potential effects for Region 2 leads us to note that their emergence hinges on the successful creation of efficient mechanisms for the economic exploitation of scientific knowledge. These can comprise academic entrepreneurship, i.e. the foundation of a new firm by the star, formal and informal networks between the star scientist and the local industry, membership of the star in advisory boards of science-based firms, various forms of localised knowledge spillovers (e.g. citations of publications and patent specifications), etc. Consequently, only "embedded stars" who establish a range of contacts to actors in the host region will potentially act as an engine of growth, whereas "isolated stars", who lack such essential linkages will probably set off only a few economic effects.

In the following Section we will discuss those factors which attract and retain highly skilled migrants and scientific elites.

4 Attraction and mobilisation of talent: Which factors do really matter?

Which factors attract highly-skilled labour and, consequently, shape the economic geography of talent? This question is of outstanding importance, given the importance of knowledge spillover agents for regional innovation, growth and development. Among academic scholars, however, there is little consensus on this crucial issue.

According to the empirical findings of Florida (2000) the location of talent is strongly influenced by high levels of "diversity" (low entry barriers for human capital). To put it differently: talented people are attracted to locations that display a high degree of demographic diversity, i.e. places, where anyone from any background, race, ethnicity, gender, or sexual orientation can easily plug in. Other factors such as climate, cultural, and recreational amenities, in contrast, seem to play only a minor role.

The experiences of Korea and Taiwan are also interesting for the question dealt with here. Wickramasekara (2002) argues that active government programmes combined with special incentives were essential in attracting (back) skilled persons. Moreover, the rapid growth of the local economy, the high priority given to R&D, and the establishment of industrial parks (e.g. the Hsinchu Industrial Park in Taipei), and initatives by private sector industry which went "head-hunting" for talent in developed countries promoted the inflow of (returning) skilled people. Cervantes (2004) – however without any reference to empirical work – lists a multitude of factors including amongst others job opportunities, quality of working conditions, wage differentials, etc. Furthermore, he notes that for researchers and academics the conditions in the host country regarding support for research and demand for R&D staff and professors can be an important determinant in the migration decision and destination.

General claims such as those summarised above, however, conceal that the phenomenon of skilled migration is complex and diverse in nature, as it comprises very distinct groups of mobile professionals. This accentuates the need of a more differentiated approach for identifying and evaluating those factors which attract highly qualified talent. Mahroum (2000a) developed a typology of skilled migration and argued convincingly that each group of mobile professionals is driven by different push and pull factors (see Table 4).

Table 4: A classification of highly skilled mobility and types of influencing factors

Group	Type of Push & Pull Factors
Managers and executives	Benefits and remuneration
Engineers and technicians	Economic factors (supply and demand mechanisms) The state of the national economy
Academics and scientists	Bottom-up developments in science Nature of conditions of work Institutional Prestige
Entrepreneurs	Governmental (visa, taxation, protection etc.) policies Financial facilities Bureaucratic efficiency
Students	Recognition of a global workplace Accessibility problems at home Intercultural experience

Source: Mahroum (2000a)

As shown in Table 4, the group of academics and scientists, which is of special relevance for the aim of this paper, is mainly lured by bottom-up developments in academia and science, favourable working conditions, and the prestige of the host institution (Mahroum 2000a). In particular the latter aspect seems to be significant. Drawing on empirical results Mahroum (2000b) demonstrates that a high reputation of an academic or scientific institution can serve as important magnet of mobile talented scientists. This underscores the essential role of global centers of scientific gravity as a key location factor (see also Section 3.3).

Looking specifically on the location preferences of star scientists, Zucker and Darby (2006) show that stars are attracted by places which host more other stars. Star scientists tend to move from areas with relatively few peers to those with many in their scientific field. Consequently, this implies a concentration of stars over time.

Millard (2005) examines the mobility of scientific researchers in the EU within the context of the clustering of science and R&D in particular geographical areas. Reporting on a case study of Italian researchers who moved to the UK, the location decisions of this group of researchers based on the clustering of R&D in Europe and in the UK are analysed. The results point to the importance of prestige and networks in determining location decisions and these factors give established research centres an important advantage over smaller, developing ones.

Other empirical work supports the view that non-economic determinants play a crucial role in shaping international movements of academics. A study of the migration motivations of highly skilled migrants in the United Kingdom identified three groups of factors which influence scientific mobility. These comprise (1) aspects of employment (career advancement opportunities, the existence of global centres of excellence, wage differentials, and quality of research facilities); (2) economic and quality of life factors (i.e. living conditions) and (3) personal development associated with travel and experiencing another culture (DTI 2002).

A European Science Foundation report also stresses the significance of issues of status and autonomy which are not directly related to economic rewards. Martin-Rovet (2003, p.1) noted that “researchers want centres of scientific excellence and access to the best and latest scientific equipment. They want increased research funding and better salaries. They look for a society where science is respected and where their social status is esteemed”.

Finally, also Williams et al. (2004) stress that systemic features (greater openness in research agendas, career structures etc.) and reputations for excellence serve as main factors for attracting academics and scientists. Flows of highly skilled scientists, they add, tend to be highly localised in knowledge-intensive clusters. These inflows exhibit a cumulative character, as the presence of talent enhances the attractions of the key destination spaces for subsequent inflows.

The preliminary literature review of empirical studies has revealed that we still have a poor knowledge about those factors that attract and retain skilled workers and star scientists. Based on the work mentioned above, we might argue tentatively, that the results which have been found for the often broadly defined group of "talent" or "skilled personnel" do not necessarily hold true for the star scientists. There seems to be a widespread agreement in the literature that for the latter group, the presence of centres of scientific excellence constitutes the main factor of attraction. To examine the locational preferences of this type of knowledge spillover agents in more detail and to analyse which locational factors act as "magnets" for these experts and "knowledge carriers" is, thus, a key challenge for future research activities.

5 Towards a new approach for regional policy?

The prominent role of human capital in general and knowledge spillover agents in particular for growth and dynamism has far reaching implications for regional policy. They suggest the need for policies which put more emphasis on attracting and retaining talent. Flordia (2002b), for example, proposed a shift from traditional approaches that focus on the attraction of firms and the formation of industrial clusters to policies and programmes to attract and retain talent (Florida 2002b). Straubhaar (2001, p. 222) noted that "locations will specialise in producing 'attractivity' that can be sold to mobile brains. What began with off-shore locations for financial capital will continue for human capital as well."

Indeed, in recent years, the (international) mobility of highly qualified workers and the issue of an effective utilisation of their skills have captured the attention of policymakers in both advanced and developing nations and regions (Lowell 2001, Auriol and Sexton 2002, Wickramasekara 2002, OECD 2004; Reitz 2005). Many countries have implemented policies and programmes to facilitate the international recruitment of highly qualified people (OECD 2005). For an overview of various initiatives and discussion of particular examples see Iredale (1999), Saxenian (2000), Lowell (2001), Mahroum (2001, 2005), Wickramasekara (2002), Cervantes (2004), Davenport (2004), MERIT (2004), Fikkers (2005) and Giannoccolo (2006). Important measures and instruments to promote the inflow of talent include, for example, tax discounts and salaries, connecting with the diaspora, grants and scholarships, changes in legislation to allow the immigration of brilliant scientists, etc. In many cases the attempts by public authorities to attract foreign talent and key workers reflect shortages of specific skills in areas such as ICT or medicine (Auriol and Sexton 2002; MERIT 2004; Commission of International Migration 2005; Salt 2005). One reason for the growing international movement of skilled labour is the emergence of more selective immigration policies that favour well educated and talented people (Cervantes and Guellec 2002, Cervantes 2004, Salt 2005, Cervantes and Goldstein 2006). Mahroum (2001, p. 27) states that "immigration, particularly of the highly skilled, is becoming increasingly an inseparable segment of national technology and economic development policies."

As skilled labour is key for innovation and growth, a reorientation of regional policies towards a stronger focus on promoting the attraction, absorption and "anchoring" of highly qualified and mobile talent is, indeed, important.

6 Agenda for Further Research

In this paper an attempt has been made to discuss the relation between international labour mobility and distanciated knowledge flows. The movement of highly qualified workers has been identified to constitute a core mechanism of knowledge transfer. We have proposed the term "knowledge spillover agents" to capture the crucial role of talented people who transfer knowledge from one place to another by means of their mobility.

In spite of an ever growing literature on this phenomenon there are still major research gaps which deserve due attention in future work. In the following we will single out in a crude way some of the most important ones:

- There is still a poor understanding of the specific contribution of labour mobility to the international transfer and exchange of knowledge and skills. More conceptual and empirical research is necessary to disentangle the importance of migration as a mechanism for knowledge flows compared to other channels such as global networks, market linkages and informal contacts.

- Furthermore, the mobility strategies of "knowledge spillover agents" remain unclear. Little is known about the conditions and factors that promote or hamper international and interregional labour migration. Empirical evidence in particular about movements of elites and their reasons is still scarce (see also Laudel 2005).

- There is a lack of clarity regarding the impact of knowledge spillover agents on regional development. How can the impact of skilled migration in general and knowledge spillovers through mobile star scientists be conceptualised? What are the outcomes for the source region? Which types of knowledge spillover agents can be ascribed to contribute in an essential way to the growth of cities and regions?

- A final set of open questions concerns the role of policy agents in promoting the inflow of internationally mobile star scientists and other "knowledge spillover agents". Should policy makers promote the inflow of these experts and should they design initiatives to retain those who are already here? How can we justify such actions in theoretical terms? What are adequate measures? How should they be combined with other programmes to stimulate high-technology development, i.e. what is the right policy mix to promote economic dynamism and growth? Which strategies should talent-loosing regions and countries adopt?

Exploring these issues is a worthy subject and would enhance our understanding of the interweavement of labour mobility and knowledge transfer and its contribution to innovation, growth and prosperity of cities and regions.

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