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MIGRATION AND INNOVATION – A SURVEY

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Migration and Innovation – A Survey

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Abstract:

In a world characterized by competition on a global scale, persistent structural change driven by innovation and aging societies in industrialized economies, also the competition for the best talents on the labour markets becomes global and more intensive. Therefore it is not surprising that old-fashioned brain drain explanations for migration are no longer convincing. In the knowledge-based economies of the 21st centuries the ideas of brain circulation and international (diaspora) innovation networks become prevailing and should guide the design of migration policies. This paper is a survey on the theoretical and empirical approaches which address the important relationship between migration and innovation.

1. Introduction

The patterns of migration processes are complex. A first, to some extent simple explanation for this complex picture is that countries use different methods of collecting data on migration flows. A further increase in the complexity of migration processes stems from the fact that the composition of migrants is subject to considerable change over time. In the globalized economy high-skilled migration has intensified competition among countries to attract the best talents. Recent trends in international migration confirm that in developed countries more and more migrants arrive with tertiary education. International students and migrant entrepreneurs have become of outmost importance as a source of high-skilled migrants. The statistics of international students worldwide shows a strong increase for the last three decades. Moreover, migrant entrepreneurs employ on average at least 2.4 percent of the total employed population in OECD countries. A considerable number of high-skilled individuals also arrive as envoys of multinational companies.

Traditionally high-skilled migration is mainly considered as a loss to the emigration countries and analyzed under the heading *brain drain*. In this perspective, emigration of high-skilled leads to reduced economic growth for sending countries (most often synonymous for less developed countries). The implementation of policies to retract the *lost brains* (*repatriation policies*) adds a further research area to the migration literature. Return of high-skilled migrants is supposed to compensate the outflows for sending countries because the original home countries can potentially benefit from the skills and experience that migrants have gained abroad. However, impressing economic growth rates of economies like China, India or Taiwan and the role of the support from their emigrants for this economic success, is indicating that emigration of high-skilled labor, even without a return option might be beneficial for sending countries.

Today, many studies of migration processes apply network analysis to disentangle the complexity of international migration flows. With the discovery of the meaning of skilled labor networks a shift from the *brain drain view* in skilled migration to a *brain circulation view* can be noticed. The emergence of *diaspora networks* comprising well-educated migrants improves access to capital, information and contacts for its members in the home and host countries. Different terms such as intellectual diaspora networks, scientific diaspora, knowledge networks abroad and diaspora knowledge networks are found in the literature to describe the same phenomenon. These networks reveal that knowledge migration is a phenomenon beyond the migration of people only. Diaspora networks support the diffusion of knowledge and are an important component for economic growth in knowledge-based economies.

Entrepreneurship and innovation, driven by knowledge accumulation and generation, are key drivers of economic development and growth. In these learning processes external knowledge plays an important role. External knowledge becomes available through spillovers and knowledge transfers among heterogeneous economic agents. Migration is a rich source to enhance the diversity among economic agents and their individual knowledge bases. The interaction between skilled workers with heterogeneous knowledge creates knowledge spillovers and spurs idea creation. Cultural diversity may open up rich sources of innovation and creativity because it extends variety in abilities and knowledge. Networks formed by immigrants, particularly transnational networks make communication and information exchange easier and support the exploration and exploitation of the opportunities offered by cultural diversity. This process of mutual learning and cross-fertilization is embedded in institutional structures which locally differ strongly.

In this paper we survey the theoretical and empirical literature on the relationship between innovation and migration. We begin with a descriptive view on figures describing the development of migration flows and their structuring over the past decades. We then survey the theoretical literature explaining migration of high skilled starting from traditional neoclassical approaches embedding migration into an equilibrium framework and ending with Neoschumpeterian approaches which reflect on the knowledge which travels back and forth with the migrants as well as the possibilities to improve the innovation potentials by cross-fertilization of different knowledge and cultural backgrounds. In section four of this paper we then survey the rare empirical studies of this phenomenon and collect evidence for a confirmation of the brain circulation and innovation network view related to Neoschumpeterian economics.

2. A descriptive view on high-skilled migration

2.1 International Migration and the Measurement Problem

Migration has existed throughout history, in different forms and influenced by wars, natural catastrophes, business cycles and political issues. The *United Nations* estimate that around 214 million people in the world live abroad. This is about 0.3 percent of the world population. Generally people migrate because of humanitarian reasons, family-related reasons or working reasons. Based on their migration intentions, migrants are classified in different categories (Castles, 2000): refugees, asylum seekers, irregular migrants, forced migrants, labor migrants as well as highly-skilled and business migrants.

Comparing international data on total immigrant population suffers from the different national views concerning who is an “immigrant”. This makes research in this field so difficult. For example, some European countries, Japan and Korea refer to foreign residents;

according to their definition, immigrants are viewed as persons with a foreign nationality. Other countries, basically the settlement countries such as the USA, Canada, New Zealand and Australia refer to foreign-born population by which they mean the first generation of migrants who have immigrated to the country of residence. Because the acquisition of the nationality by immigrants is likewise easier there, statistics on persons of foreign nationality are rare. The simplification of naturalization in several countries together with the increasing figures of migrants makes estimates based on the two different concepts less comparable. With an increasing share of immigrants and an increasing share among them acquiring the citizenship of the host country and become nationals the scale of population of foreign citizenship tends to remain stable or to grow only slowly, while the population of foreign-born continues to increase strongly (Dumont & Lemaître 2005, p.116).

Pronounced asymmetries in data collection are a further distortion of comparisons of immigration flows. The taxonomies of the various countries with respect to different immigrant categories differ: Some countries for instance include asylum seekers in their immigrant population, some others not. Also the duration of the stay to be counted as an immigrant differs from country to country. Concerning *emigration*, the picture is even more complex. Several countries do not collect such information at all. Therefore, collecting data in order to compare countries with respect to the net migration flow is far from being easy.

2.2 Trends in international migration

The time period between 1956 and 2004 covered in figure 1 displays the trend of the net immigration to the OECD countries as a percentage of the countries' population. The net international migration for OECD countries in 1956 was 10 percent in the total population of OECD countries. In 2004 it was above 30 percent and in 2002 this percentage peaked with almost 40 percent. Most of the peaks in this time series can be traced back to specific historical events, for example the 1962 peak marks the end of the Algerian war and return of many French citizens from Algeria.

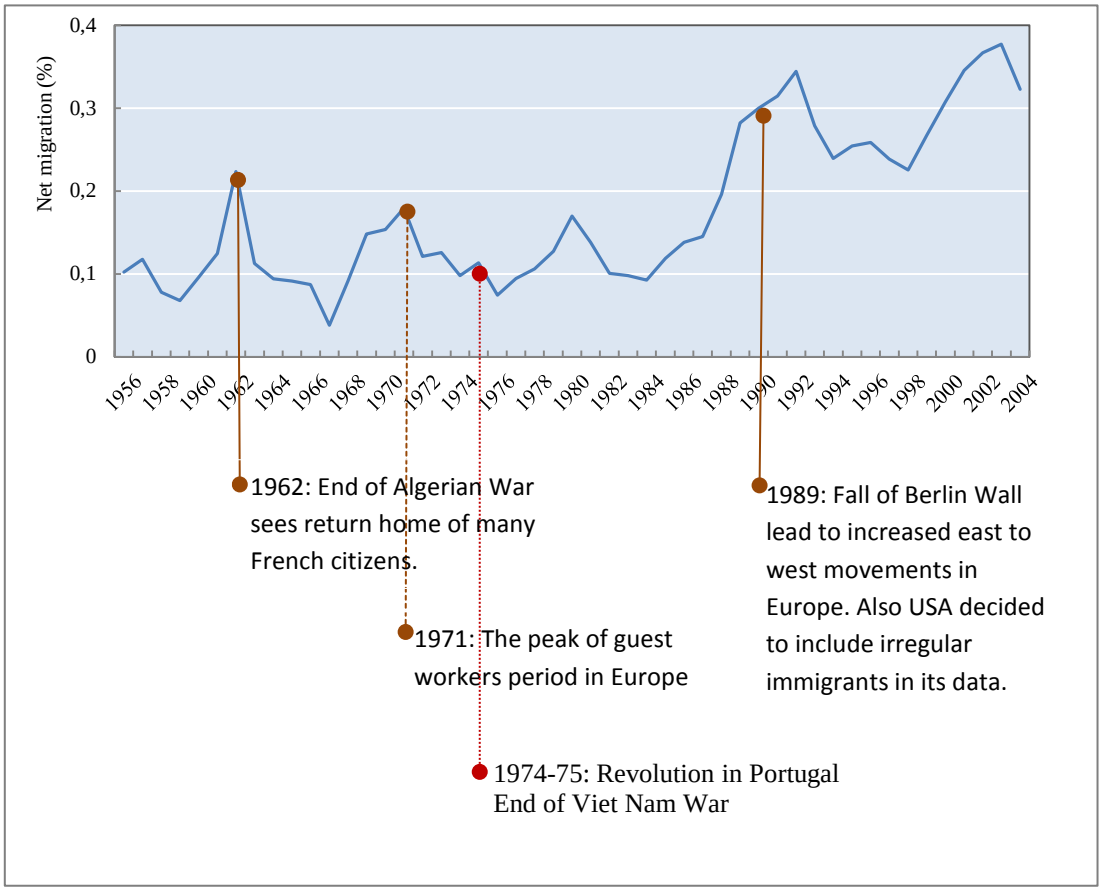
One of the important developments in international migration after World War II has been the emergence of *guest workers*: Western European countries such as Germany, Switzerland, Belgium and France recruited workers form less economically developed countries in their process of economic recovery. The peak in this development was reached in 1971. Among these countries Germany is mostly associated with guest workers (Keeley 2009, pp. 25-26).

According to the OECD (OECD, 2001) most recent trends in international migration are characterized by an upward trend which additionally exhibits the following characteristics: a) despite the greater inflow of asylum seekers the predominance of family linked migration can be observed, b) growing employment-related immigration, c) development of new forms of immigration such as transfer of staff within multinational companies, the temporary

movements of skilled workers to provide services, higher mobility of students, and d) also retired persons choosing to live abroad. Furthermore, foreign population is increasing and diversifying but remain concentrated around urban areas.

Concerning labor market oriented migration, since 1990 three major developments have opened up new possibilities in OECD countries: Southern European countries become immigration targets in the 1990's, the eastern enlargement of the European Union in 2004 and in 2007 and the US policy revision with respect to illegal immigrants who had entered the States in the 1980's.

Figure 1 Net migration as percentage of total population in OECD countries, 1956-2004

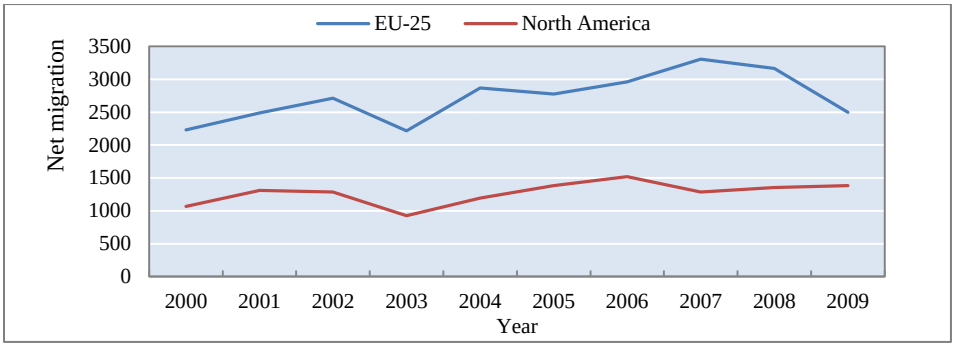


Source: Keeley (2009), p. 28, modified

Comparing net migration flows between North America and Europe it becomes obvious that although European countries are no *traditional immigration countries*, still net immigration to Europe is likewise higher (figure 2). The decline in 2009 is due to the financial crisis that affected GDP growth in most countries. Nevertheless European countries are faced with a rising labor demand. To some extent this is due to the aging problem Europe is facing. And much of the new labor demand in Europe can be satisfied with Eastern European migrants

because with the Eastern Enlargement Western European opened their labor markets towards the East (Stalker, 2002).

Figure 2 Inflow of foreign population into selected EU and North America (Thousands)



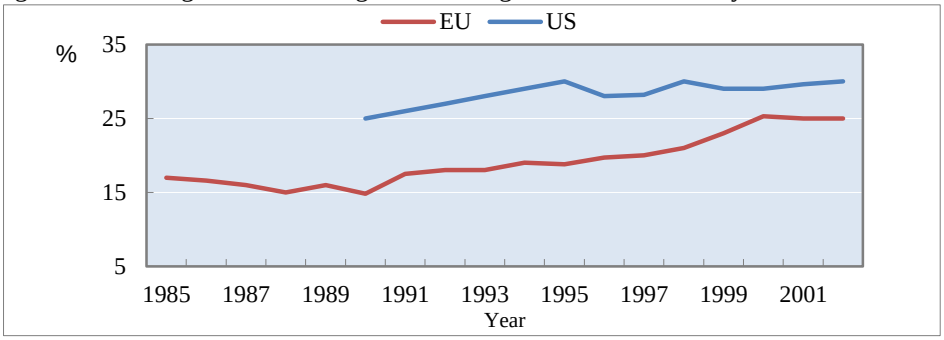
Own illustration [1]

2.3 Highly Skilled Immigration

For distinguishing between high-skilled migration and low-skilled migration, a definition of high-skilled migrants is necessary. So far, the concept of "high-skilled migrant" is not precisely defined. The understanding of skilled and high-skilled persons is mixed. Basically one finds a number of sub-categories which vary across countries. High-skilled specialists, independent executives and senior managers, specialized technicians, researchers, physicians, business people, key workers (i.e. staff with special skills) and sub-contract workers are all identified as high-skilled individuals. A straightforward method for gathering data is to define high-skilled synonymous with tertiary education. Recent trends in international migration confirm that more and more migrants with tertiary education arrive in developed countries. A comparison between European and North-American countries confirms that North-America receives more highly educated immigrants. By 2002 among arriving immigrants in the United States 30 percent have been adults with a tertiary education, while only 25 percent of the new arrivals are high-skilled in Europe (figure 3).

[1] Adapted from the data provided in OECD (2011)*a*, p. 341 see Appendix I

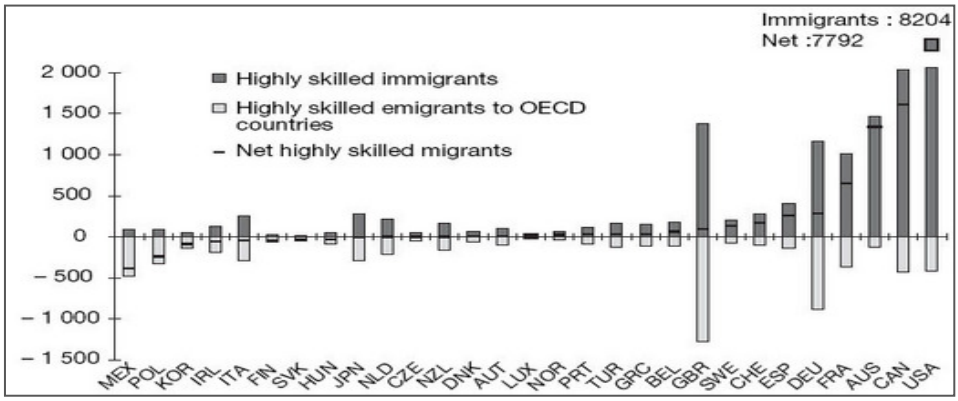
Figure 3 Percentage of new immigrant adults aged 15-64 with tertiary education



Source: IOM (2008), p. 54

Figure 4 shows for the year 2001 the immigrant and emigrant high-skilled population in OECD countries and the high-skilled net migration. With the exception of some Central and Eastern European countries, Mexico, Ireland, Korea and Finland, net migration is positive for the OECD countries. This implies that most OECD countries benefit from the international mobility of high-skilled persons. For the United States the number of high-skilled net migration is strongly positive (+7.7 million), Canada and Australia are ranked second and third. The figure illustrates partially the brain exchange within OECD countries.

Figure 4 Immigrant and emigrant population 15+ with tertiary education in OECD countries (Thousands)



Source: Dumont & Lemaître (2005), p.126

In table 1 Reiner (2010) compares - using data from 2008 - the share of high-skilled migrants in North America and four large EU countries. This comparison shows that the European countries are characterized by a higher emigration rate of high-skilled (UK ranks highest with 16.7% followed by Germany with 8.8% whereas the value for the U.S. is 0.5% and for Canada 4.9%). Additionally, the migration balances for *star scientists* for the six countries are displayed. According to ISI highlyCited.com[2] star scientists are defined as researchers that have been most highly cited in the period 1981-1999. Also this indicator expresses the

[2] ISI Highly Cited is a database of "highly cited researchers", scientific researchers whose publications are most often cited in academic journals, published by the Institute for Scientific Information.

advantageous position of the U.S. Accordingly Reiner (2010, p.499) summarizes: "All and all compared to USA and Canada, Europe seems to have a weak position in the competition for global talent."

Table 1 High-skilled migration in North America and the big four EU countries

	Share of foreign population with tertiary education	People with tertiary education, living abroad (%)	Migration balances for star scientists
Canada	38.0	4.9	0.0
USA	26.1	0.5	+ 23.4
UK	34.8	16.7	- 3.6
France	18.1	3.9	+ 0.5
Germany	14.9	8.8	- 1.7
Italy	12.2	7.0	- 1.6

Source: Reiner (2010), p. 450

After this descriptive overview of high-skilled migration, it is useful to see from which sources the high-skilled immigrants come and what their motivations are.

- International students

International students' inflows represent an important source of highly-skilled immigrants. In 2009 there have been 3.7 million international students enrolled worldwide, this is more than three times larger compared to the 1.1 million in 1990 (OECD 2011b). In the past three decades this number has been increasing drastically starting from 0.8 million in 1975. Not only the number of international students enrolled at universities and research institutes is increasing but also many of the international students after graduation intent to search for a job and stay in the host countries either temporarily - to gain first experience - or even for a longer time. For example in 2008-2009 around 17% of international students in Austria and around 33% of international students in Canada and 26% in Germany changed their status from students and stayed in their host countries (OECD 2011*b*, p. 67). Beside this, several universities are offering double degrees, student exchange programs and overseas research opportunities for PhD students. In 2008 among 3.3 million international students worldwide, 2.3 million were enrolled at the universities in OECD countries. Most international students (almost 70%) come from outside the OECD area (OECD2011 a, p. 65) and among them the Chinese and the Indian fractions are strongest.

- Migrant entrepreneurship

Migrant entrepreneurs contribute to the economy of the host country by creating new businesses. Every year, migrant entrepreneurs employ on average 2.4 percent of the total number of employees in OECD countries. In the United States between 1995 and 2005, 25.3 percent of technology- and engineering-based firms had at least one key founder who was foreign-born. 52.4 percent of Silicon Valley startups had one or more immigrants as a key founder (Wadhwa et al. 2007). In Germany, in 2007 and in 2008 migrant entrepreneurs employed more than 750,000 persons. In Canada Chinese entrepreneurs employed 650,000 workers, the majority of which were not Chinese (OECD 2011*a*, p. 157). Therefore,

migrant entrepreneurs, not only contribute to economic performance and growth, but also to entrepreneurship and innovation.

- Intra company transfers

A new form of high-skilled migration is intra-company transfers. As companies become multinational, the number of employees which move for a limited period to another country within the company increases. In several countries a considerable number of high-skilled individuals arrive as *transferees*. Several countries have adapted their policies to facilitate the movement of staff within firms. The number of intra-corporate transfers depends on the number and size of multinational enterprises in a country and their willingness or ability to recruit workers locally or to temporarily transfer their own employees. Intra-company transfers account for a small fraction of migration, although they may be a significant fraction of high-skilled labor movement (OECD 2011*a*, p. 56). Multinational firms make use of this flexibility in moving their specialists in response to their needs in different locations without having to be dependent on the existent regional competencies in the areas in which they are doing business. According to OECD data (OECD 2011*a*, p. 57) in 2009 a total of 124 thousands intra-company transferees were observed within OECD countries. This figure excludes the figures within Europe which is counted as a single area.

3. Innovation and Migration in economic Theory – A survey

In the early literature on *migration* the topics of *brain-drain* where discussed in a human capital framework. Scott (1970, p. 273) summarizes the central argument: "The human capital approach automatically leads economists to compare brain drain to capital movements and form questions about preventing it." The earliest theoretical works can be found in international trade theory, exploring whether and in what sense brain-drain is a problem. Authors like Harry Johnson (1965) and later Grubel and Scott (1966) studied the positive and negative effects of moving scientists and professionals with respect to their country of origin. On the one hand, it is argued that countries faced with emigration of their high-skilled labor force might reduce their funding of higher education (Regets 2001, p. 245). On the other hand, observing the success of emigrants raises the incentives of the natives for higher education, an effect in particular to be observed in developing countries.

Since the early 1980's *brain-gain* and *reverse-brain-drain* issues attract increasing attention. A possible negative impact of immigration for the host country, which has been discussed, is the *crowding-out* on the labor market of the native labor by immigrants. For example, Borjas (2005, 2006) argues that foreign students may crowd out native students from the best graduate schools. Regets (2001) is emphasizing a consistency problem in many of these political debates: If crowding-out effects are relevant and immigrants strengthen labor supply in the host countries, wages of high-skilled occupations decrease; from this follows lower

incentives of the locals to invest in their human capital. At the same time, however, it is argued, that low-skilled immigration substitutes low-skilled natives and reduces wages at the lower wage levels. This will lead to stronger inequalities in income distribution. If both arguments are accepted, then the consequence is that high-skilled immigration reduces income inequality whereas low-skilled migrants increase the incentive for natives to invest in human capital. This effect is empirically not proven, but studies for the United States so far show that a higher proportion of foreign-born employees goes hand in hand with higher salaries (Regets 2001, p. 251).

In this discussion De Haas (2010) argues that the ambivalent view on migration is to be seen as part of a more general paradigm shift in social and development theory. Concerning the optimistic view migration is viewed as a form of optimal allocation of production factors (De Haas 2010), in particular in a strict neoclassical view. From late 1960's the pessimistic view on migration is connected with debates on *brain-drain* effects. In this pessimistic perspective, migration increases inequalities (De Haas 2010). The empirical evidence, however, challenges both, pessimistic and optimistic views and ask for a new approach. Pluralist views on migration and development interactions such as the *New Economics of Labor Migration* (NELM) with its transnational perspective on migration and development offer such a new approach. In NELM the impacts of migration in a *knowledge-based economy* are emphasized. The strengthening of knowledge flows and collaboration between heterogeneous agents facilitated by immigrants together with the linkages they create with universities and training centers allow expecting a strong return on their human capital with the persons becoming economically active.

In cases the emigration of high-skilled workers and students were considered a "loss" in the productive capacity to the sending country - at least temporarily - the emigration countries have implemented special policies such as *restrictive*, *incentive* and *compensatory* policies in order to counteract the potential *brain drain* (Brown 2000). However, the effectiveness of these strategies remains dubious because the increasing trend in high-skilled migration was not affected. *Restrictive* policies, designed to make emigration more difficult, are effective only temporarily, if at all. *Incentive* policies are not a real option in developing countries: they can offer neither salaries nor infrastructures which are internationally competitive. *Compensatory* taxation (to be paid by the receiving country or the migrant) in order to compensate the loss to the sending country are also impossible: the loss cannot be measured in monetary terms.

Stark (2003) and Stark et al. (1997) evaluate the human capital formation in an economy with migration and without migration. They theoretically show that a carefully designed migration policy can be welfare-enhancing for the sending country. Related to human capital formation

influenced by migration, Beine et al. (2001) discuss two contradictory impacts of high-skilled migration; a *brain effect* and a *drain effect*. Since in a poor country, the return to human capital is low and therefore can lead to limited incentives to acquire education, allowing migration from this country increases the educated fraction of its population and given that only a proportion of educated finally emigrate, the average level of education increases. This impact of high-skilled migration constitutes the brain effect and is potentially positive if it dominates the drain effect. The size of the drain effect is determined by the number of educated persons that leave the country. Depending on the sizes of both effects, *beneficial brain drain* might exist. Beine et al. (2001, p. 288) further show evidence for their theory at the empirical level: "Beneficial Brain Drain is more than a theory, mainly because migration prospects seem to play a significant role in education decisions." Regets (2001) additionally argues that the incentives for human capital investment increase because *brain drain* leads to an increased scarcity of high-skilled workers in the sending country and raises the domestic returns to skills. A further positive effect stems from the improvement in the organization of labor markets for high-skilled workers in the sending country. In particular, in cases of a lack of demand for high-skilled workers, emigration acts as a *stabilizer* reducing the risk of investment in human capital.

For the authors emphasizing the positive aspects of high-skilled emigration effects on the sending country (Stark 1997, Beine et al, 2001, Mountford 1997) an optimal level of migration exists where the negative brain drain effects are compensated for. A further argument often found in the literature has to be mentioned in this survey as well: The effect of remittances of emigrants to the sending countries. Skilled migrants earn more and therefore, other things being equal, are likely to remit more. Some authors argue that the negative effects of the brain drain are somewhat offset by inward remittances from migrants (Faini 2007, p. 179).

A more recent approach to the migration of high-skilled is the *brain gain through return migration* or even *brain circulation*. This approach applies a dynamic network perspective to consider the effects of economic connections of migrants within the host country and to his/her country of origin. This perspective highlights that emigration of highly-skilled is not only a loss for the sending country. The migrants entertain linkages to their countries of origin which are used to transfer knowledge and to initiate economic activities. Also after a return of the migrants established relations connect the origin and the host countries with important economic implications for both countries. Social ties between skilled workers facilitate the transfer of knowledge and the return of experienced high-skilled migrants well connected in international business may compensate by far the brain drain of new outflows. Therefore, sending countries potentially benefit from the skills and social ties accumulated

abroad by their emigrants. In the literature different reasons for return migration are discussed: failure, conservatism, retirement and innovation (Wickramasekara 2003, p. 11). Return migration is analyzed within different theoretical approaches (Cassarino 2004). The new approach of migration economics (NELM) views return migration as a normal step after the migrants met their targets. Attachment to homeland and households eventually brings the emigrants back home after their goals are met. The returnee has acquired skills and experiences which he/she brings into the economy of the country of origin. In terms of social network theory the returnees are viewed as owners of tangible and intangible resources. Cassarino (2004, p. 265) states: "Just like the transnational approach to return migration, social network theory views returnees as migrants who maintain strong linkages with their former places of settlement in other countries." In the transnationalism theory the returnees are seen as actors that mobilize resources stemming from general attributes such as religion and ethnicity and social network theory emphasizes that actors mobilize resources available at the level of social and economic cross border networks. In both transnationalism and social network theory return is not seen as the end of the migration process but it is instead a stage of it. According to the two theories, the sending countries eventually can benefit from brain gain by return of their emigrants. Gains may flow back to the developing country via returnees with enhanced skills, personal connections, and ideas for innovation (Saxenian 2005). The return option was implemented in the 1970's until 1990's in so-called repatriation policies which should encourage high-skilled emigrants to return home. However, developing countries are usually not in the situation to offer the same incentives to their high-skilled migrants as they have access to in developed countries. Thus only a few newly industrialized countries such as China, India, South Korea, Hong Kong and Taiwan were successful in the implementation of these strategies (Brown 2002).

The standard labor market model of immigration assumes that migration is a mere reaction to the current economic conditions; nevertheless immigration evidently reacts to the countries' long-run prospects for economic growth and development. These long run impacts depend on how immigrants affect the economic growth rate. The early models of economic growth view growth as a result of an increase of the production factors, labor and capital, or improvement of technology leading to greater productivity. In evolutionary economics, instead, the key driver of economic evolution is entrepreneurship and innovation (Boschma & Martin 2010, p. 136). Creating variation and fostering the diffusion of varieties are the two important roles played by entrepreneurs. In evolutionary economics economic actors are heterogeneous implying that individuals as economic agents are endowed with different knowledge, skills, attributes and preferences. Similarly, environments are heterogeneous, implying that they are endowed with different knowledge, institutions, resources as well as demand for products.

Hence the entrepreneurial process depends on and is a result of the interaction between agents and their environment. External knowledge sources play a major role in the Schumpeterian view. External knowledge can become available through involuntary spillovers or intended knowledge transfers and collaborations. In her survey on empirical studies on location and innovation, Feldmann (1999) finds two major traditions: (i) the concept of geographically mediated spillovers which adds a geographic dimension to the determinants of innovation; and (ii) the determinants of differences in economic growth rates of different regions. In the first tradition authors try to quantify the impact of knowledge spillovers on innovation by referring to geography and based their estimations on production function. Authors of the second tradition consider for example agglomeration economics which foster innovation, and with it regional economic growth. Additional to this diversity argument, networks and national institutions play important roles in the economic development, in particular in knowledge based economies.

3.1 The role of diversity

Boschma and Martin (2010 p.142) stress a further perspective on migration and innovation by addressing the additional possibilities of cross-fertilization due to the migrants' knowledge: "Innovation is a product of interaction between actors that have sufficiently different knowledge, in order to make Schumpeterian new combinations." The combination of diverse knowledge plays an important role in the exploration of the knowledge landscape. Diversity is to be conceived as a broad concept which goes beyond diversity in production factors and resources, diversity in products but encompasses also diversity in technology and knowledge bases, behaviors and cultures. In other words, the concept of diversity stresses that economic agents are heterogeneous in all dimensions. The different types of diversities are not independent but mutually influence each other in a complementary way. Ozgen et al. (2010, p.9) describe diversity in the economy with a multilayer concept, in which ethnic, linguistic, religious and personal perceptions of belongings interact with the effects of diversity on innovation. Migration increases the diversity in ethnic identities.

Constant et al. (2006, p. 5) define ethnic identity as the balance of the commitments with a host country and the country of origin. Keely (2003) focusses on the interaction between high-skilled migrants and the local labor force which enhances the knowledge spillover pool and supports the creation of new ideas. These interactions are not random but specific patterns are to be observed in the form of clusters and networks. The networks serve as channels of knowledge transfer which besides the exchange of knowledge contribute to mutual learning and new knowledge creation. The architecture of these networks depends on national institutions and therefore differ between countries which results in varying contributions to innovation. Additionally, there is a trade-off between the positive and

negative impacts of cultural diversity. The negative impacts stem from language and cultural barriers between native workers and high-skilled migrants which increase transaction costs. A higher diversity, hence, does not necessarily imply improved innovation performance. Too much cultural diversity in a region might frustrate mutual understanding, cause social stress situations or distortion of local identities. To illustrate this relationship between diversity and economic performance De Graaff and Nijkamp (2010) introduce an inverted U-shape relation which allows for the derivation of an optimal level of diversity. Niebuhr (2009) considers the positive effects to outweigh the negative effects. This is caused by the strong complementary effects of the immigrants (p. 564): "Due to their different cultural backgrounds, it is likely that migrants and native workers have fairly diverse abilities and knowledge. Thus, there might be skill complementarities between foreign and native workers in addition to those among workers of the same qualification levels." Cultural diversity therefore supports innovation and creativity because it strengthens variety in abilities and knowledge (Alesina and La Ferrara 2005, Niebuhr 2009). A similar argument can be found in Saxenian (2006) and Kerr (2008) who see an amplification of the knowledge spillover pool due to the increasing internationalization of its sources. In this process *ethnic entrepreneurs* are of crucial importance.

3.2 The role of networks

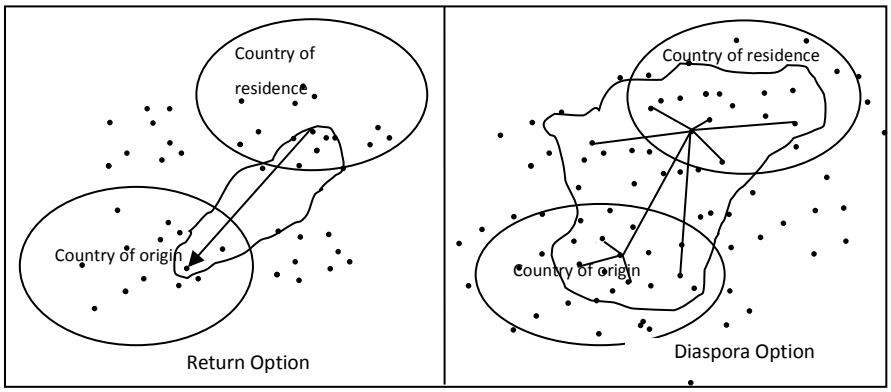
The participation in innovation networks is a source of competitive advantage for firms, regions and countries, in particular in knowledge intensive industries. The performance of innovation networks is strongly related with knowledge mobility in the network. Network structures link the diverse knowledge of agents and serve as channels for the exchange of knowledge. Pyka and Küppers (2002, p. 6) outline: "Innovation networks have three major characteristics: they are like co-ordination devices that enable and support the inter-firm learning by accelerating the diffusion of new knowledge. Second, the development of complementaries becomes possible within networks and finally innovation networks constitute an organizational setting that opens the possibility of exploration of synergies by combination of different technological competencies".

Networks with immigrants, particularly transnational networks allow for communication and information exchange which without the network linkages would be difficult. This improves the availability of information on skills, technology and capital as well as on potential collaborators. It also facilitates the timely responses that are essential in a highly competitive environment (Saxenian 2005, p. 38).

Return migration is considered as knowledge transfer in a network where the country of origin benefits from skills which are gained by its emigrants in the resident countries. As the left side of figure 5 displays, the linkage which exists in the case of return migration can be

directed from the country of residence towards the country of origin only. In this case not the full potential of the network connection is exploited.

Figure 5 Return and Diaspora option



Source: Meyer (2007), p. 7

However, the linkages between country of residence and country of origin can also be bi-directional. Groups of high-skilled expatriates keeping connections with their homelands are called *diaspora networks* displayed on the right side of figure 5. High-skilled immigration sometimes creates large, well-educated diaspora networks, which considerably improve access to capital, information and valuable contacts for firms in the countries of origin (Kuznecov, 2006). In the literature also the notions of *intellectual diaspora networks* (Brown 2002), *scientific diaspora* (Barré et al. 2003), *technological and scientific diasporas* (Turner et al. 2003, Connan 2004), *knowledge networks abroad* (Kuzentsov 2005) and *diaspora knowledge networks* (Meyer and Wattiaux 2006) are used to describe the bi-directional knowledge flows in innovation networks of migrants between the countries of residence and the countries of origin. Diaspora networks therefore offer an alternative view which goes beyond the brain drain discussion. Indeed, the network approach to brain drain (Brown 2002) has massively changed the evaluation of high-skilled mobility. Instead of the traditional brain drain outflow, a *brain drain skill circulation* moves into the forefront which displaces the potential loss of human resources with a remote but accessible asset of expanded networks (Meyer, 2001). Migration is no longer considered as a one-way path but as a dynamic process of networking and creation of linkages (Mahroum and Guchteneire 2006, p. 27). Meyer (2007) adds that the diaspora option allows for countries of origin to access not only the human capital acquired by their expatriates in the residence country, but also the access to social, cultural, intellectual and institutional capital. The diaspora networks do not have to be formally established but often are informal which is sufficient for the exchange of knowledge (Pyka, 1997). Immigrants' networks, formal or informal, are developing structures which enhance the flow of knowledge, in particular tacit knowledge, and support the development of new ideas and knowledge. It turned out that the networks constituted by skilled migrants are

different compared to networks of low or unskilled migrants (Vertovec, 2002) where knowledge exchange is less important. Diaspora networks to exchange knowledge follow similar principles which are observed in innovation networks in general. Direct communication between heterogeneous agents is important for the transfer of tacit knowledge.

Agrawal et al. (2006) develop and test a model of knowledge spillovers that depends on the social ties between inventors. They find that social ties which facilitate knowledge transfer continue to exist even after the network members are geographically separated. A further study by Agrawal and Oettl (2008) analyzes the patterns of knowledge flows which occur when inventors move. In this study countries enjoy a competitive advantage if they are able to make use of the cross border knowledge flows (*national learning-by immigration*). Also the firms might benefit from the knowledge flows from the inventor's new country (*firm learning from Diaspora*).

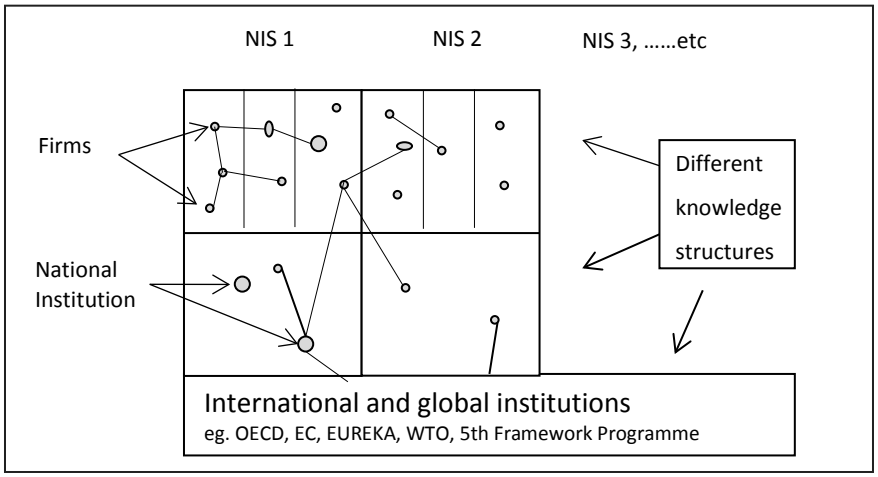
A particular role in these networks is played by transnational entrepreneurs, i.e. entrepreneurs who start a business drawing on resources from different countries: According to Drori et al. (2009) transnational entrepreneurs use their networks to explore profit opportunities in both countries and are engaged in both countries to promote their activities. With the exploitation of cross border knowledge flows and prolific frameworks supporting transnational entrepreneurship we refer already to the broad institutional set up which characterizes countries in the organization of their innovation processes, namely *National Innovation Systems*.

3.3 The role of National Innovation Systems

The concept of national innovation system (NIS) (Freeman (1987), Lundvall (1992), Edquist (1997) and Nelson (1993)) captures the interactions between different institutions and organizations that create and adopt innovations in a country. In a NIS large parts of the knowledge base is tacit and originates from the routines of leaning-by-doing and learning-by-interacting among firms. Chris Freeman (1987) highlights the role of innovation networks - comprising private and public actors in an institutional embedding – in initiating, importing, modifying and diffusing new technologies. A NIS strongly shapes the patterns of information and knowledge flows among individuals, institutions and firms and accordingly of high-skilled migrants and transnational entrepreneurs. NIS differ strongly among different countries and due to the increasing internationalization of economic activities which embeds a NISs in the global innovation system (Tomilnson 2001, pp. 32-33), NIS are also relevant for the possibilities to access international knowledge transfers. The globalizing innovation system is sketched in figure 6 which includes firms and institutions at the national level as

well as institutions and organizations at the global level which all interact in the development of the different national knowledge bases.

Figure 6 The globalizing system of innovation



Tomilnson (2001), p. 32

Besides interactions of actors in the different NIS also the movement of agents in the globalizing innovation systems is essential for the national innovation performance. How immigration of high skilled economic agents affects the countries of origin and the countries of residence depends on the designs of NISs. But not only on a national level the impact of high-skilled migration differs, but also on a regional and metropolitan level the impact varies considerably. E.g. Lee and Nathan (2010) show that high performing cities attract more high-skilled immigrants and therefore create a culturally diverse workforce which again supports their innovation performance.

4. Empirical Studies on Innovation and Migration – A survey

Empirical research on the relationship between high-skilled migration and innovation is rare and predominantly focusses on North America and some other traditional immigration countries. The United States are a striking example of how immigrant scientists have contributed to the national innovation performance. Hunt and Gauthier-Loiselle (2009) list the outstanding successes of high-skilled immigration to the U.S.: 26% of U.S. based Nobel Prize winners in the 1990s are immigrants, 25% of founders of public venture-backed U.S. companies in the years 1990-2005 are immigrants and 25% of new high-tech companies with more than one million dollars in sales in 2006 were founded by immigrants. Further, more than 50% of the engineers and scientists employed in Silicon Valley are immigrants. This high innovation performance of the immigrants is related to their participation in national and regional innovation networks combined with their bounder spanning diaspora networks; e.g. Saxenian et al. (2002) found that Taiwanese and Indian engineers have built networks in

Silicon Valley which connect them with their homeland technology community and which are used for intense knowledge and information traffic.

The main topics investigated in the empirical literature are the crowd-out and/or crowd-in effects, scale-effects, entrepreneurship and the role of diversity. As a measure for innovation mainly patent per capita data are used. Kerr and Lincoln (2008) investigate the influence of fluctuations of H-1B visas[3] and their influence on the rate of patenting by ethnic Indian and Chinese in the United States. The authors find that there is a significant correlation between the fluctuations of H-1B visa recipients and the rate of patenting. They also conclude that "total invention increases with higher admission levels primarily through the direct contributions of immigrant inventors" (Kerr and Lincoln 2008, p. 30).

Related to the effects of students' mobility, Stuen et al. (2010) studied the contribution of foreign science and engineering students to the creation of new knowledge in science and technology in the U.S. Stuen et al. (2010) study panel data of 2,300 science and engineering departments at 100 large American universities from 1973 to 1998. Their results indicate that foreign doctoral students significantly and positively influence publications and citations produced by U.S. academic departments. Moreover, increased diversity seems to be the primary mechanism by which the foreign students improve research outcomes. By adding foreigners to the team, diversity within the teams is increased. Team members would bring in complementary skills. "Diversity of the student body can generate positive spillovers from the exchange and mixing of ideas, training and methods if students from different regions bring complementary and heterogeneous skills" (Stuen et al. 2010, p. 5).

Zucker and Darby (2007) study the geographic movements of star scientists which are ranked high in science and technology and find a relationship between star scientists' movements and their innovative activities in receiving countries. Star scientists are likely to cluster in regions endowed with high-tech firms. In their study they follow the careers of 5401 star scientists between 1981 and 2004. Zucker and Dary found that the physical presence of star scientists is a catalyst for economic improvements. It is not only the immediate contribution of immigrants to research activities but also the spillover effect from the foreign star scientists on natives that boosts innovation in the host country.

Hunt & Gauthier-Loiselle (2009) conclude that "a college graduate immigrant contributes at least twice as much to patenting than his or her native counterpart (Hunt and Gauthier-Loiselle (2009), p. 20)." To assess the impact of immigration on innovation Hunt and Gauthier-Loiselle (2009) study individual patenting behavior as well as state-level

[3] H-1B visa is a visa program which allows the American employer to seek short-term help from skilled foreigners in "specialty occupations". Science, engineering and computer-related occupations make up to 60% of successful visa application. Between 2000 and 2005, 40% of H-1B recipients were form India and 10%came from China (Kerr&Lincoln (2008), p. 12). The visa is issued for three years with allowance for a single three-year renewal.

determinants of patenting. They measure the impact of highly-skilled immigrants (Hunt and Gauthier-Loiselle 2009, p. 5) on the US patent per capita between 1940 and 2000. If immigrants contribute in innovation activities and consequently increase patenting, then they should also have a positive impact on output per capita. Hunt & Gauthier-Loiselle empirically tested this for U.S. data on the individual and the country level. On the individual level, the authors define three categories of highly-skilled migrants; college graduates, holders of a post-college degree and those working as scientists and engineers. They show that immigrants were granted patents twice more compared to natives. 1.9% immigrants were granted patents compared to 0.9% of natives. Patent per capita for immigrants was 0.057 compared to 0.028 for natives. Then using this data they estimated the direct effect of immigration on patenting, while ignoring the spillover or crowd-out effect. A one percent increase in population made up of immigrants with college degree would increase patent per capita by 6 percent. Due to positive spillovers, the benefit to patenting per capita could be as high as 9-15 percent. They also found that immigrants who are scientists and engineers or who have post-college education boost patents per capita more than immigrant college graduates (Hunt & Gauthier-Loiselle 2009, p. 5). In a study with a similar methodology, Chellaraj et al. (2005) test the contribution of foreign born graduates to US innovation and technological change. They use US time-series data to show that a raise in foreign students increases patent applications more than an increase in skilled immigration do.

Partridge and Furtan (2008) investigate the link between innovation and immigration in Canada and find that highly-skilled immigrants with language proficiency in English or French have a significant impact on the innovation flow at the provincial level in Canada. Innovation outcome is measured with patents. They found that a 10 percent increase of highly-skilled immigrants led to 7.2 percent increase in the overall number of patents in the province (Partridge and Furtan (2008), p. 128).

Regarding brain circulation and commuting entrepreneurial networks the work of Saxenian et al. (2002) study the role of US educated immigrants who span their activities across borders and create economic opportunities. They explore the scope and organization of the local and transnational networks that are built by immigrants, particularly by the first generation of Indian, Chinese and Taiwanese immigrants in Silicon Valley. In their survey three issues are addressed: (i) The involvement of Silicon Valley's foreign-born professionals in the region's entrepreneurial economy, (ii) the nature of professional connections that first-generation immigrants are building to their native countries, and (iii) the extent to which immigrants are becoming transnational entrepreneurs and establishing business operations in their native countries. Their conclusions imply an extensive evidence of brain circulation between California and fast growing regions in India and China.

Ozgen et al. (2010) empirically investigate the link between migration and innovation in Europe. According to Ozgen et al. immigration may enhance innovation through five channels: (i) a population size effect, (ii) a population density effect, (iii) a migrant share effect, (iv) a skill composition effect and (v) a migrant diversity effect. The first three mechanisms result from the fact that due to immigration local demand rises. Additionally, since migrants are mostly attracted to the larger urban areas where job opportunities are best, they contribute to urban population growth, and thus strengthen the forces of agglomeration which encourages more innovation. The fourth mechanism, the skill composition effect refers to the way through which immigrants change the human capital stock of the host regions, because immigrants bring in new knowledge. According to Borjas (1999), immigrants are not a randomly selected sample of the population. There is a self-selection process in which the skilled workers who migrate may also be more entrepreneurial and less risk averse and considerably young (Ozgen et al. (2010), p. 3). Their mobility generates spillover benefits to the host countries and enhances the innovation activities there. Finally, the fifth mechanism stems from the larger cultural diversity in the host economy.

Ozgen et al. (2010) empirically study the effects of immigration on the innovativeness of the regions in Europe based on data from 12 countries (Austria, Belgium, Denmark, France, Germany (west), Ireland, Italy, Netherlands, Portugal, Spain, Sweden and UK). They construct panel data of 170 regions across 12 countries in Europe (NUTS2)[4]. Innovation outcomes are approximated by the number of patent applications per million inhabitants. Their results suggest that: (i) population size is insignificant; (ii) population density is significant but has a negative sign; (iii) the share of immigrants is statistically insignificant and not necessarily associate with innovation; (iv) the average skill level of migrants is positively correlated with patent application. An increase in the average skill level of migrants[5] has a positive and statistically significant effect on patent applications and (v) cultural diversity in the regional population is significant which means that there are positive externalities in culturally more heterogeneous regions. They find that an increase in the diversity index by 0.1 percent increases patent applications per million inhabitants by about 0.16 percent. Ozgen et al. conclude that in European regions with culturally diverse settings, higher competitiveness and availability of knowledge spillovers add to innovativeness. Their study also shows that there is a critical level of cultural diversity and that innovation is positively affected only if cultural diversity is above.

[4] The Nomenclature of Units for Territorial Statistics (NUTS) is a geocode standard for referencing the subdivisions of European countries for statistical purposes. The NUTS 1 level refers roughly to states or large regions, level 2 to provinces, and level 3 to counties.

[5] proxied by migration from source countries from which emigrants are on average higher skilled

Niebuhr (2009) investigates empirically the relationship between cultural diversity and innovation in Germany. She used employment data instead of population data and differentiates between three levels of education: no formal vocational qualification, completed apprenticeship, university degree as well as 213 nationalities. By considering the cultural diversity of the labor force at different qualification levels, Niebuhr intends to verify whether education matters, i.e. taking into account that it might be only cultural diversity of highly qualified workers which affects the process of innovation. Her results confirm that German regions with a higher diversity in their workforce are characterized by higher levels of innovation activities.

A further study by Fabling et al. (2011) tests for New Zealand whether firms located in areas with a relative more immigrants are also more innovative. They find a positive relationship between innovation outcomes and workforce characteristics such as the proportion of migrants, the proportion of people new to the area, the proportion of migrants with high-skills and the employment density. However, this positive relationship is not evident for all innovation outcomes. Moreover, they did not find these relationships for neighborhood areas. The missing direct link between innovation and local workforce characteristics implies that the spillovers from immigration to innovation are in their results not as strong as on previous studies (Fabling et al. (2011), p. 20). However, the results of Fabling et al. reflect the distinctive features of New Zealand's immigration patterns and innovation system. According to Fabling et al. (2011) it could be related to New Zealand's relatively small size and low population density that the scope of spillovers and dense networks is limited.

Hansen & Niedomysl (Hansen & Niedomysl, 2008) focus on the migration of creative persons in Sweden and address three issues: (i) creative class members move more often compared to other migrant groups; (ii) creative persons are more selective in choosing their destination and consider the salutatory culture critical for their decision; (iii) and have different reasons to immigrate. Using two different datasets, the authors identify the creative class which allows for comparison between them and other groups. Their empirical work illustrates that migration rates of the creative class are only marginally higher compared to other groups. Moreover, most migration activities for the creative class take place just after finishing university and that the creative class also moves for jobs rather than place.

Neil Lee and Max Nathan (2010), explore the impact of diversity on innovation in the population of London. London is known as one of the most diverse cities in the world, where 300 languages are spoken by schoolchildren (Gordon et al. 2009, 2007), and 31 ethnic minority groups and 38% of the working-age population were born abroad (Spence, 2008). Like Niebuhr (2009) the authors check if culturally diverse firms in London are more innovative and what forms of diversity are associated with what form of innovation. In order

to measure cultural diversity they focus on two specific aspects of diversity, country of birth and ethnic group. They construct three diversity measures: (i) LABS' (London Annual Business Survey) coverage of workforce and ownership characteristics, (ii) country of birth and (iii) ethnicity. In order to measure innovation they develop four broader innovation measures related to product and process innovation: exploring new products, modifications of existing product ranges and new equipment and new working methods. Their results illustrate that London's diversity is an economic asset. They find that diversity and innovative activity are much stronger associated for process innovation than product innovation. The role of "ethnic entrepreneurs" is of particular importance in knowledge-intensive firms in innovative product differentiation and in process innovation.

De Grip et al (2009) analyze the determinants of labor migration after graduation as well as five years after graduation in 12 European countries. They analyze the country choice of the graduate migrants. They find that not only wage gains are determining migration decisions, but also differences in labor market opportunities, past migration experience. Additionally they show that international student exchanges are strong predictors for future migration. Surprisingly, their results show that job characteristics like skills utilization in the job and involvement in innovation do not affect migration decisions. Regarding the country choice, only countries like the U.S., Canada and Australia appear to attract migrants due their larger R&D intensity. Graduates with better grades are more likely to migrate to these countries.

Miguélez & Moreno (2010) analyze the contribution made by collaborative networks and the labor and geographical mobility of inventors to the process of knowledge creation and regional innovation performance. For this purpose a knowledge production function framework at the regional level is applied which considers inventors' networks and their labor mobility as independent variables. They use patent data to identify individual inventors, and create a new dataset of individuals with information on personal address(es), their patenting histories, the owners of their patents (be it a firm, a university or other public institution, or the inventors themselves), and the co-authors in their patents. They find strong support for the positive relationship between regional labor market mobility and regional innovation intensity. The influence of networks is also fairly important, but the strength of these ties (measured with the network density) was found to have a negative influence on innovation. However patenting activities do not explain the mobility pattern of individuals nor their cooperative relationships.

Table 2 summarizes the still rare, however, diverse results of empirical studies of the relationship between migration and innovation.

Table 2: Empirical evidence on migration and innovation

	Subject of research	Result
Brown (2002)	Diaspora networks	Identification of 43 diaspora networks of highly skilled immigrants from developing countries worldwide
Saxenian et al.	focus on the development of Silicon Valley's regional economy and the roles of immigrant capital and labor in this process	Immigrants have become a significant driving force in the creation of new businesses and intellectual property in the U.S. and their contributions increased over the past decade.
Zucker and Darby (2007)	Relationship between star scientists' movements and their direct (also indirect) contribution to the receiving countries economic development: They follow the careers of 5401 star scientists between 1981 and 2004.	Physical presence of star scientists rather than the embodied knowledge in their work is a catalyst for economic improvements; here is where the labor mobility of discovering scientists becomes very important in technology transfer. Not only the direct contribution of immigrants in research activities matters but also the spillover effect from immigrants on natives boosts innovation in the host country.
Kerr and Lincoln (2008)	Impact of high-skilled immigrants on US technology formation. Fluctuations of H-1B visas on rate of Indian and Chinese patenting in the United States	Fluctuations in H-1B admissions levels significantly influence the rate of Indian and Chinese patenting in cities and firms dependent upon the program relative to their peers. Weak crowding-in effects or no effects at all for native patenting. Total invention increases with higher admission levels primarily through the direct contributions of immigrant inventors.
Partridge (2008)	Relationship between highly skilled immigrants with proficiency in language and patent flow in the province in Canada	10 % increase of highly skilled immigrants led to 7.2 % increase in patent flow in the province
Hunt & Gauthier-Loiselle (2009)	Impact of highly skilled immigration on the US patent per capita between 1940 and 2000	college graduate immigrants contribute at least twice as much to patenting as their native counterparts

Stuen et al. (2010)	contribution of foreign science and engineering students publications and citations produced by U.S. academic departments	Foreign doctoral students significantly and positively influence publications and citations produced by U.S. academic departments. Moreover, increased diversity seems to be the primary mechanism by which the foreigner students improve research outcomes.
Niebuhr (2009)	Relationship between cultural diversity in R&D employment in German regions and innovation	German regions with diversity of workforce in terms of background have higher level of innovation activities.
Ozgen et al. (2010)	relationship between innovation outcomes and workforce characteristics in 12 EU countries	In those regions of Europe with a culturally diverse setting, higher competitiveness and availability of knowledge spillovers add to innovativeness. Only beyond a critical level of cultural diversity of the migrant community, the innovation level is associated with the cultural diversity.
Fabling et al. (2011)	Tested if the firms located in areas with a relatively higher proportion of immigrants are more innovative than the others in New Zeeland.	No direct link between innovation and local workforce characteristics in New Zeeland Pattern of NIS in New Zeeland
Hansen & Niedomysl (2008)	Evidence from Sweden, migration of creative class.	The migration rates of the creative class are only marginally higher than for other groups. …Most migration activities for the creative class take place just after finishing university and that the creative class people move for jobs rather than place.
De Grip et al (2009)	Determinants of labor migration after graduation as well as five years after graduation in 12 European countries.	…. countries such as the USA, Canada and Australia appear to attract migrants due their larger R&D intensity. Graduates with higher grades are more likely to migrate to these countries.
Miguélez & Moreno (2010)	the importance of the labor mobility of inventors, as well as the scale, extent and density of their collaborative research networks, for regional innovation outcomes	positive correlation between intraregional labour mobility and regional innovation, Strength of network ties (measured as the network density) was found to have a negative influence on innovation.

5. Conclusion

Knowledge-based economies are characterized by new patterns of competition on an international and global scale. Growing highly-skilled mobility has raised the competition among countries in winning the best talents. Highly-skilled migration shows a positive and increasing trend since the beginning of 1990s. Traditional settlement countries, in particular the United States, benefit from immigrant's population. Their national policies are able to attract highly-skilled immigrants. Studies confirm that non-US citizens contribute extensively to economic development of the U.S. economy. For example empirical studies concerning the registered international patents by immigrants or the contribution of transnational networks between immigrants and their homelands confirm this observation. Compared to North American countries, Europe shows higher inflows of international migrants. However, it most immigrants arriving in Europe do not hold high skills in terms of education. Also, so far not enough studies of the European situation exist which allow for a better understanding of the contribution of immigrants to European economic development.

The present paper addresses the question of highly-skilled migration effects. The traditional approach to highly-skilled migration deals mainly with the loss to the emigration countries, namely the issue of *brain drain*. In this perspective, emigration of highly-skilled results in reduced economic growth for sending countries. However, other approaches are becoming more popular which are likely to be closer to the reality of knowledge-based economies of the 21st century. For example, return migration of highly-skilled emigrants compensates the outflows for sending countries. Although from a neo-classical economics point of view, return migration is the outcome of failed migration, the situation looks different from the angle of social network and transnationalism theory. Here, return migration gains an important role in transferring the local specific knowledge across borders. That is why origin countries potentially benefit from the skills that migrants have gained in the foreign countries. In recent studies the role of diaspora networks appears significant. Recognizing networks formed by immigrants, especially transnational networks in which they keep their ties to their homelands, triggers a shift from *brain drain* to a *brain gain* or *brain circulation*. Transnational networks provide access to the knowledge and cultural specific know-how available at distant places, due to advances in communication and transportation technologies as well as changes in the competition pattern among countries. In this sense, both sending and receiving countries benefit from the mobility of highly-skilled labor.

Neo-Schumpeterian economics in an evolutionary economics flavor stress the importance of knowledge and innovation for economic development and therefore are the adequate approaches for the analysis of the relation between innovation and migration. In the knowledge based economy the main driver behind economic development is innovation, the more innovation, the more dynamic the economy will be. Heterogeneity in economic agents

and interactions between them is the source of idea creation. The mobility of labor contributes to diffusion of tacit knowledge. Cultural diversity is the result of international migration; this constitutes the basic ground for knowledge spillovers. The diversity brought by immigrants in the total workforce has complementary effects to the native labor force. Diversity is however accompanied with costs due to language barriers and cultural barriers. The transfer of knowledge occurs in the networks and clusters which migrants form. Network structures link the diverse knowledge of the agents and facilitate the exchange of knowledge. That is why it is essential to explore the networks and their roles. Finally, it is the design of the National System of Innovation which creates the prerequisites for innovation activities. The extent to which immigrants contribute to innovation depends on the interaction between them and institutions embedded in the National Innovation System. Most results confirm that innovation is enhanced by the presence of highly-skilled migrants.

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