ИССЛЕДОВАНИЯ И РАЗРАБОТКИ: МИРОВОЙ ОПЫТ И НОВЫЕ ТЕНДЕНЦИИ

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Why firms do not enrol in socio-technical networks — empirical evidence from Portugal —

The R&D system in Portugal was reorganised using a model designed to improve links with firms in order to facilitate the transfer of knowledge and to improve innovation capacity. In this paper a survey is used as the basis for an analysis on if, why and to what extent firms and other entities linked with each other and how this affected their innovation capacity. Methods of Multiple Correspondence and Cluster analysis were applied. Our discussion of the results led us to question the notion of "transfer of knowledge" and the role of economic theory in the construction of this reality.

Keywords: Networking capacity, transfer of knowledge, economic theory, Multiple Correspondence Analysis (MCA).

Introduction

In this article, we work on the assumption that there is a strong association between firms' capacity for innovation and their networking capacity and that the institutions mak-

ing up the R&D system, whose job it is to facilitate the "transfer of knowledge", should act as *translators* in the construction of innovation networks. This assumption gains consistency with the knowledge that these institutions are extremely heterogeneous in Portugal because the networks are particularly adapted to the diversity of firms. One of our goals is to identify and describe the configuration of the networks that are being built in the many possible interactions between the different entities, including different types of technological innovation, accepting that they differ according to the shape and size of those networks. This analysis will also make it possible to draw conclusions on firms' integration in the "innovation space" and identify the factors that contribute most to this integration. This analysis is made on a macro state scale through a survey applied to a representative sample of manufacturing firms. Our discussion of the results of this analysis caused us to question the idea of "transfer of knowledge" and to reflect on the role that economic theory plays in the construction of this reality.

Questions about firms' heterogeneity, innovation and networking capacities

Several case studies in Portuguese firms (Oliveira et al, 1996; 1998; 2008) led us to the conclusion that large multinational firms and small technology-based firms in science-based sectors have, by definition, the innovation strategy and know-how to become a *noeud* in innovation networks[1]. The work of small and medium firms is still founded on traditional Fordist industrial culture and they therefore continue to compete in old markets using the same old tools; the price of products is the most important of these in that it reduces heterogeneity (Callon, 1998: 21) and defines a specific market segment where these firms compete. They do not know how to compete in other market segments defined by innovation even though European public policies have tried to guide and shape firms and other institutions for innovation, notably SMEs (Godinho and Andrez, 1998). As a result of these policies, the Portuguese R&D system has been reorganised to improve links with this type of firm in order to facilitate the transfer of knowledge. We also conclude from these case studies that these firms do not appreciate the importance of being part of an innovation network, mainly because they do not want to be linked to other firms and institutions which they regard more as rivals or strange to their world than potential innovation partners. Moreover, even if some have a different understanding of networking, they frequently do not know how to link up with other entities. In addition, socio-technical networks are not interested in *enrolling*[2] *these firms since they have nothing interesting to negotiate. These results gave rise to our hypothesis that many firms are in a process of exclusion from the innovation space*[3].

[1] The ANT uses the idea of a socio-technical or socioeconomic network depending on whether it is a question of design networks and social production of technical objects (technical and/or scientific poles) or networks that include consumers and therefore focussing on the market (Callon et al., 1995). We have used the innovation network idea for this article.

[2] In the sense that an ANT actor may enrol or be enrolled by others (Callon, 1999: 182).

[3] By innovation space, we mean the institutions making up the R&D system, public policies, companies and other players operating in this space, which is also the territory/place in which / where these entities are situated and relate with each other. Innovation space is the term we have given to this complex relationship and the co-construction of players and institutions. Innovation

This paper explores this hypothesis by making an in-depth analysis[4] of both the extent of this phenomenon and also if and why innovation institutions can be present in a certain space but not link up with each other (interact) in spite of all the public policies and incentives to improve networking. In addition, we examine if and why firms act differently from each other and the results of their action in terms of their integration in the *innovation space*. We will also analyse to what extent networking capacity is related with technological innovation.

The reorganization of the R&D system to promote the transfer of knowledge

The (re)construction of the R&D system after Portugal joined the EU in 1986 was supported by substantial investments and public policies in the field of higher education, science and industry. It was organised in accordance with a model designed to facilitate the production and transfer of knowledge from universities and polytechnics to industry through very heterogeneous intermediate institutions (figure 1). These institutions should act, in theory, as *translators* in the construction of innovation networks (Callon, 1986).

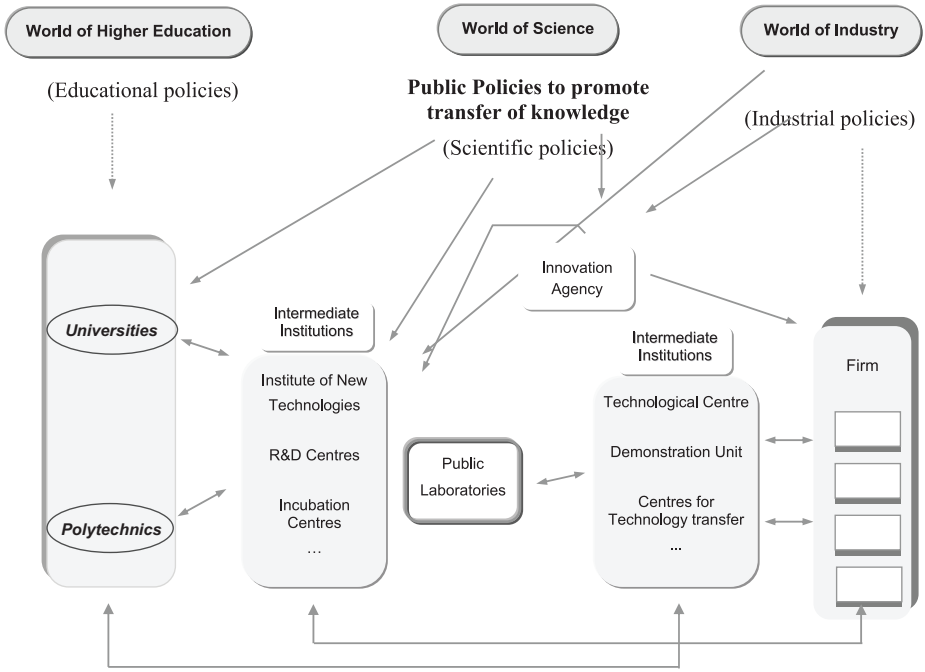


Figura 1 — New architecture of R&D system

space is not synonymous with the national innovation system because it is a co-construction that emerges from interactions between players, objects and institutions. See Oliveira, 2008 for the development of this notion.

[4] About macro and micro controversies (Knorr-Cetina and Cicourel, 1981) and the use of some ANT concepts at a macro level, see Oliveira, 2008.

The new architecture of the R&D system took into account the fragilities of manufacturing, which is based on traditional sectors (Lança, 2000), an almost total lack of science-based sectors, mostly small or very small firms and the absence of *national champions* which were historically an important cornerstone in the construction of national innovation systems in industrialised countries (Caraça, 1999).

From the exclusion to the integration of firms in the innovation space: networking capacity

On examining the innovation space, we find entities (firms, technological innovations, universities and other institutions close to the world of science or industry), including human beings, that may or may not have relationships with each other. It is necessary to know whether these entities construct links in the complex process of possible interactions among firms, intermediate institutions, universities, people and different types of knowledge. But if, despite the potentialities of the R&D system, all or some of these entities are unable to link, how will it affect innovation capacity? Why do some entities form innovation networks while others remain isolated? What impact will this type of situation have on the integration of firms in the innovation space? Will networks really be important to innovation capacity?

Method

Our choice of methodology to answer these questions is guided by a macro state scale[5] supported by a survey of a representative sample of firms[6]. We explored the relationships between several indicators: knowledge incorporated in people (% of highly educated employees and R&D departments), technological innovation (radical and/or incremental), links with R&D entities (research centres, universities, public labs, IPQ[7], technological centres and technical consultancy)[8]. We applied a Multiple Correspondence Analysis (MCA) to this set of almost categorical variables (Meulman, 1992; Gifi, 1996; Geer, 1993a; Geer, 1993b; Heiser et al, 1994; Carvalho, 2008). MCA allowed us to sum up the associations between the multiple variables and it provides a graphical display of the multidimensionality of the

[5] From the point of view of describing reality, macro state means a certain scale of this description, associated with a resolution capacity for the elements of this reality, like a zoom effect. In a macro state we can observe only a compacted reality and describe it in broad terms. In turn, fine granularity means closeness to the object and allows us to observe finer elements of this reality.

[6] The target population used to build the sample consisted of manufacturing firms with more than 10 employees (N=5047 companies) in the Lisbon and Oporto metropolitan areas listed in the BELEM base (Establishment and Enterprise Base) for 2004 of the National Statistical Institute (INE). Our sample was stratified by metropolitan area, sector of activity and firm size, to a total of 1769 companies. The questionnaire response rate was 46.6 %, which guaranteed the representativeness of the final sample, according to predefined criteria.

[7] Instituto Portugu s de Qualidade/ Portuguese Quality Institute.

[8] Other entities represented in Figure 1 were not included in the multiple correspondence analyses as a frequency analysis shows almost total absence of links with firms.

innovation space, representing all the categories of the variables into a sub-space with the minimum number of dimensions possible.

The MCA results were used to classify groups of firms using a clustering method in order to quantify their size in the innovation space.

Differentiation in the innovation space: exclusion and integration of firms

Figure 2 suggests differentiation within the innovation space through knowledge accumulation criteria embedded in people (highly educated employees), or in R&D departments or in product innovation.

There are four different groups of firm. Two of them, on the left of figure, are isolated from other entities while the other two, on the right, are networked with different entities of the R&D system. These four groups occupy this location in the innovation space mainly due to the distribution of different categories of highly educated employees[9].

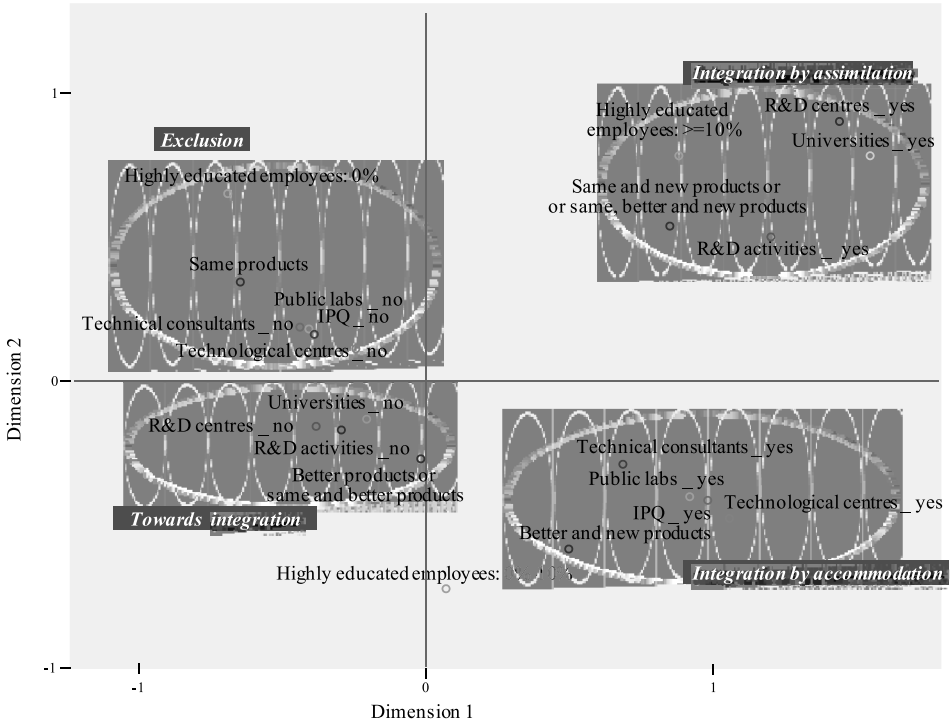


Figure 2 — Differentiation in the innovation space: from exclusion to increasing integration of groups

[9] This indicator is calculated by the ratio between the number of highly educated employees and total employees.

Caption of Figure 2

R&D activities _ yes R&D activities _ no	The firm conducts R&D The firm does not conduct R&D
R&D centres _ yes R&D centres _ no	Relationship with research centres _yes Relations with research centres _ no
Technical consultants _ yes Technical consultants _ no	Relationship with technical consultants _yes Relationship with technical consultants _ no
Universities _ yes Universities _ no	Relationship with universities [1] _yes Relationship with universities _no
Public labs _ yes Public labs _ no	Relationship with public labs _yes Relationship with public labs _no
IPQ _ yes IPQ _ no	Relationship with Portuguese Quality Institute _ yes Relationship with Portuguese Quality Institute _ no
Technological centres _ yes Technological centres _ no	Relationship with technological centres _ yes Relationship with technological centres _ no

In fact, we see a hierarchical distribution of these different categories: firms that have no highly educated employees (0 %), firms located in an intermediate area with 0–10 % and firms with 10 % or more. This distribution of knowledge incorporated in people goes hand in hand with the capacity for innovation and networking that generates different types of network and innovation and is a kind of emergent effect of the accumulation of knowledge. Only firms with their own R&D departments and higher percentages of highly educated employees are linked to universities and other R&D entities. Although firms without their own R&D departments and a lower percentage of highly skilled employees can still be enrolled in innovation networks, they link with other entities rather than universities. Therefore, only two of these four groups are innovation networks.

We can classify these groups using the criteria of internal accumulation of knowledge in accordance with their degree of exclusion from and integration[10] in the innovation space (figure 2):

1. Exclusion — the firms in this group do not have highly skilled employees, their own R&D departments or technological innovation and are not linked to other entities. It is as if a "seed of knowledge" is needed for firms to belong to the innovation space;

2. Towards integration — this group of firms is between exclusion from and integration in the innovation space. It is different from the previous group because it has a higher level of accumulated knowledge incorporated in people (0–10 % higher education) and it is associated with technological innovation (incremental). But it is not enrolled in a network;

3. Integration by accommodation — this group is different because firms have been able to enrol in innovation networks by linking with some entities (public labs, IPQ, technological centres and technical consultancy). Besides this capacity for networking, it also has a higher level of accumulated knowledge and innovation capacity (incremental and radical innovation);

4. Integration by assimilation — this group has been able to link with universities and other R&D entities. This capacity for networking is associated with the fact that they have the highest internal accumulation of academic knowledge, incorporated both in highly skilled employees ((≥10 %) and R&D departments.

[10] The classification of firms' integration into *exclusion*, *accommodation and assimilation* was inspired by Piaget's distinction between changes by accumulation and by assimilation.

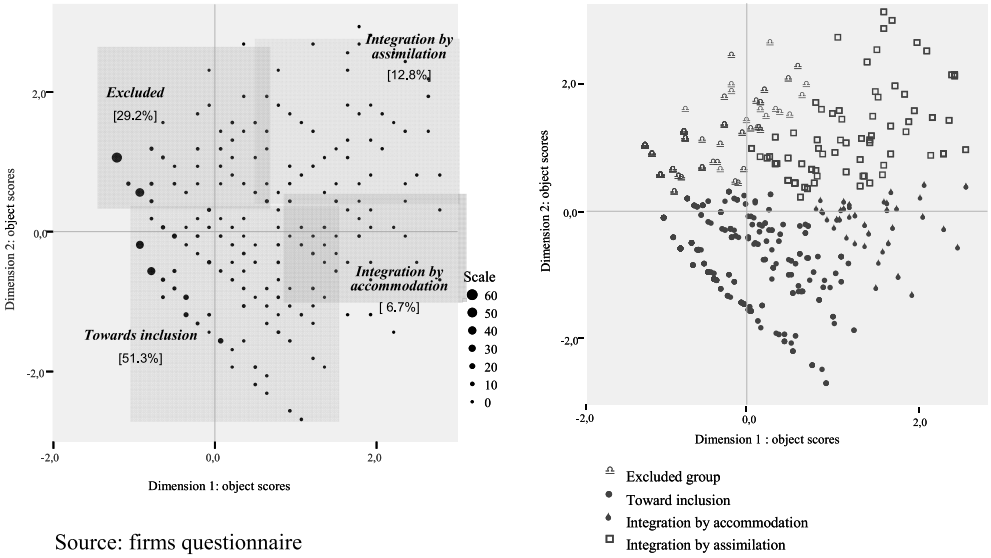
In more general terms, we can conclude that a certain *accumulation of knowledge* within firms or, in the words of Choen and Levinthal (1990) an 'absorptive capacity', is a basic condition for constructing links with other entities and innovation networks and to integrate them in the innovation space. As the accumulation of knowledge in firms increases, so does their capacity for networking and innovating.

Finally, this analysis confirms our initial feeling that innovation is strongly connected with networking capabilities.

The size of groups in the differentiation of the innovation space

The results of the Multiple Correspondence Analysis (MCA) also reveal the firms' position in the innovation space (figure 3). In order to quantify the relative weight of the four groups, we took the optimal quantifications — object scores in the two dimensions — obtained by MCA and we applied a nonhierarchical clustering analysis using an optimizing procedure (Carvalho, 2008).

The excluded group and the group moving towards integration in the innovation space are the biggest (29.2 % and 51.3 % of firms respectively). The groups which are integrated in the innovation space form a minority in Portuguese manufacturing (accommodation group: 6.7 % and assimilation group: 12.8 %).



Source: firms questionnaire

Figure 3 — Frequency and position of the groups in innovation space

Discussion

These results caused us to question the philosophy behind the reorganisation of the Portuguese R&D system and the role that economic theory played in the process. This is

an example in which economics, especially the idea of the transfer of knowledge, performs, shapes and formats reality (Callon, 1998).Why are most of the firms in exclusion process or poorly integrated in the innovation space after the reorganisation of the R&D system and given the mission of each intermediary institution? Why is there no interaction with the entities designed to insert them into the innovation space and why has no knowledge been transferred to the firms that needed it most?

Let us focus on this idea of transfer of knowledge. From the economics point of view, innovation is a central problem which is mainly focused on knowledge and only marginally on humans. Knowledge is regarded as a commodity and humans reduced to the condition of a body incorporating knowledge, like any other object which incorporates knowledge.

The transfer of knowledge is considered to be like that of any other good or service, such as capital or any merchandise. In theory, humans have no active place in the process. It is the metaphor of the invisible hand in the market of technology. From this standpoint, the problems arising in the transfer of knowledge lie in the obstacles to the circulation of this same knowledge; mechanisms and policies should therefore be promoted that remove these obstacles and encourage the production, circulation and use of knowledge. It was in an attempt to solve this problem that a series of political measures introduced in the 1990s sought to promote physical proximity between institutions throughout Europe. This was also why the R&D system was reorganised in Portugal. It was reconfigured following the economic theory model. In fact, diversified institutions were built in accordance with the needs of the different firms' profile, in which material proximity to these firms was guaranteed so that the transfer of knowledge would be automatically guaranteed. However, according to our results, this has not happened in most companies. Why is this?

The idea of the transfer of knowledge raises two major issues. The first is that we suspect that the problem is unfocused; in other words the issue should focus symmetrically on the Persons and the Knowledge — as H-NH — and not only on knowledge as an independent entity. The other problem, to which the first is subsidiary, is the theoretical concept of the individual as a means of incorporating knowledge[11]. We would argue that economics dehumanizes people and reduces them to the category of carriers of knowledge.The price of this reduction or disentanglement (Callon, 1998) is that after people's human qualities have been kicked out the door, sooner or later they will come in through the window; this has been the case not only in clashes emerging from conflicts of interest[12], but also in the so-called inefficiency in the transfer of knowledge for which universities have been blamed[13].

In this framework, it is important to understand exactly not only what we mean by transfer of knowledge but also how it works. It is transferred from where to where? Who is involved? Is it a transfer of knowledge or should we regard it as part of the problem of different interests between the different entities involved, requiring translation in the sense of ANT?

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[11] Even though the incorporation of knowledge is in itself a problem with regard to equipment, prototypes and texts. (Caraça, 1999), for example, considers that technology is situated at an explicit level of knowledge of nature, and therefore has the characteristics of a certain domain of knowledge and is based on specific languages. In other words, equipment may be considered technology, but as a possible expression of tacit knowledge. On this basis, he wonders whether it makes sense to say that knowledge is mysteriously incorporated into machinery and equipment.

[12] On this issue, Etzkowitz (1996) among others, on the conflicts of interest in the registration of patents. In the area of health, the main controversy is the conflict of interest between private industry, research at universities and public health interests (cf. Boyd and Bero, 2000; Korn, 2000; Kaiser, 2002).

[13] On the critical development of this question (Beise and Stahl, 1998).

Collins (1993:95) tells two stories which constitute an enlightening metaphor on the subject:

"Let's start by asking how knowledge is transferred. Consider a couple of light-hearted but revealing accounts. A comic strip in my possession concerns industrial espionage between companies, which manufacture expert systems. One firm has gained a lead in the market by developing super expert systems and another firm employs a spy to find out how they do it. The spy breaks into the other firm only to discover they are capturing human experts, removing their brains, slicing them very thin, and inserting the slices into their top-selling model. (Capturing the spy, they remove and slice his brain, enabling them to offer a line of industrial espionage expert systems!).

Another good story involves knowledge being transferred from one brain to another via electrical signals. A Vietnam veteran has been brainwashed by the Chinese with the result that his brain has become uniquely receptive. When one of those colander-shaped metal bowls is inverted on his head, and joined via wires, amplifiers, and cathode ray displays to an identical bowl on the head of some expert, the veteran speedily acquires all the expert's knowledge...once he has been equipped with someone else's abilities, the CIA can use him as a spy... this is the way that we transfer knowledge between computers...abilities are transferred between computers in the form of electrical signals transmitted along wires or recorded on floppy disks...if we think a little harder about the model as it applies to humans, however, we begin to notice complications...".

In fact, knowledge can be produced, taught, learned, used, applied and broadcast through complex phenomena that are not simple transfer processes like transferring money through a bank order. Whether knowledge is incorporated in humans or machines or any other NH, it does not live separately from the subject-that-knows and should therefore be regarded as an intrinsic part of the H-NH relationship.

Another aspect of the same problem relates to the idea of humans' incorporation of knowledge. The opposite of the incorporation of knowledge is 'ex-corporation', to coin a phrase. In other words, when the emphasis is placed on the transfer of knowledge as an entity that survives outside the interaction with humans, we assume that the holders of tacit knowledge[14] are a kind of passive entity that opens up without resistance or reaction so that this knowledge can circulate formally or informally. This dehumanisation of humans is reduced to the condition of resources. The idea that prevails is that the difficulties in disseminating knowledge arise from something beyond the control of humankind i.e. it cannot be codified. When this approach to the question is taken to its extreme from the economics standpoint, it means that the problem is regarded as more inherent to the knowledge itself than to the will of humans. As Latour (1991:105) said on another subject "... the number of loads that one needs to attach to the statements depends on the customer's resistance, their carelessness, their savagery, and their mood...and it (depends also) on the cleverness".

But there is a further problem that cannot be ignored and that sociology of work and sociology of professions have brought to the fore. It is the human's use of knowledge-as-power phenomena — sometimes in struggles for survival, others in power struggles or just defending interests –; although disguised in different ways in the history of work, it is still present in everyday action. Knowledge-as-power is also present in the *translation* processes with the aim of constructing a link in an innovation network. But translation is not the same as transfer of knowledge, and this should not be forgotten when innovation policies are designed.

[14] For a critical discussion of the import of Polany's concept to innovation economics (Oliveira, 2008).

Conclusion

The main purpose of this study was to identify and describe the results of actions taken by firms and R&D institutions to construct innovation networks so as to understand the explanation for this and to analyse the result in terms of the firms' integration or exclusion in the *innovation space*.

We identified four clusters of firms. Firstly, these clusters define a structural line marking a *dualization of the innovation space* in accordance with a greater or lesser concentration of knowledge in firms. The number of highly educated employees is the most important variable to explain firms' capacity to construct innovation networks; this dimension is associated with their capacity for innovation.

In other words, some firms interact with institutions in the R&D system, forming innovation networks and integrating the innovation space in two ways which we have called *accommodation* and *assimilation*. These firms are opposed to other groups with no links to the R&D system institutions and therefore excluded from the innovation space.

This dualization is asymmetrical in that the last groups have a much higher relative weight (around 80 %). But the dualization is still affected by the fact that the space remains segmented by internal cleavages with very different innovation capacities, ranging from none at all to incremental and radical innovation. In more general terms, we can say that a certain *accumulation of knowledge* in firms is essential for them to link with R&D system institutions. It is not enough to construct intermediate institutions in the hope that an invisible hand transfers knowledge and makes innovation networks appear in the innovation space.

A further conclusion is that the accumulation of in-house knowledge is closely related to innovation and networking capacity. And only firms with in-house R&D have the capacity to establish links with universities and other producers of academic knowledge.

These results made us question why the reorganisation of the R&D system, which aimed to adapt the profiles of different firms and bring them closer so as to facilitate the transfer of knowledge, was unable to prevent the exclusion of a substantial number of these very firms from the innovation space. This question led to a reflection on the role of economic theory in the construction of reality[15].

About the question of the transfer of knowledge, we criticised the restrictive conception of human action trapped in the paradigm of *Homo Economicus* that prevails even in heterodox approaches to innovation. This perspective leads both to the dehumanisation of humans and the humanisation of things in which knowledge is the key factor as if they were independent entities. We suggest that knowledge in its different forms should be regarded as an intrinsic part of the H-NH relationship as an active entity in innovation networks. Moreover, *translation* is not same as transfer of knowledge and this should be taken into consideration when designing innovation policies.

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[15] On this issue see also Callon, 1998.

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Mobility of Highly Skilled Workers and Academic Collaboration in India and Russia[1]

mobility of highly skilled workers has become an inseparable and regular phenomenon which has resulted shortage of professionals' in developing countries. Mobility of professional from emerging economies, particularly from India, China and some Eastern European countries, is not a new phenomenon, however over the last few years rate of migration has amplified which has drawn attention

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