SYNESIS
A JOURNAL OF SCIENCE, TECHNOLOGY, ETHICS, AND POLICY

Transnational Knowledge Networks in Nanotechnology in Mexico: Policy incentives and Dynamics

Marcela Suárez[1]

1. Freie Universität Berlin, Lateinamerika-Institut, Rüdesheimer Str. 54-56, D-14197, Berlin, Germany, (0049) 1636332063, Email: marce.srz@gmail.com.

Abstract

To what extent do incentives from Science and Technology Policy (S&TP) at the local, regional, national, and international levels affect the emergence and dynamics of knowledge production networks in the field of nanotechnology in Mexico? My ongoing research shows that policy instruments both simultaneously promote and hinder knowledge production in such networks. During recent years, S&TP discourses have been dominated by the idea that network promotion is a necessity in Mexico. In practice, however, policies coming from four different governmental levels have, to a certain extent, resulted in contradictory incentives. At the national level, the majority of allocated public resources have been invested in instruments that do not reward active formation of networks, while, at the local and regional levels, producing knowledge in cooperation with foreign institutes and transnational companies has been encouraged. As a result, some public research centers are well connected to transnational networks but only weakly so at the regional and local levels. Combining spatial, sociological and economic network approaches, this work seeks to offer new perspectives and bring new insights into the debate.

Keywords: knowledge production networks, incentives, space

Introduction

Defined as the capacity to understand and measure matter at the nanoscale, nanotechnology is an interdisciplinary and promising technology whose applications are still at the early stages of the innovation process. Currently there are more than fifty countries with national nanotechnology plans (1).

New intensive knowledge fields, like nanotechnology, boost new interactional modes of knowledge production in networks, whose consequences seem to have reshaped not only the way in which knowledge is produced, but also the mechanisms of Science and Technology Policy (S&TP), scientific infrastructure, and funding (2-5).

Over time, approaches and instruments related to Mexico's S&TP have undergone several changes. Since the early years of the institutionalization of S&TP in the 1970s, a clear separation has been made between scientific and the technology policies. Mexico's adoption of the linear model of knowledge production implied that, during that time, public resources were almost entirely used to promote science, which it was thought would automatically lead to technological developments.

But a shifting of S&TP discourses in relation to network formation can be observed. Since 2002, discourses have been dominated by the idea that the promotion of networks is a necessity in Mexico. Consequently, initiatives to promote interaction between actors have been set in

motion. These have been top-down, short-term, low-resource initiatives that encourage a constant process of creation, destruction and redesign of instruments and have only had limited success.

In Mexico no formal program exists that specifically promotes nanotechnology activities, although some efforts have been made in this direction. Two national nanotechnology laboratories were created in 2006 and, one year later, nanotechnology was designated as a strategic area in the Scientific, Technological and Innovation Special Program. Over time, projects have been funded through various National Council of Science and Technology's (CONACYT) instruments (Institutional, Regional, and Sectoral Funds). Some universities and public research centers (PRCs) with strong capacities in physics, biology, medicine, and material science are the main protagonist in nanotechnology activities and have institutional projects in this field. Particularly material science has been identified as one of the areas with great promise in Mexico.

As in other countries, nanotechnology has challenged Mexican S&TP to develop new mechanisms for executing power and creating new discourses. The present paper addresses the following question: to what extent can incentives coming from S&TP at the local, regional, national, and international levels affect the emergence and dynamics of knowledge production networks in the field of nanotechnology in Mexico? Relying on a case study method, I examine the impact of incentives in the knowledge production networks of the Public Research Center on Advanced Materials (CIMAV). The paper is organized as follows: in section 2, the theoretical framework and analytical perspective of this study are discussed, followed by a presentation of the data and methods used in section 3. In section 4, the study results are presented and discussed, and the final section contains some concluding remarks.

Theoretical background

The increasing interest in networks related to knowledge and innovation has led to an explosive growth of scholarship inspired by diverging lines of approach. Over time, authors have referred to the concept in different ways: as collaboration networks (6,7), knowledge networks (8-10), techno-economic networks (11,12), innovation networks (13-16), and production networks (17).

In spite of the great scholarly interest in knowledge networks, several issues have been left unquestioned or have only played a minor role in the debate. The four following gaps are observable: 1) there is a strong inclination to think of networks as delocalized subjects, unrelated to the political context in which they develop; 2) the factors that influenced the origin and dynamics of networks have been discussed only superficially, particularly in newly emerging fields such as nanotechnology; 3) there is a lack of analysis of knowledge networks and links between their local and global levels; 4) there is still little knowledge about the ways in which incentives from S&TP affect knowledge production in networks within developing countries. This study is focused on examining the latter gap.

Changes in modes of knowledge production that promote networks can be seen as manifestations of new ways of knowledge governance. With respect to this issue, there is an extensive literature (18-22) that has discussed governance of science and its formal system for producing, promoting, evaluating, funding, and coordinating scientific knowledge. One of the main arguments derived from that literature that is related to the aim of this paper is that governance of scientific knowledge has undergone a number of major changes, namely in terms of mechanisms for executing power, coordination, incentives and rules that determine the types of knowledge to be generated.

In this paper, I propose the term 'knowledge production networks' to refer to interactions among researchers in PRCs, universities and companies the aim of which is to produce knowledge. I also use the concept in a broader sense that takes into consideration incentive structures coming from the S&TP instruments, evaluation processes and policy-making actors involved. Though different types of incentives exist, this study will concentrate on three of them: monetary, symbolic (use of discourses and narratives), and material (artefacts or materialized discourses).

Data and Methods

Data collection

This paper is based on a case study of knowledge production networks in the field of nanotechnology at the CIMAV, which was created in 1994 and is part of the 27 PRCs of CONACYT. The center is located at the Chihuahua Industrial Complex (Chihuahua, Mexico) to-

gether with numerous companies. The CIMAV also has an auxiliary branch that is located at the Research and Technological Innovation Park in Monterrey (Nuevo Leon, Mexico) created in 2008. The unit of analysis is the interaction between actors involved in nanotechnology research projects.

The fieldwork was conducted from November 2010 to June 2011 in three different stages. Qualitative data were mainly derived from forty open and semi-structured interviews with actors participating in nanotechnology research projects. Interviewees held research and/or managerial positions at CIMAV, CONACYT, and the National Research Network in Nanoscience and Nanotechnology.

During the first stage, pilot interviews were conducted to identify projects in which different actors were involved and to collect documents to validate the oral information provided by interviewees. In the second stage, in-depth interviews were conducted with project coordinators in Chihuahua (Chihuahua, Mexico), Monterrey (Nuevo, Leon, Mexico), and El Paso (Texas, USA). At the end of each interview with a project's coordinator, respondents were asked to complete a questionnaire to provide quantitative data about knowledge production, dynamics of interaction, flows of knowledge, and incentives affecting the network. In the third stage, quantitative data were collected concerning articles that are included in the Scopus database. In order to restrict the analysis specifically to the field of nanotechnology, the prefix nano* was added and the CIMAV name in the search query to extract articles for the period 1994 to 2011. With the data collected, we were able to identify with whom actors interacted to produce knowledge.

The case study was conducted with the prior knowledge and permission of all participants at CIMAV. All interviewed consented to participation and anonymized publication of the results. Also, the Free University Berlin, in which this project was developed, provided Institutional Review Board exemption.

Data analysis

Both the interviews and documents were examined according to the key concepts of the research (knowledge production, networks, and incentives) and were subsequently coded by means of Atlas.ti. A database was also created, based on all the gathered information containing research projects related to nanotechnology conducted from 1994 to 2011 at CIMAV.

Three different circles (patterns) of interaction for producing knowledge within nanotechnology research in CIMAV were identified: articles, projects and patents. The CIMAV networks were examined in line with the following criteria: 1) performance and intensity of interaction of the actors participating in the projects; 2) relevance of a project in relation to the final scientific products of interaction: articles, patents, new projects, technological developments, and technological transfers; and, 3) differences in incentives coming from the particular contexts in which they developed.

Finally, three spatial categories were used to analyse the networks: transnational, transregional, translocal. At the transnational level, interaction of CIMAV researchers with actors in different countries, mainly from US universities was considered. At the transregional level, interaction between CIMAV and actors located in different states inside Mexico, such as, Chihuahua, Nuevo Leon, and Coahuila was examined. At the translocal level, the focus was CIMAV's interaction with actors in different localities inside the state of Nuevo Leon (Monterrey, Santa Catarina, San Pedro Garza), where the main projects with companies were conducted.

Nanotechnology at CIMAV: building transnational networks

In this section results of the case study are reported and discussed with regard to the incentives and dynamics of networks in the field of nanotechnology at CIMAV.

CIMAV is one of the main actors in nanotechnology networks in Mexico. In 2004, nanotechnology was designated a key area with the creation of the Nanotechnology Institutional Program, encompassing the following tasks: 1) promote research activities, human resource training, and links with business; 2) increase researcher mobility; 3) boost networks with leading international institutions; 4) encourage national leadership and international recognition in the field; and 5) attract more public resources.[ii]

In 2005, nanoscience curricula were incorporated in postgraduate programs at CIMAV. The year 2008 was important for nanotechnology activities at CIMAV, as the following initiatives were launched: 1) The National Laboratory of Nanotechnology at CIMAV in the Chihua-

hua headquarters (Chihuahua); 2) CIMAV's new auxiliary branch was opened at the Research and Technological Innovation Park in Monterrey (Nuevo, Leon), where nanotechnology was selected as a key area of interest; and 3) announcement of the creation of the Cluster of Nanotechnology and the Nanotechnology Incubator in Monterrey (Nuevo Leon). By 2009, a dual PhD Nanotechnology Program between CIMAV and the University of Texas at Dallas had been created.

All these actions and projects were the result of incentives associated with different instruments, coordinated at diverse governmental levels. In the following sub-section, the incentives related to these projects are addressed.

Nanotechnology incentives at CIMAV

Based on the current analysis, there appear to be collective and individual identifiable types of incentives that affect the mode of knowledge production and the

Table 1. Incentives affecting modes of knowledge production and networks at CIMAV.

Govermental level	Agency	Instrument	% projects out of the total	Basic	Applied	Direct incentives to networks
International	CIMAV/CONACYT/International agencies/foreign goverments	Institutional Fund	5.3	X	X	X
	CONACYT/SEP	Sectoral Fund	21.2	XXX		
National	CONACYT	Institutional Fund	20.0	X	X	X
	CONACYT	N R S*	n.a.	XXX		
National/Regional	CONACYT/CIMAV/ Companies	Innovapyme/Innovatec	15.9		XXX	
	CONACYT/Regional goverments	Regional Fund	15.3		XX	X
Regional	Gov. Nuevo Leon	Incubator	2.9		XX	X
	Gov. Chihuahua	Ministry of Education, Sports and Culture	1.2	XXX		
Local	CIMAV	Collaboration projects (without funding)	18.2	XXX		
	CIMAV	Monetary	n.a.	XX	X	
	CIMAV/Nuevo Leon goverment	Material	n.a.			XXX
		Symbolic	n.a.			XXX

Source: Own formulation based on interviews at CIMAV
* National Researchers System instrument
n.a.: not applicable
SEP= Ministry of Public Education
X: Indicates the instrument's orientation towards the mode of knowledge production
X= Slightly oriented
XX= Noticeably oriented
XXX=Significantly oriented

emergence of networks in nanotechnology at CIMAV. First, there are collective incentives that are implemented through the projects at four different governmental levels: international (EU and US transnational agencies), national (CONACYT), regional (CONACYT with regional governments) and local (CIMAV). Second, there are individual incentives that encourage researchers to produce knowledge, primarily coming from the National Researchers System (NRS of CONACYT) and CIMAV's monetary incentives. By means of these instruments, researchers have been rewarded according to their scientific performance, with bonuses amounting to an additional 30 to 40 percent of their salaries. The effect of this type of instrument is that researchers have mainly been encouraged to produce peer-reviewed articles and concentrate on human resources training but at the expense of developing problem-oriented research and technological development. Table 1 presents the main instruments affecting modes of knowledge production in the field of nanotechnology at CIMAV in terms of the range of governmental levels.

Regarding the incentive structure for nanotechnology projects, CIMAV's role differs in accord with the governmental levels (international, national, regional, and local). On a more international level, CIMAV's efforts to take advantage of available resources for nanotechnology research coming from US and EU agencies resulted in the implementation of a strategy that instigated the construction of networks with top research universities, primarily located in the US. Sponsorship by foreign agencies is still low; nonetheless, it has increased over time.

At the national level, researchers at CIMAV have been funding their projects mainly through the Sectoral Fund for Basic Research, distributed by CONACYT in coordination with the Ministry of Public Education as its principal partner. Because this fund finances basic research, it is the main reason why many incentives have focused on basic science projects.

The second instrument of importance is the Institutional Fund, which is more difficult to classify due to the variety of areas it promotes. On the one hand, it has been encouraging development of scientific research and new areas of interest, as well as human resource training. On the other hand, it has also been promoting interactions at the international level, mainly with the US (i.e., the University of Texas). This instrument has strengthened the infrastructure for conducting nanotechnology research via creation of the Nanotechnology Laboratory at CIMAV in 2008, though CIMAV has primarily been using this instrument to stimulate development of basic research.

The third instrument of importance is the National Research System, which primarily addresses incomes for individual researchers. Since salaries in Mexico are rather low, CONACYT, universities, and PRCs have implemented compensatory bonuses according to researchers' productivity at five hierarchical levels. Overall, this instrument strongly reinforces the inclination to produce basic knowledge, while promoting peer-reviewed articles and human training. Interaction with other actors to produce knowledge is less promoted by the National Research System evaluation. The Sectoral Fund for Basic Research and National Research System instruments[iii], in particular, are the reason that half of the projects at CIMAV can be classified as basic research: meaning that, among other things, they are generally conducted without any other actors involved.

At the national level, the primary interest of the instruments used is to stimulate production of knowledge, with special emphasis on scientific products that garner international prestige (e.g., articles and participation in international conferences). The relevance of networks, however, takes into consideration the necessities of other actors, society and companies. Although some attempts have been made to promote network development, mainly by the Institutional Fund, these can be characterized as top-down initiatives that have focused on short-term results, lacked proper resources, and did not take into consideration much of the previous social interaction between actors.

At the regional level, CIMAV has used the Regional Fund instrument of CONACYT in coordination with the Nuevo Leon regional government to create the Cluster of Nanotechnology and the Nanotechnology Incubator, which have been implemented as a symbolic and material incentive to produce knowledge. Out of the total projects at CIMAV, 15.3 percent were conducted with companies. Those projects have greatly increased since 2009, after the CIMAV's new branch in Monterrey was opened at the Research and Technological Innovation Park.

At the local level, CIMAV, as a public research center, also has individual incentives for its researchers according to their scientific productivity. The Center implemented monetary incentives comprised of almost the same structure as that propagated by CONACYT through

NRS, which promotes the production of basic research, as well as a variant that encourages the development of links between researchers and businesses. However, the incentives to produce basic research are dominant.

For instance, according to the institutional incentive structure of CIMAV, the research evaluation process gives twice as much importance to peer-reviewed articles in international journals than to registration of a patent, and the international publication of books and journals is more highly regarded than national publication. The consequences of this might explain the lack of discussion and focus on national or societal problems of knowledge produced, with subsequently weak interaction with local actors to produce knowledge. Thus, occurs a process of delocalization in the sense that the production of knowledge is mainly directed towards global scientific interest.

As the aforementioned incentive structure suggests, a twofold tension exists 1) between the different governmental levels (international, national, regional, local), which levels steered by the main actors' interests, and their particular contexts, and 2) between incentives that reinforce the production of basic research (Sectoral Fund of Basic Research, Institutional Fund, National Research System, and CIMAV's monetary incentives) and those that have encouraged the emergence of networks coming Nuevo Leon and CIMAV's symbolic and material incentives.

Having presented evidence that this twofold tension has simultaneously promoted and hindered knowledge production in networks, the next section presents and discusses the CIMAV's dynamics of knowledge networks.

Dynamics of knowledge networks

As previously mentioned, other actors are involved in almost half of CIMAV's nanotechnology projects. Interaction with the purpose of producing knowledge does not result in a single network, but rather in a set of relationships with different actors, dynamics, levels, and outcomes. All the instruments and incentives working at the four levels (international, national, regional, local) have promoted networks with diverse logics and dynamics. Analysis of the interactions has occurred at three spatial levels: translocal, transregional, transnational.

The transnational network is well connected and involves long-term actors, such as SRLL Laboratory and the University of Texas in their different localities: El Paso, Dallas, Austin, and San Antonio. The interactions take place within this network had been concentrated upon the production of peer-reviewed articles and human resources training.

Interviews with the coordinators of the projects revealed that interaction in the transnational network helped to increase the visibility of their research, informal collaboration, and discussion of relevant research lines with the national scientific community. Researchers also considered participation in the projects with these actors as a positive experience, one which provided them with an opportunity to get to know different knowledge production styles and access to relevant equipment. Nevertheless, it became evident from the interviews that transnational interaction entails with it priorities in focusing on certain research lines that have no or few links with necessities or problems at the local level.

When examining the dynamics of the networks it is noted that whereas networks are well connected at the transnational level, their regional and local connections are less developed. Interaction for producing knowledge at these levels was highly dispersed, and only involved a small number of actors, as can be seen in Table 1.

CIMAV has been using the Regional Fund instrument to finance applied nanotechnology projects, together with the creation of CIMAV's auxiliary branch in Monterrey. This encouraged the emergence of the transregional network between CIMAV, Chihuahua (Chihuahua); CIMAV, Monterrey (Nuevo Leon), and other PRCs located in Saltillo (Coahuila). Their interaction has been stable over time and leads to products such as joint projects with companies and peer-reviewed articles. The flow of knowledge between these actors has complemented CIMAV's lack of capacities in specific research lines in chemistry, and improved CIMAV's links to industry.

The CIMAV branch at Monterrey, in particular, has been the point of accumulation of different types of knowledge and its translation. Analysis of the data gathered reveals that the circulation of knowledge (experience of linking companies and applied knowledge flows) embodied in researchers' mobility between PRCs has contributed to the development by CIMAV of future projects with companies at the local level.

At the translocal level, CIMAV interacted with 16 companies (large national and transnational companies) lo-

cated in different parts of Nuevo Leon (Santa Catarina, San Pedro Garza, and Monterrey). Only a group of five companies and the Nanotechnology Incubator have had concentrated and repeated interaction in order to produce knowledge.

In projects with companies, researchers highlighted the improvement of learning process, development of new techniques, and implementation of theoretical ideas in producing artefacts as main results of such interactions. In this respect, the Nanotechnology Incubator has operated as a platform for bringing together different types of knowledge.

In interviews, researchers pointed out the following problems facing the development of networks:

a. lack of incentives for producing applied knowledge,

b. lack of a culture to link basic and applied knowledge,

c. lack of incentives that take into account links with companies,

d. lack of incentives for transferring technology,

e. excessive bureaucracy,

f. regulations that are an obstacle to introducing required material inputs into the country,

g. long delivery times for public resources,

h. changes in the juridical framework for promoting relationship with companies and networks that have hardly been keeping up with practices and customs, and,

i. reticence on the part of companies to risk participating in innovation projects.

Such sentiments are evident in the following remarks at CIMAV:

> "We do not have the culture as a country to link basic and applied science. Companies, on the one hand, do not have the education to support PRCs, as they prefer to bring technology in from other places. On the other hand, we do not have the culture to try that our projects provide somehow solutions to their problems or develop technologies interesting to them." (Personal communication at CIMAV, January 21, 2011)

The quote illustrates problems inhibiting not only the development of links between CIMAV and companies, but also links to other kinds of actors. In terms of points of intersection between the networks, they mainly seem to be between the transregional and translocal levels. This is not only the result of different types of knowledge produced and actors involved, but is also due to the circulation of knowledge and its subsequent trajectories. The creation of translocal interaction with companies was caused by the circulation and accumulation of knowledge at the transregional scale, mostly associated with previous experiences with companies and specialization of research lines. In that sense, it turns out that researcher mobility between PRCs was important for producing nanotechnology knowledge.

Concluding remarks

This paper discussed the extent policy incentives have had an effect on the dynamics of networks in nanotechnology in Mexico. The approach is differentiated from other studies concerning networks in nanotechnology, such as Robles (23), in two respects. First it takes into consideration different governmental levels, their instruments and incentives to boost networks on different spatial scales. Second, it analysed the networks in terms of their various outcomes (publications, projects, patents, artefacts), which has enabled a better understanding of their dynamics. Such a form of analysis creates room for further qualitative analyses of networks that can add a political dimension to the picture.

It was observed that Science and Technology Policy discourses in favour of networks have gained increasing importance during recent years, while in practice most public resources have been invested in human resources training and basic research instruments. Similar results regarding the incentive focus on basic science and human research training have been largely discussed (24, 25, 26).

This is not to say, however, that the impact of such discourses can be thoroughly neglected. In fact, they have been translated into material and symbolic incentives that are important for understanding the emergence of CIMAV's networks and their particular dynamics: development of stronger networks at the transnational level, but weaker in the transregional and translocal levels.

In sum, this paper has addressed a twofold tension generated by the incentive structure of S&TP which, at the same time, has been both hindering and promoting the development of nanotechnology networks while also explaining their dynamics. This tension is comprised of 1) incentives from different governmental levels, particularly those at the national vs. regional levels and 2) incentives that encourage basic research knowledge, resulting in a lack of interaction of researchers with other actors for producing knowledge, low interest/focus on national problems, difficulty of circulation of produced knowledge at the local level, and pursuit of scientific prestige that reaffirms hierarchically and exclusively structured mode of producing knowledge. As well, this has been contributed to by incentives that encourage the promotion of networks, which have resulted in well-connected transnational networks and dispersed interaction, concentrated in a few actors at the transregional and translocal level. As a consequence of this twofold tension, there is still much room for improvement at the local level and, for this purpose, it is indispensable to reflect upon the tensions that exist in the governance of knowledge production networks between global and local levels.

Additionally, this paper addressed the impact of current incentives in the emergence of nanotechnology networks and their dynamics. This is not to claim, however, that there is a strict causal relation between incentives and networks, as the emergence of networks depends on multiple factors. Rather this paper, only discusses the evidence from the standpoint of S&TP incentives.

Acknowledgments

This work was founded by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) through the International Research Training Group "Between Spaces, Actors, and Representations of Globalisation".

Competing interests

The author declares no competing interests.

Notes

i. This instrument is formally designated "Mixed Fund", but for practical reasons in this paper it is called "Regional Fund".
ii. The PRCs in Mexico receive public funds for their operations, but they also need to generate their own resources, which may come from public or private national sources or from abroad.
iii. The Sectoral Fund for Basic Research is a fund administered between CONACYT and the Ministry of Education to support basic science projects.
iv. The National Research System is an instrument that rewards researchers according to their scientific performance. The instrument also classifies researchers, according with their scientific output, in five levels: candidate, level I, level II, level III, and emeritus researcher.

References

1. Soltani AM, Tabatabaeian SH, Hanafizadeh P, Bamdad SJ. An evaluation scheme for nanotechnology policies. J Nanoparticle Res. 2011; 13(12): 7303–12.
2. Wang J, Shapira P. Funding acknowledgement analysis: an enhanced tool to investigate research sponsorship impacts: the case of nanotechnology. Scientometrics. 2011; 87(3): 563–86.
3. Cozzens S, Wetmore J, editors. Nanotechnology and the challenges of equity, equality and development. 1st ed. Dordrecht: Springer; 2011.
4. Gelfert A. Nanotechnology as ideology: towards a critical theory of "converging technologies". Science, Technology and Society. 2012; 17(1): 143–64.
5. Simakova E. Making nano matter: an inquiry into the discourses of governable science. Sci Technol Hum Values. 2012; 0(0): 1–23.
6. Mullins N. The development of a scientific speciality: the Phage Group and the origins of molecular biology. Minerva. 1962; 1: 83–106.
7. Ynalvez M, Shrum W. Professional networks, scientific collaboration, and publication productivity in resource-constrained research institutions in a developing country. Res Pol. 2011; 40: 204–216.
8. Podolny J. Networks, knowledge, and niches: competition in the world wide semiconductor industry, 1984-1991. Am J Sociol. 1996; 102(3): 659–89.
9. Powell, W, Snellman K. The knowledge economy. Ann Rev Sociol. 2004; 30: 199–220.
10. Bonnacorsi, A. Vargas J. Proliferation dynamics in emerging science. Res Pol. 2010; 39(8): 1034–50.
11. Callon M. The dynamics of techno-economic networks. In: Rod C, Saviotti P. Walsh V, editors. Technological change and company strategies: economic and sociological perspectives. London: Harcourt Brace Jovanovich; 1992; 72-102.

12. Latour B. Reassembling the social: an introduction to actor-network-theory. Oxford: Oxford University Press; 2005.
13. Freeman C. Networks of innovators: a synthesis of research issue. Res Pol. 1991; 20: 499–514.
14. DeBresson C. Amesse F. Networks of innovators: a review and introduction to the issue. Res Pol. 1991; 20: 363–79.
15. Pyka A. Innovation networks in economics: from the incentive-based to the knowledge-based approaches. Eur J Innov Manag. 2000; 5(3): 152–63.
16. Rampersad G, Quester P, Troshanj I. Managing innovation networks: exploratory evidence from ICT, biotechnology and nanotechnology networks. Indus Market Manag. 2010; 39: 793–805.
17. Saxenian A. The origins and dynamics of production networks in Silicon Valley. Res Pol. 1991; 20: 423–37.
18. Ravetz J, Farrel R, editors. Governance of dcience: The new politics of science, historical perspectives and future prospects. Institute of Governance, Public Policy and Social Research. Belfast: Queen's University Belfast; 2005.
19. Irwin A. The politics of talk: coming to terms with the 'new' scientific governance. Soc Stud Sci. 2006; 36(2): 299–320.
20. Whitley R. Changing governance and authority relations in the public sciences. Minerva. 2011; 49 (4): 359–385.
21. Whitley R; Gläser J, editors. The changing governance of the sciences. the advent of research evaluation systems. Dordrecht: Springer; 2007.
22. Åm, H. Trust as glue in nanotechnology governance networks. Nanoethics. 2011; 5 (1): 115–128.
23. Robles E. Dominique Vinck. A panorama of nanoscience developments in Mexico based on the comparasion and crossing of nanoscience monitoring methods. J Nanosci Nanotechnol. 2011; 11: 1–9.
24. Dutrénit G, Capdevielle M, Corona J, Puchet, M, Santiago F, Vera-Cruz A, editors. El sistema nacional de innovación Mexicano: instituciones, políticas, desempeño y desafíos. México D.F.: Universidad Autónoma Metropolitana; 2010.
25. Arza V. Channels, benefits and risks of public-private interactions for knowledge transfer: conceptual framework inspired by Latin America. Sci Public Pol. 2010; (7):473-84.
26. Bozeman B, Gaughan M. Impacts on grants and contracts on academic researchers' interactions with industry. Res Pol. 2007; 36:694–707.