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INTELLECTUAL PROPERTY RIGHTS AND NATIONAL INNOVATION SYSTEMS IN MEXICO *

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* The opinions expressed in this paper are those of the author and do not necessarely reflect the position of WIPO and/or ECLAC.

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I. INTRODUCTION

1. During the second half of the 1980s, important changes took place in the regulatory framework for intellectual property rights (IPRs) in the industrialized and less developed countries. The reasons behind these changes were, on the one hand, governments' and firms' growing acceptance of the importance of knowledge assets in international trade, and, on the other, the US government's pressure during the GATT negotiations, the Uruguay Round, to harmonize institutional norms regarding intellectual property rights. Underlying this proposal, most developed economies support the idea that the heterogeneity of IPRs in GATT member countries produce serious distortions in world trade, and particularly discourage foreign direct investment. The debate has concluded with an international proposal that was called '*Trade Related Aspects of Intellectual Property Rights*' (TRIPS). This initiative was passed in 1993, when GATT/WTO member countries approved TRIPS during the Marrakech Conference. Mexico has accepted this regulatory framework and introduced changes in the domestic law that regulates IPRs.

2. This new norm has been introduced, together with the consolidation of the trade reform which began during the second half of the 1980s, and which concluded with the signing of NAFTA and Mexico's membership in the OECD. Mexico is a country that has implemented important economic reforms as trade liberalization, privatization of state companies and economic integration with the USA and Canada (NAFTA). Since the beginning of this liberalization period, and combined with the further privatisation of services, Mexican industry has experienced a profound structural transformation, and one of the major consequence has been a steady internationalization process that is based on an external performance which the nation never had experienced before.

3. The central idea of this paper is that the impact of the new IPR framework and these economic changes can not be understanding outside of the behavioural patterns and linkages that characterize the Mexican Innovation System[1]. Thus, the analysis of the new IPR framework will be applicable to a collection of different agents: residents, non residents, transnational companies, local firms, universities, research centers and sectors, and the interactive linkages between them. It is argued that the new IPR's framework and the economic reforms, particularly, trade liberalization, do not provide incentives for the upgrading of technological capabilities in the Mexican system. In particular, both sets of incentives interacting between them reinforce adverse mechanisms for the diffusion of innovation within the system. Section one presents a definition of national innovation systems and relates this with the institutional framework promoted by the IPRs regime. Section two describes the differences in patent systems considering the flows of three categories: (i) applications for patents from residents;
(ii) applications for patents from non-residents; and (iii) external applications for patents. In the following two sections, our analysis focuses on the incentives promoted by the IPRs regimen introduced in Mexico and its impact on the innovation system. Section five is dedicated to a brief conclusion.

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1 World Bank addresses as "systems of knowledge".

II. INNOVATION SYSTEMS AND INTELLECTUAL PROPERTY RIGHTS

4. In modern innovation theory, the firms' strategic behaviour and alliances, as well as the interactions between firms, research institutes, universities and other institutions, are at the heart of analysis of the innovation process. More specifically, in the concept of a national innovation system, as introduced by Freeman (1987) in the mid-1980s and as further developed by Nelson (1993), Lundvall (1993), Metcalfe (1995), Edquist (1997), Cimoli and Della Giusta (2000), innovation is considered an interactive process in which the above-mentioned features are captured.

5. Following the concepts introduced in Freeman (1987) and Nelson (1993), and within national boundaries, analysis is carried out on a set of actors (firms and, particularly, other institutions such as universities, research organisations, etc.), as well as on the links between these actors in the innovation and diffusion processes. Metcalfe (1995) provides the following policy-oriented definition of a National Innovation System (NIS): a "set of institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process". At a system level, the interpretation presented here is consistent with, and indeed, is a complement to institutional approaches that build on the observation that markets do not operate apart from the rules and institutions that establish them. The institutional structure of the economy creates the pattern of constraints and incentives that shape the organisational and technological context within which each economic activity takes place. Thus, the IPRs regime adopted should be viewed as an institutional change that impacts the NIS configuration and performace (Foray 1993, David 1992).

6. Most of the promoters of the homogenization of the IPRs regime argue that the incentives contained in this will stimulate the creation of a market for knowledge, where investment in R&D and its intrinsic uncertainty can be paid back. Some general conjectures support the above: i) a system of IPRs that protect innovation will better stimulate the public welfare in the world economy; and ii) such a pattern of incentive stimulates better the realization and risks sharing of the activities on R&D. These points support the argument that protection is the better incentive to promote innovation. Indeed, this institutional design of incentives fit very well with innovation systems in developed economies, where we have the concentration of most R&D activities and technological efforts.

7. A first point to be observed is that countries do not depart from the same line. They have differences in their innovation systems (Cimoli and Dosi 1995). The differences that characterize a developed country with respect to a developing one are: i) higher R&D expenditures (public and private); 2) more recourses and solid institutions dedicated to training of human resources and universities; 3) higher articulation in networks that interlink institutions and production systems; and 4) higher concentration of the innovative leader at the world level, etc. In a system like this, an IPRs regime that incentive protection of innovators and their activities is coherent with an improvement of the welfare in terms of the benefit that a society has from the introduction of new goods and production process.

8. The case of developing countries is substantially different[2]. The recent literature on these themes confirms that the impact of the IPRs reforms on developing countries can produce adverse mechanism to promote innovation and growth (Combe and Pfister (2000). Particularly, in the case that the incentives promoted by the IPRs regime are superposed to the market driven reforms. That is, economies that adopt an IPRs regime that incentive the protection of innovative activities; and, on the other, they implement also liberalization policies to allow a higher diffusion of trade and capital movements. Some general impacts can be summarized as follows:

- If a large number of knowledge content products are produced in developed countries at a higher price, this specialization pattern will produce a deterioration of the terms of trade of developing countries affecting their growth possibilities. The static welfare effect is negative for developing economies;

- The relation between IPRs protection and FDI is ambiguous. On one side, FDI could increase if the protecting IPRs regime is adopted but, on the other, there is no guarantee that FDI diffuse innovations locally;

- The relation between IPRs and technological effort seems to be very weak. Most developing economies have not increased their efforts after the adoption of the IPRs regime; and

- The superimposition of free trade and IPRs regimes reinforces adverse incentives for the upgrading of local technological capabilities.

III. ASYMMETRIES IN PATENT SYSTEMS (PS)

9. Compiled from WIPO (World Intellectual Property Organization) information, table 1 confirms that Latin American countries represent almost a third of the flow of applications for patents. Mexico's situation is noteworthy in that its volume of applications (15 percent) is higher than Brazil's (13.5 percent). Patenting data from Japan and Korea indicate that these economies maintain a leadership (Aboites 2001).

Table 1 Patents applications

Countries	1997	E.U. = 100
North America:		
U.S.	236,692	100.0
Canada	54,446	23.0
Latin American		
Mexico	35,932	15.2
Brazil	31,983	13.5
Argentina	6,683	2.8
Europe		
Germany	175,595	74.2
England	148,209	62.6
France	112,631	47.6
Spain	113,767	48.1

2 See among others: Braga and Willmore (1991), Diwan and Rodrik (1991), Bertin and Wyatt (1988), Vaistos (1971), UNCTAD (1996).

Portugal	106,687	45.1
Greece	82,443	34.8
Sudeste Asiatico		
Japan	417,974	176.6
Corea	129,982	54.9
Sources: WIPO (1998), Intellectual Property Statistics and OEA (1999), Indicadores tecnologicos de AL.		

10. The countries patent systems display highly contrasting behaviors under the effect of institutional homogenizing of the IPRs regulatory frames. Although the changes in the regulatory frame agreed upon by the WTO (World trade Organization), the TRIPs, Trade Related Intellectual Property Rights, took place in 1993 (Marrakech), it is a fact that from the late 80s to the early 90s they were already under way in the majority of the countries studied.

11. Mexico, for example, approved them in 1991. This is why for the purpose of studying the evolution in the flow of applications for patents, the period of study that goes from 1981 to 1997 was divided in two: the first (1981-1989) covers the years before the TRIPs reforms; the second period (1990-1997) covers the years after the changes in them took place. Applications for patents are observed in order to determine the existence of a certain degree of continuity or, on the contrary, of a significant inflexion in the flows of patents between the two periods (Aboites 2001, Aboites and Soria 1999). For this purpose two types of applicants are considered: internal -applications for patents from residents and non-residents; and external applications for patents abroad. The first flow is analyzed with information from WIPO, while external patents, those granted abroad of each economy, are based on USPTO, US Patent and Trademark Office. Three types of patent systems (PS) are defined where each of them is based upon the evolution of the flow of residents' patents, non-residents patents, and external patents (Aboites 2001). These patterns are; i) Stable PS (France and UK); ii) Converging PS (US, Canada, Germany, Japan and Korea) and iii) Divergent PS (Mexico, Brazil, Argentine and Spain). Each was characterized as follows:

- Stable: this is a PS whose basic internal flows (applications for patents from residents and non-residents) do not suffer any significant modification when passing from one time subdivision to the next. They preserve, within a certain range, the previous trend. This internal continuity shows us that the changes in the regulatory frame (implementation of the TRIPs of the WTO) did not alter domestic trends registered in the first time subdivision. On the other hand, there was a significant increase in the flow of patents in the external ambit between one time subdivision and the other. This shows that in a country with a stable PS there were no significant changes in internal trends although externally modifications did occur. In other words, they kept the same dynamism displayed before the amendments to the regulations that took place in the 80s and after the changes in the TRIPs during the 90s.

- Converging: its two basic flows (resident and non resident) of applications for patents have similar trends and this tendency is emphasized during the second time subdivision; however, in some countries applications from resident increase their relative share. Besides, the flow of external patents presents a significant increase when passing from one time subdivision to the next. In quantitative terms the flows of internal applications (residents and non-residents) increase their intensity above two percentual points in the average rate of growth. A positive and considerable change was registered between the two analyzed time subdivisions.

- Divergent Patents System: here the two basic flows of applications for patents show a gap when passing from the first to the second time subdivisions. Such behaviour is due, on one hand, to the increase in the flow of applications from non-residents. On the other hand, there is a stagnation or contraction in the flow of applications from residents. The fact that neither the applications from residents or the external applications are sensitive to institutional changes. The PS promoted by the IPRs regime is far from contributing to the stimulation of inventive activity. On the contrary, it seems that this new incentives addressed to protect innovation have indeed inhibited it.

12. A general trend indicates that the harmonizing of IPRs produced an unprecedented increase in patenting around the world. This trend is led by industrialized countries, especially by the three regions that are the stepping-stone of the Triad and the globalization of world economy where Latin America does not take part as originator of patents, notably Mexico, but as an ever-expanding recipient of flows of technology codified in patents. This is another profound difference between divergent PS (Latin America) and converging PS. It should be kept in mind that stable and converging PS are characterized by an increase in external applications for patents after the international change of IPRs.

IV. PATENTING IN USPTO

13. As can be observed, the great pole of attraction is the US Patent and Trademark Office (USPTO) where the majority of technology-related transactions take place. Here, three (Europe, US and Southeast Asia) are the most important in the world representing more than 90 percent of the total patenting registered. Dosi, Pavitt and Soete (1990) have called this group the *Innovative Countries Club*. Moreover, this select group is actually generating state of the art technologies related to information and communications, biotechnology, new materials etc. The analysis of patents granted in USPTO, carried on countries and sectors between (1980-1999), display the following main trends:

- From the analysis of patents granted to non-residents in USPTO, we observe that in the last decades occurred both the emergence of Japan and the European decline. Subsequently, from the late 80s and associated to the changes in the regulation frame of the TRIPs, industrializing economies in Southeast Asia registered a rapid increase. On the other hand, Latin America maintained its low patenting activity in the USPTO, which can be interpreted as a lack of integration to that part of the world that produces knowledge.

Table 2, Patents granted in the US by foreign country, 1950-1999 (shares)

	1950	1958	1965	1973	1979	1986	1995	1997	1998	1999
Australia	1.54	0.60	0.94	0.92	1.12	1.14	1.00	0.95	1.07	1.02
Austria	0.48	1.12	1.16	1.02	1.19	1.09	0.74	0.75	0.58	0.69
Belgium	1.07	1.14	1.50	1.23	0.98	0.74	0.87	1.02	1.03	0.93
Canada	11.16	7.99	7.00	6.20	4.56	4.01	4.61	4.73	4.42	4.64
Denmark	1.36	0.74	0.74	0.70	0.56	0.56	0.44	0.66	0.58	0.70
France	15.54	10.36	10.90	9.38	8.46	7.22	6.18	5.88	5.46	5.49
Germany	0.57	25.60	26.40	24.25	23.87	20.80	14.45	13.94	13.53	13.42
Italy	0.86	3.02	3.38	3.39	3.14	3.05	2.36	2.46	2.35	2.14
Japan	0.03	1.93	7.43	22.10	27.69	40.35	47.64	46.10	45.88	44.70

The Netherlands	8.10	5.71	4.15	3.03	2.80	2.20	1.75	1.61	1.82	1.79
Norway	0.95	0.61	0.42	0.42	0.43	0.25	0.28	0.28	0.29	0.32
Sweden	6.67	4.64	4.50	3.40	3.02	2.70	1.76	1.72	1.82	2.01
Switzerland	9.73	8.80	6.97	5.79	5.40	3.70	2.31	2.17	1.90	1.84
United Kingdom	36.00	23.45	20.62	12.56	10.07	7.37	5.42	5.33	5.15	5.13
Total NICs	1.41	1.31	1.71	1.36	1.45	1.50	7.53	9.55	11.26	12.23
-Mexico	-	-	-	-	0.19	0.11	0.09	0.09	0.08	0.11
-Argentina	-	-	-	-	0.13	0.05	0.07	0.07	0.06	0.06
-Brazil	-	-	-	-	0.10	0.08	0.14	0.12	0.11	0.13
-Korea	-	-	-	-	0.03	0.14	2.54	3.76	4.85	5.12
-Taiwan	-	-	-	-	0.20	0.64	3.55	4.09	4.61	5.31
-Other NICS	-	-	-	-	0.80	0.48	1.14	1.41	1.54	1.50

Source: USPTO (2001)

- What the study of the patents system suggests is that Electrical-Electronic (E-E) technologies emerge and predominate. Thus, innovations tend to gravitate towards E-E technologies associated to digital technologies in information and communication. This is true in the case of US and Southeast Asia, the two regions more economically active during the 90s. On the other hand, European countries have kept to the area of Chemistry, traditionally their field of expertise. Among the regions studied, Latin America is the only one where the importance of mechanic technology as innovative activity is still alive. This is especially true for Mexico. In other words Latin America keeps itself inside the technological pattern and learning capabilities developed in the import substitution period. Most of the patents granted in mechanical activities reflects the upgrade. Particularly, for Mexico, the case of some large groups in the chemistry, brewery, and glass containers sectors where not only it has been developed increasing production capacity, but have dedicated their R&D activities to support the knowledge-base of the firms during the import-substitution phase.

Table 3 Patents granted in USPTO by sectors and countries

	United States	Canada	Mexico	Argentina	Brazil	Germany	England	France	Spain	Japan	Korea
1986-92											
Chemistry	27.7	23.1	42.4	16.9	19.3	33.0	31.9	31.4	25.5	27.2	19.1
Electric-Electronic	22.1	16.9	8.6	13.7	11.2	16.2	24.9	22.5	8.7	38.5	48.3
Mechanical	50.2	60.0	49.1	69.4	69.5	50.8	43.2	46.1	65.8	34.3	32.6
1993-99											
Chemistry	27.9	27.4	41.9	21.8	24.0	35.8	36.3	37.3	33.3	26.6	21.2
Electric-Electronic	28.2	20.6	8.1	8.8	10.0	17.3	28.1	23.5	11.2	45.5	55.3
Mechanical	43.9	51.9	50.0	69.5	66.0	47.0	35.5	39.2	55.5	27.9	23.5
Tendency											
Chemistry	0.2	4.3	-0.5	4.8	4.7	2.8	4.5	5.9	7.8	-0.6	2.0
Electric-Electronic	6.1	3.7	-0.5	-4.9	-1.2	1.1	3.2	1.0	2.5	7.0	7.0
Mechanical	-6.3	-8.1	0.9	0.1	-3.6	-3.9	-7.7	-6.9	-10.3	-6.4	-9.1

Source: USPTO (2001)

V. PATENTING SYSTEMS: EFFORT AND PERFORMANCES

14. In table 4, we observe a set of indicators revealing not only the level of economic activity but also other aspects that reflect innovative activity.

15. The countries with converging PSs have a per capita GDP above the OECD average, while the level of Expense in R&D ranges between a 2.3-2.9 percent of the GDP. Stable PSs present a close-to-average GDP per capita, while the level of Expense in R&D falls in the range of 1.5-2.2 percent of the GDP. Finally, countries with divergent PSs are characterized by a GDP per capita level below half of the average of the OCED. Expenditure in R&D, this is in all cases under the unit as proportion of the GDP.

Table 4, Technological efforts and performances (1999)
Countries and technological indicators

	A	B	C	D	E	F	G
US	152	2.77	74	20	0.9	34.6	10.4
Canada	116	1.61	53	25	0.6	33.7	3.3
Mexico	36	0.34	6	2	0.2	66.2	0
Argentina	60	0.38	22	2	0.16	41	-
Brazil	38	0.76	7	2	0.5	64	-
Germany	106	2.32	58	21	0.8	37	5
UK	100	1.87	52	29	0.7	33.3	3.2
France	98	2.24	60	20	1	42.3	2.7
Spain	81	0.88	30	16	0.4	43.6	0.2
Portugal	74	0.65	24	7	0.4	65.2	0
Turky	28	0.49	7	4	0.2	64.5	-
Greece	66	0.5	20	16	0.2	46.9	-
Japan	110	2.91	83	15	0.6	20.9	10.6
Korea	71	2.89	48	5		19	0.7

A) GDP per capita (OECD average=100), B) R&D expenditures as a share of GDP, C) Number of researchers in 10000 economically active population, D) Scientific papers per unit of GDP, E) Government R&D expenditures in the total GDP, F) Government expenditure shares in R&D , G) Index of technological intensity of patents.

Source: J. Aboites (2001)

16. In the Latin-American region, expenditure in R&D as a fraction of the GDP is relatively low (below one). As we have seen these countries have divergent PSs; the same holds true for the average low-income European countries (Portugal and Greece). This contrasts with North America and Southeast Asia whose level of R&D Expenditure is close to three percent of the GDP. Europe, it has been pointed out, is divided in two groups: those with an R&D expenditure relatively high and similar to the US, and those with a low income per capita that present a relatively low expenditure in R & D, below one. In countries with low efforts in R&D expenditure, the contribution of private sector in R&D activities is very poor too. At this level, we can state that R&D efforts tends to reflect also the production specialization of each country and its industrial structure. Here, again the specificity of Latin American countries, which are specialized towards natural recourses and cheap labour. Other asymmetries are shown in columns three and four enlisting the number of researchers in the economically active population and the scientific and technical articles published. The last two columns of table 4 show the degree of strength and technological intensity and the same asymmetries, high value for industrialized countries with converging PSs and weak in countries with divergent PSs, like Latin America and Mexico.

17. Table 5 relates the performance of PS through our taxonomy developed above and the main features of innovation system in the different. Converging PS (US, Japan, Korea, Taiwan and Germany): displaying a strong innovative activity especially, although by no means exclusively, in E-E technologies. These PS are linked to solid NIS (high R&D Expenditure, adequate human resources and a growing participation of the private sector) creating a dynamic impact in the USPTO and supporting its strength in the creation of more articulated system to promoteinnovative activities. Besides, these countries are the ones that establish competition with transnational companies from Europe and the US displacing them through their level of patenting in the USPTO. Stable PS (European countries with high income levels, except Germany and Canada): showing a considerable innovative activity in Chemistry and less dynamic in E-E. These PS are linked to solid NIS that is nonetheless technologically dated vis-à-vis the emergence of the new paradigm based on E-E.

18. Divergent PSs (Spain, Mexico, Brazil, Argentina, Portugal and Greece): displaying a low domestic innovative activity. Their inventive activity persists, especially, but not exclusively, the one associated to mechanic technologies and in some cases to Chemistry. These PSs are linked to still unsound NIS (low Expenditure level in R&D, unskilled human resources and low participation of the private sector). Their penetration in the USPTO is very low in the last three decades and there was no new impact made to the regulatory frame. In short, the nature of NIS with a low degree of integration linked to divergent PS is the transfer of technology from abroad. As we have seen the Mexican economy is some kind of paradox: while sharing several macro-economic features with Korea (dynamism in exports with a high technological content, economic growth, etc.) its innovative performance is weak. This is the subject of the following section.

Table 5 Innovation systems and patenting pattern

Patent systems	Efforts of innovation system	Insertion in the USPTO
Convergent US, Canada, Germani, Japa., Korea	Higher expenditures in R&D High share of firms expenditures in R&D Surplus in the technological balance A well developed system to support human resources Virtuous networks between firms and institutions Export oriented to product with high technological content	Increasing Increasing E-E technologies, Chemical stable and decreasing in mechanics
Stable France, UK	Higher expenditures in R&D High share of firms expenditures in R&D Deficit in technological balance A well developed system to support human resources Exports oriented to product with medium technological content	Decreasing Increasing E-E technologies, Chemical stable and decreasing in mechanics
Divergent Mexico, Brasil Venezuela, Spain	Lower expenditures in R&D Lower share of firms expenditures in R&D Deficit in the technological balance A weak institutional system to support human resources Weak networks between firms and institutions Export oriented to product with low technological content	Non important Non significance of E-E technologies, stable mechanical, increasing in chemical

Source: J. Aboites (2001)

19. In the case of Latin American countries the configuration of innovation systems has suffered structural changes, (Cimoli 2001). For example, the role-played by MNCs and large domestic conglometere, the presence of the state in the economy, the regulatory mechanism in services activities and so on. Thus, in a world of increasing returns to scale in production of knowledge, at the level of the firm, and of synergies and interdependencies between firms and other repository institutions involved in the ‘production’ of skilled man power and

technology, (such as universities, public R&D laboratories, and so forth), the conditions are given for the globalization process to induce a dualistic world-wide pattern of production organisation. In such dual pattern, R&D and engineering activities increasingly will tend to concentrate in developed countries while developing economies will remain 'locked-in' in the production of low value added industrial 'commodities' as well as in 'maquila' type activities. We have also seen that in many cases this has involved the transferring abroad of many 'in house' performed R&D and engineering efforts. The local operation has turned more into the nature of an assembly activity, strongly based on imported parts and components as well as on externally supplied technological and engineering services. This mechanism is likely to induce an increasing isolation of peripheral countries from the world of technology generation.

VI. INCENTIVES TO PATENTING IN THE MEXICAN INNOVATION SYSTEM

20. The IPRs regime that correspond to the previous industrial property law (1976) have changed radically. One important modification regards the duration of the period of patent protection: this period was ten years in 1976, and it was extended to twenty years in 1991. Other regards the use of a patent when a patented product is imported. Thus after 1991, the new regime permits transnational companies to import patented products without having to produce them locally.

21. Comparing the evolution of patenting activities in two periods, before trade liberalization (1982—87) and during the process itself (1988—99), we can state that: i) before trade liberalization, patent applications by residents and non-residents decreased; ii) during the process of liberalization, non-resident applications grew considerably, while resident patenting continued its tendency to decrease. As a result, there was strong growth of patenting by non-residents, compared to total patenting. The United States is the country that has increased its participation the most (60 %), despite a decrease during the 1995 crisis. Europe and Japan follow. In this context, two important trends can be observed: i) the flow of total and non-resident patent applications is closely linked to domestic and foreign direct investment during the 1978—96 period; and ii) there is no significant relation between resident patenting activities and the evolution of total private sector investment (Aboites, 2001).

22. Launched in 1994 NAFTA (North America Free Trade Agreement) exerted decisive influence on the behavior of residents and non-residents patents flows in Mexico (Aboites and Soria, 1999). The average annual rate of resident applications during the first period (1981-1989) was 3.6%, while in the second period (1990-1997) it has dramatically decreased to 7.7%. The growth rate of the application of non-residents was 2.2% during the first time subdivision, while for the second period external agents reached an unprecedented dynamism, 34%. External applications for patents did not register any significant changes in Mexico. During the first time subdivision the flow went up 3.3 percent while during the second subdivision it reached 4.9 percent.

23. During the 1991-1994 period, there was growth of applications by all patent-holders, whereas in the 1994-1996 period there was a substantial decrease in different types of patent-holders (Aboites 2001). Between 1991 and 1994, the most important growth in patent applications was from firms, universities and research institutes. Individual persons had the

lowest growth. Between 1994 and 1996, there was an overall decrease, universities and research institutes being the most affected. It is important to point out that firms are the main patent-holders, since eight out of ten patents belong to firms, specifically transnational companies. (see table 6).

Table 6 Patents granted in Mexico for MNCs (1980-1992)

Sectors	1980-1982	1983-1986	1987-1989	1990-1992
1 Chemistry	1,393	1,240	1,106	1,679
2 Electric-Electronic	1,009	631	466	414
3 Non electrical machines	851	672	632	993
4 Transport	170	134	124	176
5 Other technology	183	141	137	243
Total	3,606	2,818	2,465	3,505

Source: Source: J. Aboites y M. Soria (1999).

24. In synthesis, a growing pre-eminence of the non-residents applications is noticeable. Moreover, a large part of the problem can be related to the role played by the transnational companies that use used patents to block competition and to protect their markets (Aboites and Soria 1999, Aboites 2001). This trend is markedly accentuated from the first year of negotiations of the NAFTA. The above trends confirm our categorization of the Mexican PS as a divergent one.

25. Chemicals, metal products, machinery and equipment are the sectors in which 88 per cent of patent applications are concentrated. They are also the most active sectors in the number of patent applications during the 1991-1994 period. In the chemical sector, the growth of patent applications is linked to PEMEX, the government-owned Petroleum Company. The rest of the manufacturing sectors, specifically the traditional ones (food and beverages, textile, leather, etc.), have less relative importance in patent applications. R&D intensive sectors with a predominance of multinational firms (pharmaceuticals, biotechnology and others) were noteworthy because of their dynamism in patent applications. However, R&D efforts and linkages with the other components of Mexican NIS are very poor. This is particularly true for the pharmaceutical industry, where there is no incentive for R&D, or for linkages between universities and domestic companies related to the generation of new molecules that are national discovery (Arvanitis. and Villavicencio (2000), Gonsen. and Jasso (2000). Another characteristic that distinguishes the system of patents registered is that applications for patents in electronic technology are relatively low. In effect despite the boom in electronic exports, there has not been a significant increase in R&D efforts and patenting activity.

26. Korea is an interesting case that can be compared with Mexico, in particular Korea was in the “watch list” of the US trade representative for a long time. “It is mainly argued that Korea’s intellectual property rights law does not meet standards set out by WTO Agreement on TRIPS. Most, notably, Korea does not provide for TRIPS consistent protection for pre existing works and sound recording. The US have also raised concerns with the level of patent protection for pharmaceutical and the protection of data in Korea, as well as with

Korea's market access restriction on pharmaceutical products and on motion picture and cable TV programming" Combe and Pfister (2000). In other words, the Korean PS is characterized by a set of incentives that support the diffusion of innovation and protect the technological capabilities achieved in the industrialization period.

27. In the case of Korea only the second time subdivision (1990-1997) is analyzed due to lack of any more information from the OECD. The trends registered in this subdivision are striking: applications from residents increase at an average annual rate of 51 percent; in other words, the highest of all the countries studied. Dynamism from non-residents is also considerable: 12 percent. It may be observed that at the beginning of the period under study, residents submitted less applications for patents than foreigners, but at the end (1997) they greatly surpassed them. Undoubtedly Korea's patents system is converging and the most dynamic in the last decade. Add to this the impressive flow of external applications in this country (43 percent), which, as we shall see later, has spread over industrialized countries, particularly in the US economy where the amount of patents granted to Korea is comparable to the United Kingdom's.

28. The previous section suggests that in countries with converging PSs, exporting is strongly associated to the innovative activity reflected in patents. Mexico is renowned by a strong dynamism in exporting manufactured goods comparable to Korea's[3]. Nevertheless the coefficient correlating patents with exports of manufactured goods shows pronounced differences. In fact, in the coefficient of residents' patents on exports of manufactured goods in Mexico reaches 0.47%, while Korea the same indicator is abut 66% (US, 22%, Japan, 84%). Besides Mexico is strongly deficient in its technological balance (Aboites and Soria 2000). This suggests that while in Korea exports are associated with innovative activity, the same does not hold true of Mexico.

29. This set of contrasts between Mexico and Korea should be looked into from the perspective where Korea is seen as an economy with a converging PS and a NSI that has consolidated its upgrade of technological capabilities in the last decades. A fact that explains the differences between both countries is entailed in the concept of selective dynamic intervention, derived form the experiences of developmentalists. For example, one of the keys to their success has been the ability to program the level and composition of non-competitive intermediate and capital goods. For example, the case of South Korea, where quotas, directed credit and targeting were used in order to select those industries that were to provide foreign exchange through exports. The industries whose exports were promoted were those in which the country possessed a static comparative advantage whereas the industries which enjoyed of protective policy were subject to the condition of developing a dynamic comparative advantage. At the aggregate level, thus, it was also possible to obtain a balanced portfolio in terms of sources and uses of foreign exchange. Within the industries supported to develop dynamic comparative advantages, it seems that the major actors in technological learning have been large business groups, the chaebols, which have been able at a very early stage of development to internalize the skills for the selection among technologies acquired from abroad, their efficient use and adaptation, and, not much later, have been able to grow impressive engineering capabilities (Kim 1993). This process has been further supported by a set of institutions and networks dedicate to improve and upgrade human recourses (Amsden, 1989).

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3 Mexico share of manufactured goods in exporting market of OECD for high technology is 3.3% , the Korea shre is 4.6%.

VII. PERFORMANCE OF MEXICAN INNOVATION SYSTEM

30. After the trade reform, Mexico has substantially increased its participation in the world arena, in terms of exports as well as imports. Most of the surviving and efficient firms (both MNCs and large domestic firms) have increased their exports (components for automobiles, chemicals, plastic products, glass, beer, electronics, steel, cement, etc.) and imports of intermediate and capital goods. The image that we have is that Mexico is a country in which production activities are highly globalized and that a new specialisation in the global chain of production is emerging (Capdevielle, Corona and Hernandez (2000), Unger and Oloriz (2000)).

31. Nonetheless, all types of firms have some integration with countries that lead in international trade and technological innovations, thus becoming dependent on imported technology, as well as on imports of the most technologically dynamic products and intermediates. In a similar context, the majority of the transnational companies patenting is for commercialization and protection of their product locally.

32. Mexico's R&D efforts are rather poor in comparison to those at the technological frontier. Moreover, R&D is highly concentrated in the export sectors (automobiles, glass, cement, office machinery and computers, electronic equipment, etc.). R&D effort principally focused on addressing the modernization of production processes and improvements in production organisation and product quality. Most firms have not developed co-operative R&D efforts with other firms and institutions. As a matter of fact, the pattern of R&D efforts, which have been scarce and scattered, and other modes of technology transfer has been mainly dominated by a higher integration of imported inputs in most competitive sectors (Capdevielle, Corona and Hernandez (2000)). More general, there are a number of general factors in the Mexican NIS that can explain the impacts of the superimposed incentives provided by the new trade and the IPRs regimes (Cimoli 2000). In particular:

- FDI and assembly activities*:* Foreign direct investment (FDI) refers to activities and decisions taken by multinational enterprises (MNEs). The Mexican patterns of trade specialization and performance (for example, international competitiveness) can then be analysed as the outcome of the processes that result as the MNEs decision on the localisation and quality of FDI. In this context, regional integration through the NAFTA has played a crucial role as an institutional regime or framework that supported the incentives for the MNEs. Today, technological developments occur mainly in the home bases of MNEs and only a small portion is transferred to countries like Mexico. This process determines, on the one hand, that Mexico participate actively at the globalization of production and, on the other hand, that its participation in the globalization of scientific and technological activities is very poor. As companies transfer only some of their R&D activities to Mexico, we can expect that the present concentration of corporate R&D will by and large lead to a even stronger international divergence of technological development (Patel and Pavitt (1991), Chenais (1988) and Freeman and Hagedoorn (1995), Unger and Oloriz (2000)).

- Most of the production activities in Mexico have increased their demand for knowledge and technology provided by foreign sources. For example, maquiladora operations dominate the production of science based components, thus allowing for very limited links and flows to other domestic suppliers of intermediates. The diffusion of this type of industry introduces only very weak connections with the domestic productive firms and institutions (Unger and Oloriz (2000)). The "maquila innovation system" mainly support and stimulate the networking activities in the abroad firms and institutions, reinforcing thus knowledge and technological advantages in developed economies. Thus, its technological externalidades do not display any proof of having contributed in any way to the construction of technological skills or the strengthening of the Mexican innovation system. When comparing the behavior of patents systems between sectors an important paradox in is emerging. In fact, the exporting maquiladora industry specialized in electronic accessories and automotive parts closely related to this type of technology do not apply for patents.

VIII. SUBSTITUTION OF LOCAL TECHNOLOGICAL SOURCES

33. The imported equipment used throughout the industrial system replaces, as is a surrogate for, the learning capability that could accumulate in specialised domestic suppliers of equipment in a well integrated industrial system. The main changes could be observed in the modes of how sectors and the type of firms (considering Foreign Firms and Non Foreign Firms) are inter-inked with foreign production networks and sources of technology. Particularly, the pattern related to R&D efforts and other modes of technology transfer mainly has been substituted by a greater integration with imported inputs, stronger linkages with foreign engineering services and institutions (as universities and other research institutes) for the most successful exporting sectors. Their direct contribution to R&D and technology transfer is not substantial.

34. The personnel employed in R&D activities, quality control and local adaptation of design mainly interact within multinational firms where they work and, furthermore, those firms are characterized by reduced linkages with the domestic higher education institutions, local research centers and laboratories. In this context, for example, universities show an increasing effort to improve and create linkages with the production system. But those efforts are inhibited by two principal factors. On the one side, we have the bureaucratic organization of most public universities and, on the other, we see lack of the demand form the industrial sector, the modernized one and the more science based, which demand «knowledge» from institutions and research centers abroad. In the long term, these ideas are consistent with a depreciation of competencies of local human capital and adverse incentives to develop linkages with local research centres.

IX. INHIBITION OF LOCAL NETWORKS

35. The interaction between firms and the local institutions that produce knowledge is very poor, a fact that is most keenly felt by those companies belonging to the science-based sector. Within the production system the activities of engineers, technicians and the experience of the labor force constitute the most relevant sources of knowledge, particularly for firms within the scale-intensive and science-based sectors. Public sector or university research centers are not a relevant source of knowledge for Mexican firms. This is a rather remarkable fact in the case of firms within the science-based sector, since this sector is strongly linked with such centers in the more developed countries. This process is reinforced by the protective incentives introduced by the homogenisation of the IPRs regime.

36. A substantial and widespread perception is that: networks are a powerful engine for innovation systems. Regarding recent parables of globalization and liberalization, it could be conjectured that the benefits generated by knowledge intensive networks are not equally distributed. Moreover, the specialisation of production supports a system of networks where the demand for knowledge and innovation is continuously addressed towards advanced economies. This increases their capabilities of capturing the benefit and advantages.

At first sight there thus appears a contradiction between the theoretical vision that support the idea that countries capture the benefits of globalization and most empirical evidences on the increasing gaps in the capabilities of capturing the benefit of networking and innovative activities (Cimoli 2000).

X. CONCLUSIONS

37. In developed economies, the IPR regimes promote R&D efforts and linkages between different type of components of the innovation system. Thus, the main difference between developed and peripherical economies lies in the effect that the protection of IPR has on the innovative activities. In Mexico, there has been a reduction in domestic patenting. Thus, despite the increase in non-resident patents, there is not a local adequate diffusion of the technological knowledge that arrives in Mexico from abroad. This suggests that the existing networks are not stimulated for the diffusion of this type of technological information towards the national agents, which is a distinguishing characteristic of the Mexican innovation system. This leads us to conclude that there are two factors that block the diffusion of technology that is codified in patents: i) the majority of the transnational companies patenting is for commercialization (by importing patented products or to block competition); and ii) the transnational companies support their R&D effort at home and, preferably, develop network with institutions and high technology firms in developed economies. An important conclusion that is derived from the previous statement is that NAFTA met expectations of increasing foreign direct investment, but the same is not true for the local diffusion of technology flows. In other words, the transnational companies mostly patent to commercialize, thus favoring the creation of networks abroad. Thus, we can affirm that the changes in intellectual property rights in Mexico have strengthened the transnational companies' strategies by permitting the diffusion of their innovations through trade, instead of through the creation of local innovation and technological networks.

38. The incentives by the IPRs do not fit properly in the case of developing economies; particularly, in those that have adopted liberazation policies and market oriented reforms. Countries do not start from the same line. This asymmetry clearly reinforces the prevailing gap between local and external technological capabilities, which now benefit further from the globalization process. These interactions between the incentives promoted by economic reforms and IPRs regime are seen in a complementary perspective as responsible for the occurrence of what has been called "lock-in by historical events" and "self reinforcing process" (Arthur, 1989, David 1994). Liberalization and globalization of markets cum the homogenisation of the IPRs regime in a context of competing firms under increasing returns to scale mechanisms can eventually reinforce the technology gap between nations and the weakness of NIS in developing countries, if the 'destruction' of local capabilities is not compensated by the diffusion of knowledge transferred (or diffused) by the globalised firms.

[Annex follows]

ANNEX

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