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Globalization and Networking of R&D Activities

--- Analysis Centering Around the Cases of IBM Com, Philips N.V. and NEC Corp.---

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1 Introduction

Current empirical studies about internationalization of Research and Development(R&D) have mainly been based on two approaches. One refers to the number of overseas R&D units, overseas R&D costs and the number of overseas R&D staff members etc., primarilly based on questionnaire style data (Behrman,J.N.[1980], Dunning,J.[1992], Florida,R.[1997], Hirota,T.[1986], Iwata,T.[1994], Kuemmerle,W.[1997], Ronstadt,R.[1977], Serapio,M.G.[1994], Serapio,M. and Dalton G.H.[1995], Takahashi,H.[1997]). The other approach examines patents granted in the US, so that it can identify which overseas R&D operations or labs invented these patented technologies (Cantwell,J.[1991], Etemad,H. and Dulude,L.S.[1985], Hayashi,T.[1989], Patel,P.[1995], Patel,P and Pavitt,K.[1991], Pearce,R.D and Singh,S[1992].

However, there still seems to be mainly two unsolved issues as far as overseas R&D of Japanese companies are concerned. One issue is that while many researchers taking the former approach have revealed that Japanese companies have intencified thier overseas R&D activities, particurally in the US, in terms of such input factors as R&D expenditures and the number of overseas R&D facilities,etc., some others taking the latter approach argue that these companies still concentrate their R&D activities at home so that their overseas R&D activities do not play key roles in their R&D performances but play roles something as ‘listening posts’.

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The other issue is that although some of these recent studies mentioned above have noticed, more or less, the tendency towards a international networking of R&D activities, the fact has not necessarilly been revealed concretely.

In this paper, I shed light on these two issues by clarifying their degree of internationalization and networking2 of R&D by three Multinationals, IBM Com, Philips N.V. and NEC Corp. I take an approach here refering to US patents and scientific papers as results of their R&D activities in the areas of industrial technology and basic research. One of the biggest merits of this approach is that nominal R&D operations are eliminated, so that the substantial R&D activities in these two R&D fields can be grasped. However, a critical point to be noted here is that results of R&D activities are not always mirrored on the number of patents granted. Namely, patented technologies could be mainly based on the inventions in the technological fields of industrial engineering centering on hardware technologies. These technologies are, therefore, rather produced in the latter processes of product development in hardware technology fields. On the other hand, the results of basic research which includes software technology fields could be rather assessed by searching through scientic papers published on the technical journals. In fact, by taking this another approach, different overseas R&D patterns have appeared which will be verified in the following section.

At first let us examine the recent geographic composition of overseas R&D facilities of Japanese companies.

2 Geographical composition of 60 overseas R&D operations of 35 Japanese companies

INSERTAR FIGURA 1

Figure1 shows the geographical composition of 60 overseas R&D operations(and/or Labs) of 35 Japanese companies. They are limited to those which were newly established from 1995 to 19973 . As is shown in the figure, the number of R&D operations in North America accounts for the biggest share with 51.7 percent of the total. The following regions are Asia with 26.7 percent, Europe with 20.0 percent and others with 1.7 percent4 . Total number of the

2 The term 'Networking of R&D' can be used in a broad sence including not only joiny research among institutionss, but also licensing agreements and other various kinds of strategic alliances. However, in this paper it ia actually restricted to joint resaerch.

3 The number of these R&D units abroad of the Japanese companies are limited to those which are found out in two the Japanese newspapers, The Nikkeishinbun and The Nikkeisangyoshinbun, over the same period. Some other oversea R&D units which have not been appeared in the newspapers, therefore, are not counted.

4 Other country is Israel whose R&D mission at this point is development of switching technologies for European and Asian markets.

nationalities which these overseas operations of 35 Japanese companies belong to is 11 countries, and the breakdown by the nationalities of these 60 overseas R&D operations are 31 in USA, 7 in UK, 6 in Singapore, 3 in France, China, and Malaysia, 2 in Germany and Thailand, 1 in Taiwan, India, and Israel respectively. According to the figure, the ratio of Asia seems to be much higher comparing with that surveyed by Serapio and Dalton during 1985 - 1991(Serapio and Dalton[1995]5). Apart from these R&D facilities of the companies, other Japanese major companies had already set up R&D facilities in these countries and enforced their foreign operations . When examining overseas R&D activities of Japanese companies in terms of the number of foreign R&D facilities, they seemed to have been active in investing in overseas R&D.

However, R&D activities in Asian operations, among others, seem to be not R(research), but rather largely D(Development) oriented, centering on such engineering work for Asian markets as testing, designing, and other adaptation work which are still out of patentable technological reach.

Those in Europe and the US seem to be R oriented for global market, except such automobile companies as Toyota and Akebono in the US and Nissan in UK, whose R&D missions are mainly development for local and regional car markets. As a whole, Asia appears to hold an important position for overseas R&D locations of Japanase companies in terms of the number of R&D operations.

3 Globalization and networking of R&D at the level of industrial technology (industrial engineering)

Industrial engineering in R&D activities is rather addressed downstream in the process of putting a concept into a product. I examine here to what extent and in what structures the internationalization and networking of R&D activities of these companies have been being conducted in terms of industrial engineering. For this purpose, I emply here the method of searching through US patents so that we can identify who the inventors are and what their nationalities they reside are. The main reason to search through US patents can be found that the more important invented technologies which are expected to exploit on a world wide level, the more they are tended to be applied for to the US which has a biggest market as a country and

5 According to their survey, Asia accounts for

many competitors in the technology fields. US patent data based on this section are obtained through [INPADOC] which is a database on patenting infomation.

(a) Globalization and networking of R&D activities of IBM Com. in the fields of industrial technology

INSERTAR TABLA 1

Table 1 illustrates a classification of the numbers of patents acquired by IBM Com in the U.S. in 1980, 1985, 1990 and 1995 by the nationalities of research institutes to which researchers who invented the patented technologies belong. As is clear from the table, the numbers of U.S. patents invented by researchers at IBM institutes inside and outside the United States have both tended to grow, consequently causing the total number of US patents granted to IBM to increase significantly. On the other hand, while the ratio of U.S. patents granted to technologies invented solely and jointly by IBM institutes overseas has remained almost the same, around 15percent, the number of US patents attributable to the IBM oberseas' inventions also increased steadily since 1985.

In order to further clarify these trends, the searching results are verified by putting them into diagram form with additional consideration given to the details of joint inventions. Figs. 1 and 2 are schematic diagrams showing the trend of internationalization and networking structure of R&D in the four respective years over the same period, based on the numbers of U.S. patents obtained by IBM's R&D facilities in different countries. The following five points could be pointed out from these diagrams:

First, as already examined above, a steady increase is observed in the number of patents granted to inventions developed by researchers who appear to belong to overseas IBM research institutes. Second, the number of nationalities to which researchers who invented these U.S.-patented technologies belong has also increased steadily. The number of such nationalities was four in 1980, seven in 1985, ten in 1990, and eleven in 1995, which is rather a sharp upward movement over the years. Third, the number of joint inventions between inventors whose nationality is the U.S. and those with other nationalities has also increased, from 2, 11, 16 to 42, along with the number of nationalities of non-American researchers who were involved in IBM's joint inventions, which has shown an increase from 2, 5, 9 to 12.

The fourth point is that joint inventions with such Asian researchers as Korean and Taiwanese appeared in 1990 and in 1995, respectively, in addition to the appearance of two new-type joint

inventions characterized by the involvement of researchers with three different nationalities, that is, the U.S., Brazil and France for one and the U.S., France and Taiwan for the other.

The last notable point is that the number of U.S.-patented technologies that were invented by researchers belonging to domestic IBM research institutes has also been increasing in line with the number of U.S. patents granted to inventions by overseas IBM researchers.

From these five points, considering the fact that the ratio of U.S. patents granted to domestic IBM inventions of the total number of U.S. patents acquired by the entire IBM has not decreased, it would be reasonable to conclude that IBM has enhanced its R&D capabilities or technological development strength on a global basis by reinforcing its overseas R&D structure. Since IBM's domestic R&D capabilities have also been strengthened, it cannot be argued that its dependency on overseas IBM research institutes has increased. It would seem rather that the enhancement in the R&D networking with overseas IBM research institutes has in consequence led to the strengthening of domestic IBM research institutes in their R&D capabilities.

(b) Internationalization and networking of R&D activities of Philips N.V. in the field of industrial

technology

Philips N.V. has main laboratolies in 6 countries6 which comprise Netherlamds, Germany, United Kingdom, France, United States and Taiwan. The total number of researchers of the labs is 2,835 as

of 1998 . The number of US patents which Philips obtained in 1985 is 527, of which that attributed to overseas inventions that Netherlands has not been involved amount to 49.8 percent. In addition, the number of international joint inventions between Netherlands nationalities and foreign nationalities is 19 accounting for 3.6 percent of all. In consequence, when taken these figures together, internationalization of R&D of Philips in 1985 in a broad sense, gets to 52.4 percent. Whereras the ratio in a narrow sence in 1995, on the other hand, declined slightly to 45.6 percent, that in a broad sence is still over 50 percent. The interesting point to be identified

6 The breakdown of the nationalities of the labs is as follows;
Netherlands : 1,700(Philips Natuurkundig Laboratorium), Germany : 400(Philips Forschungs Laboratorien)
United Kingdom : 270(Philips research Laboratories), France : 190(Laboratories d'Electrique Philips S.A.S)
United States : 250(Philips Res.-USA), Taiwan : 25(Philips Innovation Center Taipei)
Since examining years are 1985 and 1995 respectively, Philips Innovation Center Taipei which was recently established may not have played an important role yet.
It is to be noted that patentable inventions can not nessesarily be made by researchers at labs, but by engineers at R&D facilities of divisions in the fields of electric & electronics technologies. Therefore, overseas R&D sections in Austria or Belgium seem to play an important role.

here is that the number of nationalities of researchers or engineers involved in the inventions excluding Netherlands has increased from 11 to 14, and that of the cases of international joint inventions including Netherlands has also increased from 10 to 15 over the same period as are illustrated in Figure 3 and 4. In this regard, the results appear to indicate that while internationalization of R&D of Philips has stabilised over these years, it evolved its R&D activities towards a more internationalized networking structure.

INSERTAR FIGURA 4

(c) Internationalization and networking of R&D activities of NEC Corp. in the field of industrial

technology

As Figure 5 reveals, of 180 US patents that NEC obtained in 1985, the number attributed to overseas invention was only one which was invented by an American researcher(or engineer), and the remaining 179 US patents were invented by its Japanese R&D staff members. Accordingly, the percentage ratio of the domestic inventions in Japan accounts for 99.4 percent of all. On the other hand, of 1,043 US patents that NEC acquired in 1995, the number by overseas inventions was 30 comprising of 29 American and one German, which still accounts for only 2.9 percent of the total.

In addition to these overseas inventions, one international joint invention between Japanese and American researcher(or engineer) was found. The other remaining 1,012 US patents which accounts for 97.0 percent of all, were invented in NEC's domestic R&D facilities.

Therefore, when we examine the internationalization of NEC's R&D activities from the point of patented technologies, the ratio is still well under five percent, although the absolute number is getting to increase. What is further to be noted is that overases R&D activities of NEC is still virtually restricted only to the US. It indicates, therefore, that as far as patented technologies are concerned, although internationalization of R&D of NEC is steadily developing, it has not reached a stage of globalization. In this sence, it seems to be quite appropriate to conclude that NEC has concentrated its R&D activities at home in the fields of patented technologies.

INSERTAR FIGURA 5

4 Internationalization and networking of R&D activities at the level of basic research

While industrial engineering or industrial technologies which mainly comprise the patentable technologies are positioned fairly downstream along the flow of R&D activities, basic reaserch is positioned in the upperstream in the process. The analytic approach employed here, for verifying the internationalisation and networking structures of basic research activities, is to search for the scientific papers published in the name of IBM, Philips and NEC, and classify them according to the R&D facilities their authors belong to (Hayashi[2]). Data used for this purpose are obtained from the [JOIS] database of the Japan Information Center of Science and Technology (JICST). The target of this search is the first 1,000 papers in the order of publishing among the scientific papers published in the name of IBM in 1981 and 1994, and all those of Philips and NEC papers published in the USA in 1985 and 1995. We should be cautios ,however, how far scientific papers reflect the basic research capabilities of companies. Whereas Sony Corp. or Canon, for example, hold competitive basic research capabilities, the number of papers in their names published in the US are quite limited. Researchers in these companies do not seeme to be encouraged to write papers so as to obtaine paptents. In consequence, the numbers of papers in the name of SONY and CANON published in the US in 1995 are less than 10 percent and 40 percent as many as that of Philips N.V's respectively. On the other hand, while the numbers of US patents obtained by SONY and CANON in 1995 are 2 times and 1.5 times as many as that of Philips in the same year. It could not be concluded that the basic research capabilities of these Japanese companies are ten percent or fourty percent as much as that of Philips'. However, although it implys some drawbacks, examining the trends of papers of companies in detail could provide us such useful information as internationalization (and/or globalization) and networking of R&D activities of companies.

(a) Globalization and networking of R&D activities of IBM Com. in the field of basic research

The numbers of scientific papers published by IBM researchers in the name of IBM in 1981 and 1994 are 4,045 and 1,902, respectively7 . Table2 shows the results of searching through the first 1,000 papers published in the respective years and classifying them by countries in which the research institutes the IBM authors belong to are located. The reasons for limiting the search to scientific papers are to verify the quantitative share of each country resided by authoring IBM

7 : The numbers of papers published in the name of IBM based on a search through JOIS for respective years are as follows (the search was conducted in July 1996):
1981 : 3,855, 1982 : 4,160, 1983 : 4,359, 1984 : 4,384, 1985 : 4,045,
1986 : 3,436, 1987 : 1,904, 1988 : 2,146, 1989 : 2,259, 1990 : 2,411
1991 : 2,327, 1992 : 2,200, 1993 : 1,899, 1994 : 1,902 (Hayashi[3])

researchers and those who belong to other institutions participated in the joint research with IBM at the level of basic research, thereby to determine the extent of internationalization and networking of IBM's R&D activities at the level of basic research.

INSERTAR FIGURA 6

Fig. 6 classifies the targeted 1,000 IBM papers published in 1981 by nationalities of institutes the authors belong to, with the number of papers jointly authored with researchers at an institute in another country taken into account. As shown in this figure, the number of papers published by researchers belonging to IBM research institutes in the United States is 939, representing 93.9 percent of the 1,000 papers. Among them, however, are 23 papers authored jointly with an overseas institute other than IBM and 1 with an IBM institute overseas. After subtracting these, the total number of papers consisting of those published solely by IBM institutes in the U.S. and those jointly published by U.S. IBM institutes with non-IBM institutes in the United States is 916 (91.6 percent).

By contrast, IBM papers published by researchers belonging to overseas IBM institutes, including those papers jointly published by them with overseas non-IBM institutes and those jointly authored between IBM research institutes located in different countries outside the U.S, totals 60, accounting for merely 6.0 percent of the total. The nationalities of these IBM institutes are Switzerland, Germany, France, Israel, Austria, England, Italy, South Africa, Spain, Sweden, Norway and Japan (12 countries).

INSERTAR FIGURA 7

Fig. 7 shows a classification by the same method of the first 1,000 papers published in 1994 in the name of IBM. What is to be indicated from a comparison between figure 6 and Fig. 7 are the following four points. First point is a relative decline in the total number of papers solely published by U.S. IBM institutes and jointly published by them with U.S. non-IBM institutes to 7348 , i.e., 73.4 percent. Second is that the number of papers jointly published by U.S. IBM institutes with non-IBM overseas institutes based on international joint research activities increased sharply from 23 in 1981 to 103 in 1994 . Third is an increase in the number of papers published in the name of IBM institutes outside the U.S. (total number of papers solely by overseas IBM, joint papers by overseas IBM and overseas non-IBM, and joint papers between non-U.S. IBM in different countries) accounted for 155 out of 1,000, showing a significant rise

8 The majority of joint research partners is US Universities totalling 88. When examining other remaning papers excluded in the research, the number of Universities parcipated in the joint research with IBM should further increase.

from 5.4 percent in 1981 to approx. 15.5 percent in 1994. Finally, the fourth characteristic is that, although the nationalities of research institutes that researchers who published papers in 1994 in the name of IBM belong to range across 12 countries, which is as many as those in 1981, the number of nationalities of overseas non-IBM institutes that joint authors of the target papers belong to, after excluding the nationalities of overseas IBM institutes that published joint papers in 1994, increased from 3 in 1981 to 10, including East Asian countries.

From the four points mentioned above, the extent of internationalization of IBM's R&D activities at the level of basic research according to the number of scientific papers is evidently growing, demonstrating that a global network of international R&D activities, including joint research with overseas institutes, is under steady construction.

INSERTAR FIGURA 8 Y 9

(b) Internationalization and networking of R&D of Philips N.V. in the field of basic research

As Figure 8 and 9 show, whereas the total number of papers paublished in the USA that researchers of Philips were involved increased slightly from 235 in 1985 to 247 in 1995, that by resaerchers who belong to Philips Netherlands were involved decreased from 124 to 112 over the same period. It illustrates, on the contrary, that the ratio of its internationalization of R&D in the basic research fields has increased in a broad sence from 47.2 percent to 54.7 percent in this decade. It is important to note here that the ratio in a narrow sence which excludes Philips Netherlands, decreased from 41.7 percent in 1985 to 36.8 percent in 1995. Consequently, the biggest reason why the ratio of internationalization of R&D in a broad sence has increased is due to the fact that joint research between Philips Netherlands and overseas institutions, particulary with non-Philips overseas institutions has increased over the same period.

Turning to the degree of networking of R&D of the company, as the figures provide some overview that not only the number of nationalities involved in the joint research papers apart from Netherlands has increased in number and variety, but also the cases of a more diversified international joint research have become prominent.

It could well be summarized that in terms of the number and joint research structures of papers, the basic research capabilities of Philips N.V. would seem to have been maintained through internationalization and a further network oriented structures of R&D.

(c) Internationalization and networking of R&D of NEC Corp. in the field of basic research9

9 : R&D fields and locations of NEC Corp. are as follows:

As is indicated in Figure 10, the number of papers in the name of NEC published in the US in 1985 is 196, of which that by its overseas institutes is seven (:3.6 percent), that by international joint research is three (:1.5 percent), and that by Japanese researchers is 186(:94.9 percent). The papers in the name of the overseas institute the authors belong to are those written by researchers of NEC's US R&D institutes. On the other side, as is demonstrated in Figure 11, the number of papers in the name of NEC in 1995 is 338. Of which that of sole papers by researchers who belong to NEC's US institutes is 36, that of joint papers witrh US local institutions is 44, and that of overseas joint research papers between NEC's US institutes and other overseas research institutes excluding Japan is 14. The number of papers by NEC's overseas research institutes is , accordingly, 124 which accounts for 32.4 percent of all. In addition, the number of papers by international joint research between NEC's domestic R&D institutes and overseas research institutes is 17, which accounts for 3.9 percent of all. Therefore, the number of papers by its international R&D activities, in a broad sense, amounts to 139 which accounts for 34.9 percent of all.

INSERTAR FIGURA 10

This means that while the ratio of the number of papers by its domestic research institutes declined from 94.9 percent in 1985 to 65.1 percent in 1995, that of its overseas institutes increased from 3.6 percent to 23.7 percent over the same period, and that of international research in a broad sense increased rapidly from 5.1 percent to 31.9 percent. What is also to be kept in mind here is that, as are illustrated in figure 10 and 11, its R&D activities are not only internationalized, but also international joint research networking is being drastically established. Interestingly, as figure 11 reveals the extent of networking of US R&D activities of NEC is apparently higher than that of Japan's in terms of the domestic and international joint research.

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(1)Domestic R&D Locations:
1 Central Research Lab(Computers and Communications , established in 1975, Kawasaki)
2 Tsukuba Research Lab.(New Concepts, New Materials, New devices, established in 1989,Tsukuba)
3 Sagamihara Research Lab.(Ulysses, established in 1987, Sagamihara)
4 Kansai Electronics Lab.(Compound semiconductor devices, established in 1991, Ohts)
5 Kansai Research Lab.(Human Interface Field, established in 1990, Osaka)

(2)Overseas R&D Locations:
1 NEC Research Institute(Basic Ryes. in New Materials, devices Mechanisms of Human Logic & Thinking, established in 1989,New Jersey, Princeton)
2 C&C Lab NEC USA(C&C System Technologies, established in 1991, Princeton in 1995, San Jose)
3 C&C Research Lab NEC Europe(C&C Technologies, in 1994, Sankt Augustin, in 1995, Berlin,Germany)

While 55 percent of 80 locally written papers of NEC's US R&D units has been carried out in collaboration with 17 US Universities, 3 companies and 3 scientific institutions, 13.6 percent of 220 those of Japan's R&D units has been conducted in collaboration with only 15 local Universities, 7 companies and 3 other institutions. This indicates that NEC Japan has pursued its domestic R&D projects mainly at its in-house R&D units without intenfying its domestic R&D network with other non-NEC institutions at home. It indicates, on the contrary, that it has enhanced its international R&D networks centering on US R&D units.

INSERTAR FIGURA 11

Internationalization of R&D of NEC Corp. is therefore, in a relative term, more advanced than IBM Com., in terms of basic research, although it is far from globalised. It could be concluded, therefore, that innovative activities of its industrial technologies are mainly carried out domestically, exploiting the theoretical fruits that were created at (and jointly with) its overseas basic research activities.

5 Conclusion

After overviewing the regional distribution of recently established overseas R&D units of 35 Japanese companies, this paper has mainly verified the degree of internationalization and networking of R&D activities of three companies at the level of industrial technology in the fields of industrial engineering, and at the level of basic research by searching through US patents obtained by them and scientific papers published in the name of these companies.

According to the results of searching through the targeted papers, it is viably pointed out that their networking for joint research with their own overseas research institutes, overseas universities, laboratories or other research facilities is steadily progressing and that, at the basic research level, the achievements of overseas research institutes are increasing in weight in the total. Also in the results of searching through the patents, the fact that they acquired an increasing number of patents by technologies newly invented by their overseas R&D facilities is clear evidence that the development capabilities of their overseas R&D facilities at the level of industrial technology are growing.

These tendencies are clearly found out in the case of IBM Com. These trends can be observed not only from the increase in the number of IBM's R&D facilities overseas that published papers and those that invented patented technologies, but also from the progress in the

globalization of IBM's joint research network with a wide variety of R&D institutes overseas. These trends further suggest the following two possibilities. The first possibility is that IBM may have succeeded to a sufficient extent in establishing a system to subsume achievements gained through the internationally distributed technological development capabilities into its domestic system, thereby leveraging the relatively decreasing technological development capabilities of U.S. IBM alone. The system thus established has allowed IBM to ensure relative enhancement of its enterprise-wide technological development capabilities by addressing globally and strategically the relative decrease in the technological development capabilities held by U.S. IBM alone. The second possibility is that the establishment of global R&D structure by IBM may have led to the construction of a global transfer system for technological information that allows R&D achievements to be transferred instantaneously to overseas R&D operations on a global scale via the global intra-firm R&D structure. This successfull established global intra-firm R&D structure in turn implies that the more this structure play the role of taking in the results of R&D activities by overseas R&D facilities, the more these results disperse globally.

In the case of Philips N.V. the extents of internationalization of R&D interms of patented technologies and basic research which demonstrate the highest among three multinationls investigated here have both tended to be stabilised around 45 - 50 percent over this decade. It is interesting to note, however, that the extents of networking of its R&D activities in terms of these technologies have steadily been enhanced so that it seems to have made extensive use of overseas R&D resources and maitained its R&D competitiveness.

Finally, whareas the extent of internationalisation of NEC’s R&D activities in terms of patented technologies has stayed under 5 percent over this decade, that in terns of basic reaserch has been drastically increased over the same period. Regarding to the extent of its networking of R&D in terms of patented technologies it does not seem likely that NEC has enhanced its overseas R&D capabilities in the fields of patentable technologies. By contrast that in terms of basic research has been prominently progressed centering around US. However, it could not be concluded yet at this moment whether NEC Corp. would further follow these trends or not.

As a summary, when considering the number of overseas R&D units and possibly other R&D input factors of Japanese companies, Asian position would seem to be overestimated. However, when considering the number of patents invented by their foreign R&D units, Asian position for Japanese companies and also internationalization of R&D of the Japanese companies would seem to be underestimated. The main reason, it would seem, is that R&D units of

Japanese companies in Asia still mainly play a role as a technology transfer unit from Japan to adapt to local needs. Finally, as a concequence of searching through scientific papers, R&D actinvities of such Japanese company as NEC appear to be evolving towards internationalisation and networking at a much higher ratio than other such multinationals as IBM or Philips in terms of basic research.

From the findings above, althogh our sample is too small to draw any firm conclusions, I would dare to conclude that current trends in the globalization and networking of R&D activities by multi-national enterprises are moving toward the establishment of a global-scale system for centralizing and dispersing technological information. Thus, as the multi-polar technological development structure manifests itself increasingly, the tactical importance of networking and globalization of R&D activities grows in international business strategies.

INSERTAR FIGURA 12

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