Foreign R&D Activities of Swiss Multinational Enterprises: Trends, Drivers and Implications at Home

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Abstract: Based on a questionnaire survey sent to the most innovative Swiss multinational enterprises (MNEs) and an analysis of their patents and patent citations, this research explores different issues: (1) the level and pace of the internationalization of research and development (R&D) activities, (2) the motives of foreign R&D activities differentiated by developed, developing host countries and China, (3) the role of the home country as a source of knowledge, and (4) the intra-firm reverse knowledge transfer. The results show that Swiss MNEs perform an increasing share of their R&D activities abroad with a strong emphasis on the demand side motive. The main partners are a few developed countries, but MNEs invest and will continue to invest strongly in China and Asian countries. Nevertheless, even if data show that the share of Swiss inventions in the total inventions of Swiss MNEs is decreasing, home country still remains the most contributor to its MNEs' innovations. Finally, knowledge transfer to parent company is mostly related to local customers and markets, and its high specificity makes the transfer difficult. This implies that reverse knowledge transfer concerns mainly adapting activities in the case of Swiss MNEs.

Introduction

The purpose of this paper is to participate in the ongoing research on the effects of outward foreign direct investments (FDI) in R&D on home economies. This subject has been less explored than the

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effects of outward FDI in production activities or in low-value-added activities, as high-value-added activities such as R&D services were undertaken mostly in the country of origin (see for example Patel and Pavitt, 1991). However, evidence from recent studies indicates that R&D activities operated abroad have strongly increased since 1990, limiting the argument of non-globalisation of high-value-added functions. As R&D plays a part determining for the competitiveness of national economy, this trend towards the internationalisation of R&D has an ever larger impact on the policy makers' agenda and has been the subject of official reports (see for instance UNCTAD, 2005). Discussions on this issue have involved different dimensions. On the one hand, the internationalization of R&D activities allows MNEs to learn from others and acquired specific knowledge located in host environment. Home economy can benefit from this dispersion when the acquired knowledge in foreign location is transferred to the parent company. On the other hand, the internationalisation of R&D activities leads to concerns from both MNEs (depleting their proprietary technologies by interacting with foreign partners), and home countries (loss of technological capacity, the "hollowing out" effect). This study contributes to this subject through an empirical investigation based on a firm-level panel data of 71 Swiss MNEs. First, theoretical basis of the impacts of outward FDI in R&D on home countries will be outlined. Then, research issues and results from an econometric analysis of patents and patents citations, as well as data from a questionnaire, will be presented.

Effects on home countries

The geographical dispersion of innovation facilitates the technological development of the firm and influences its productivity (Branstetter, 2000; Braconier et al., 2001; Van Pottelsberghe de la Potterie and Lichtenberg, 2001; Shimizutani and Todo, 2007; Kotabe et al., 2007). According to the theory of international business, the competitive strength of MNEs is improved through their access to specific assets in the host country, which are complementary to the specific assets the MNE already owns and which are not readily available in the country of origin. Indeed, Dunning, in his eclectic paradigm (Dunning, 1979, 1988, 1993), stated that *"Enterprises engage in production abroad whenever they possess net competitive advantages over firms of other nationalities which can best be exploited by foreign rather than domestic production, and which are more profitable to internalize than to sell or lease to other enterprises"* (Dunning, 1979, p. 289). Thus, the motive to move abroad is to use the

firm's competitive advantages in conjunction with factor advantages in a foreign country. In the case of R&D activities, factor advantages of the host country relate to the possession of assets as specific skills, knowledge or technological capacities; knowledge of the local market (tastes, needs, regulations, education levels); availability of qualified labour; and low costs of R&D activities.

MNEs must install subsidiaries in host countries to benefit from these advantages, as knowledge remains to some extent localised and cannot be transferred easily across border. Thanks to their physical presence, MNEs can acquire knowledge through meetings, workers mobility, brainstorming sessions or training. Home countries can profit from this dispersion through the transfer of knowledge from foreign subsidiaries to parent company (the so-called “reverse technology transfer”, see Criscuolo, 2002; Frost and Zhou, 2005). This knowledge transfer can occur between subsidiaries of MNEs and its parent company ("intra-firm reverse technology transfer"), and can then spread to other domestic companies in the home country ("inter-firm reverse technology transfer"). There are thus three possible steps in the transfer of knowledge: from the local environment of the host country to the MNE's subsidiary, from the MNE's subsidiary to the parent company and from the parent company to the local environment of the country of origin[2]. However, “knowledge transfer is a complex phenomenon and in practice, successful transfer is often not easy to achieve” (Easterby-Smith et al., 2008, p. 677). In a study of 98 subsidiaries belonging to 15 Swedish MNEs, only 10 percent could be categorized as "Integrated Players", while the majority had a very low degree of integration of knowledge with the rest of the MNE (Andersson and Forsgren, 2001, cited by Forsgren, 2008). The results were the same in the survey of 255 foreign subsidiaries of German MNEs (Kutscker and Schurig, 2002). The difficulties of transfer can be summarized in three reasons. First, knowledge is more easily acquired when the MNE is embedded in the host region. Indeed, knowledge is disseminated more quickly and easily when the MNE has links with suppliers, clients, competitors, research institutions, universities or industry associations. Secondly, transfers work better if receivers of knowledge have the required absorptive capacity. This means that employees must understand, implement and assess the value of knowledge, and, in addition, should not be reluctant to learn new ideas. And thirdly, geographical distances create practical obstacles to person based communication mechanisms, which is the best way to transfer new knowledge. Indeed, according to Rabbiosi and

[2] In fact, knowledge transfer may take place through MNE in at least five different forms (e.g. Gupta and Govindarajan 1991; Rabbiosi and Piscitello, 2007): (i) flows from parent company to subsidiaries, (ii) flows from subsidiaries to parent company, (iii) flows from local environment to subsidiary, (iv) flows from subsidiary to local environment, (v) flows to peer subsidiaries. However, in the subject of the implications of home country, the three flows mentioned in the text are the most relevant.

Piscitello (2007), codified communication (for instance written media) is a much less effective way of transferring knowledge than personal communication (inter-unit trips and visits, international committees, training involving participants from multiple units), which facilitates the development of interpersonal ties in the MNE.

Furthermore, personal communication generates difficulties through differences in the cognitive knowledge, specialization, language, social norms and identities of individuals, as well as the possible unwillingness of participants to reveal what they know and pass their capabilities to others (Buckley and Carter, 2004, p. 376-7). These differences could decrease with connections and frequent interactions between individuals. However, geographical and temporal distances create practical obstacles to interactions, given the difficulties to meet easily. It is therefore essential to increase the connectivity within the MNEs in one way or another in order to make effective internal mobility of knowledge (Makela et al., 2007, p. 17). Furthermore, a gap in the vision adopted by the parent company and the perspective of subsidiaries can result in conflict or incomprehension (Buckley and Carter, 2004, p. 377), which may be reduced during interactions of units within the MNEs.

In summary, transfer of knowledge requires:

(Transfer between the host country and the subsidiary):

- Embeddedness of MNE in the local environment
- Absorptive capabilities of the subsidiary

(Transfer between the subsidiary and the parent company)

- Communication between subsidiaries and parent company
- Common vision between the parent company and the subsidiaries
- Willingness to absorb and share knowledge
- Absorptive capacities of the parent company

(Transfer between the parent company and the actors in the country of origin)

- Links between actors and the MNE
- Absorptive capacities of the actors
- Willingness to learn new ideas

Negative effects of outward R&D can also occur. First, MNEs, and accordingly their country of origin given that the key technologies of MNEs are often developed there, can lose control over their proprietary technologies by interacting with foreign partners and thus lose a strategic position in

international markets. This stems from the fact that the technologies of MNEs can fall into the hands of competitors abroad. Secondly, firms can displace R&D from their country of origin to foreign locations. In theories of international business, MNEs were generally expected to exploit abroad their competitive advantages developed in the home country (see Hymer, 1960; the traditional product cycle theory, Vernon, 1966; or Caves, 1974). According to Rugman (1982, p. 20): “the key factor influencing the location of multinational branch offices is the ownership advantage developed in the home nation and exploited abroad to satisfy local markets”. These traditional approaches to the multinational growth argued that learning of knowledge consists predominantly of a one-way movement of technologies from headquarters to affiliates. In centralising R&D activities in their home country, MNEs can benefit from economies of scale, facilitate the coordination and the control of R&D investments in being closed to headquarters which closely monitor such activities, limit the risk of imitation and the leakage of information, and finally decrease the costs of communication and coordination. Besides, according to Narula (2002), companies are embedded in the innovation system of their country of origin. Indeed, they are familiar with the environment, and a change of system is long and costly. Thus, the high costs of integration in innovation systems of host countries, compared to the relatively low marginal costs to stay in the innovation system of the country of origin, creating inertia that makes companies hesitant to internationalise. Therefore, firms are supposed to operate technological activity mainly in the home country. According to Patel and Pavitt (1999, p. 94), “Even very large corporations in most cases perform most of their R&D at home. As a consequence, companies’ innovative activities are significantly influenced by their home country’s national system of innovation.”

However, internationalization of R&D activities has raised concerns about the decreasing role of home country in the generation of domestic firms’ innovations and a potential result of relocation. Indeed, a new important source of competitive advantage is the capacity of foreign subsidiaries to create innovations based on host country’s technological competences. On the one hand, initial firm-specific technology developed at home can be exploited abroad in order to adapt products or processes to local conditions (“asset-exploiting activities”, Dunning and Narula, 1995; Kuemmerle, 1999). In this context, core activities are concentrated in home countries, and foreign activities enhance the technologies developed at home. On the other hand, domestic R&D activities are not the only sources of knowledge that MNEs exploit. They can also access foreign sources of knowledge to complement their R&D activities at home, or to acquire or create new unique intangible assets, for example, by

gaining access to the O advantages enjoyed by firms in that location (“asset-augmenting activities”). In this strategy, the core of innovative activities may be decentralised and important innovations are produced abroad. Once the MNE becomes embedded in the host national system of innovation, marginal costs of expansion there decline and the MNE has inertia to invest here. If the home innovation system has weakness and the costs of internationalisation are reduced, a relocation of R&D could take place. A point to highlight here is the difference between the firm and the country. MNEs can improve their competitive advantages and increase their number of employees, while the country of origin can lose its competitiveness and jobs. The problem of "hollowing out" lies not in the MNE seeking to improve its competitive position, but in the weakness of the innovation system in the country of origin (lack of qualified labour, specialized knowledge, public expenditures in R&D, universities, technological transfers, adaptation of new knowledge, intellectual property, related industries). Policies have been done in some countries to prevent the relocation. Japan, for instance, attempts to counteract the relocation through an attractive framework for engineering (availability of highly skilled workers, very good infrastructure, significant trade with China, intellectual property legislation, cooperation between universities and MNEs, government support, Arthur D Little, 2007). This points up the new concerns raised by the internationalisation of R&D activities.

Summing up, the internationalisation of R&D offers opportunities, as well as threats, to the economic future of home countries. The next section will assess empirically the relocation issue and then will analyze the intra-firm knowledge transfer.

Research issues

The purpose of this paper is to probe some specific issues concerning the effects of outward R&D on home countries. The case of Switzerland was chosen, because Swiss MNEs have internationalised their R&D activities to a great extent (since 1992, they spent almost the same amount in R&D expenditures abroad than at home). Furthermore, in contributing 34 percent of the total GDP in 2004 (BCG and AmCham, 2007, p. 8), MNEs represent an important part of Switzerland's economy, and play a dominant role in the innovative activities of Switzerland.

First, we will look at the relocation issue by analysing the role of home country as a source of knowledge for Swiss MNEs’ innovation. Secondly, we will examine whether the Swiss economy can benefit from foreign R&D activities through the intra-firm reverse knowledge transfer.

1) Role of the home country as a source of knowledge

One of the potential threats of the internationalisation of R&D activities concerns the relocation of domestic R&D. This section will thus consider whether home country still matters in a context of high internationalisation of R&D. The first proposition in this issue is that relocation occurs when firms decrease domestic R&D while increasing foreign R&D activities. The second proposition assesses that a potential relocation could occur when home R&D activities contribute less to the innovative development of the MNEs than foreign locations. The third proposition is that relocation could occur when the motives of internationalization prevail the motives of centralization.

a) Level and pace of the internationalisation of R&D activities amongst Swiss MNEs

The extent of Swiss MNEs innovative activities operated outside the home country is analysed in this point. Patents are frequently used to reflect the innovative performance of countries, regions, firms, as well as other aspects of the dynamics of the innovation process (OECD, 2006a, p. 6). Advantages and disadvantages of using this indicator have been largely discussed (e.g. Griliches, 1990), and most authors tend to conclude that patent statistics can be useful indicators: "*In spite of all the difficulties, patents statistics remain a unique source for the analysis of the process of technical change. Nothing else even comes close in the quantity of available data, accessibility, and the potential industrial, organisational, and technological details.*" (Griliches, 1990, p. 1702). It has to be noticed that not all inventions are patented and inventions patented are not always innovations. However, patents are a good indicator of the technological production of the firms, as they use patents as legal protection for their most valuable innovations (Filippaios et al., 2007, p. 6).

In this section, patents data indicate the level of the global innovative activities of Swiss MNEs, as patent records include the name and the address of the inventor(s), as well as the name and address of the applicant(s). Assuming that the address of the inventor coincides with the geographical location of the invention (measure used by Cantwell, 1992; Le Bas and Sierra, 2002; Patel and Vega, 1999 among others), this information allows us to identify where the technology underlying the innovation was mainly carried out.

The MNEs included in the data set are headquartered in Switzerland and are the most innovative firms according to patents application (only firms with a minimum of 20 patents during 2004-2006 were included in the analysis). A total of 71 firms were investigated (according to the Industry Classification Benchmark, 32 firms are in the industry "Industrial good and services", 14 in "Health care", 9 in

"Chemicals", 5 in "Personal and Household goods", 4 in "Technology", 3 in "Construction and materials", 2 in "Telecommunications", 1 in "Food and Beverage" and 1 in "Financial services"). The ownership and affiliates structure of the firms were constituted with annual reports and web sites. There may be some errors introduced by the fact that we do not have the complete ownership data for the full period. Spelling mistakes on firms name were verified in a manual process. We were able to identify a total of 39281 patents applied at the European Patent Office during the period 1978-2006.

Patents were selected by their applicants (i.e., the multinational firms groups), and we identified the location of the invention by looking at the inventor's address. Using this information, we were able to identify a total of 96651 inventors, including 36918 inventors in Switzerland and 59733 inventors from 70 different foreign countries. This number of inventors exceeds the number of patents (39281), as some patents have multiple inventors. In this case, we use a fractional counting method (see OECD, 2006b, Criscuolo et al., 2002; Verspagen and Schoenmakers, 2004). For example, if there are *p* inventors in Germany, and *q* inventors in France for the same patent, Germany is attributed *p/(p+q)* of the patent, and France *q/(p+q)*.

Data in Table 1 show that there has been a strong increase in the level of internationalisation of Swiss innovative activities. Swiss MNEs patents generated in foreign subsidiaries amounted to 43.6 percent of the total Swiss MNEs patents in the 1980s, to 54 in the 1990s, to 61.8 between 2000 and 2006. These results confirm that Swiss MNEs locate a growing part of their R&D activities outside the home country. The argument that R&D activities are centralised in the home country is thus no longer valid according to patents data.

The breakdown by partner country reports that Swiss MNEs' inventions are concentrated in a few countries and that Germany (DE), the United States (US), France (FR), United Kingdom (GB), Sweden (SE), Japan (JP), and Italy (IT) are the main partners for Switzerland. In considering only patents invented abroad, Germany accounted for 40.7 percent of all patents, the United States 23.2 percent, France 8.3, United Kingdom 7.1, Sweden 5.9, Japan 3.4 and Italy 3.3.

Table 1. Evolution of the location of Swiss MNEs patents' inventors, 1980-1989, 1990-1999, 2000-2006

Periods	CH	%	DE	%	US	%	FR	%	GB	%	Others	%	Total patents
1980-1989	4550	56.4	1374	17.0	879	10.9	278	3.4	470	5.8	519	6.4	8070
1990-1999	4094	46.0	2301	25.9	1014	11.4	351	3.9	296	3.3	841	9.5	8897
2000-2006	8434	38.2	5266	23.9	3197	14.5	1193	5.4	791	3.6	3171	14.4	22052
1980-2006	17078	43.8	8941	22.9	5090	13.0	1822	4.7	1557	4.0	4531	11.6	39019

In comparing these results with other studies, it could be noticed that Swiss MNEs are strongly engaged in R&D abroad. In Verspagen and Schoenmakers (2004) analysis of 52 European based MNEs, the mean of the share of patents originating from foreign regions with a priority date in 1997 was 0.18. Patel and Vega (1999) showed that European firms have 22.7 percent of their patents granted from foreign subsidiaries (evidence based on US patent statistics). Cantwell and Kosmopoulou (2001) have shown that 11.27 percent of US patents of the world's largest firms were attributable to research in foreign locations during the period 1991-1995. According to Le Bas and Sierra (2002), 58.5% of patents of 13 Swiss firms from their sample were based on R&D activities undertaken abroad (1994-1996). This share was very high in comparison with the 19.5 percent from the total firms of their sample. The overall share of US patents attributable to foreign locations was around 15% in Criscuolo and Patel (2003) study (1996-2000), and Switzerland has the highest share of technological activity abroad (68.3%).

However, assuming that the address of the inventor coincides with the address of the laboratory implies an important bias in Switzerland. Indeed, this country has a relative small workforce and hires a great proportion of frontier workers (for instance, the composition of the nationalities in a big company in Basel is 45 per cent Swiss, 22 per cent German, 22 per cent French and 11 per cent from other European countries). In order to limit this error, another analysis was done through a questionnaire sent to the 71 Swiss MNEs described previously. 23 enterprises responded in June 2008 (response rate of 32 per cent).

The results of the questionnaire show that Switzerland contributes mostly to Swiss MNEs' innovation. The second country of importance is Germany, then the United States and China. Companies will

continue to invest strongly in China and Asian countries (these regions have the strongest tendency to increase). The difference between Table 2 and Table 1 is the presence of China, other European countries and Asian countries.

Table 2. Country distribution of R&D in Swiss multinational enterprises

Country	Degree of importance (0 to 4)	Tendency (-1 to 1)
Switzerland	3.96	.32
Germany	2.38	.38
USA	2.20	.41
China	1.30	.83
United Kingdom	1.22	-.07
Other European countries	1.11	.27
France	1.00	.13
Asian countries (except China)	1.00	.61
Japan	.89	.07
Other developed countries (non European)	.61	.13
Other developing countries	.39	.25

Notes: Each company was asked to rate the contribution of research by country of its own R&D to the technological advancement of the company.
Scale: of no importance = 0, 1, 2, 3, 4 = of major importance
Last column: future tendency: decreasing = -1, 0, +1 = increasing (missing excluded)

To sum up, the percentage of patents owned by Swiss MNEs and invented in foreign subsidiaries has increased (from 43.6% between 1980-1989 to 61.8% between 2000-2006). However, according to the number of patents invented in the main countries, it seems that Swiss MNEs have not reduced their activities at home and Switzerland remains the country where Swiss MNEs do most of their innovative activities (1412 inventions were generated in Switzerland in 2005, 736 in Germany, 560 in the United States and 207 in France, see Table 3). Furthermore, firms have no intention to relocate (the answers of the questions “Does your company intend to relocate Swiss R&D units?” and “Has your company decreased Swiss R&D resources in order to increase foreign R&D resources?” tend to be negatives). Thus, this section assessed that Swiss MNEs have not decreased R&D activities at home while increasing foreign R&D activities. However, this has not been sufficient to discard fears that Swiss R&D is being marginalised at the world level, as the percentage of total foreign inventors has increased at a higher rate (12 percent) compared to Swiss inventors (6.7 percent) or to the overall inventions (9.2 percent) during the period 1980-2005 (see Table 3). Furthermore, the number of patents invented in all foreign countries accounted for 2231, while the number of patents invented in

Switzerland accounted for 1412 in 2005. In other words, the inventions of Swiss MNEs made at home have not decreased, but have grown at a lower rate than their overall inventions.

Table 3. Annual average growth rates of the number of Swiss MNEs patents by inventor's location, 1980-2005

	Period	CH	DE	US	FR	GB	Total foreign countries	Overall patents
Number of patents	1980	299	44	41	15	27	146	445
Number of patents	2005	1412	736	560	207	161	2231	3643
Annual average growth rate in %	1980-2005	6.7	12.5	11.5	11.6	7.7	12.0	9.2

b) Value of R&D activities at home and abroad

Patents data have shown that there has been an expansion of Swiss MNEs R&D activities undertaken in foreign subsidiaries. In order to remain at the head of this international competition, Swiss R&D centres must provide a specific contribution to the international network of R&D (Fleisch Elgar et al. 2007, p. 21). This section will evaluate the contribution of Swiss R&D activities in analysing the value of the inventions made in Switzerland.

To measure the economic and technology value of a patent, we use the number of citations received by this patent (proxy used by Criscuolo and Patel, 2003; Harhoff et al, 1999). Most patent applications include a list of citations to earlier patents that capture "prior art". These citations determine the boundaries of a patent's claims of novelty, inventive activity and industrial applicability (OECD b, 2006, p. 38). A range of indicators based on patent citations have been developed, providing insights into knowledge flows and value of patents[3]. According to Criscuolo et al. (2002, p. 9), "the assumption is that a reference to a previous patent indicates that the knowledge in the latter patent was in some way useful for developing the new knowledge described in the citing patent." In this section, we will identify the most highly cited patents to examine the quality of the foreign technological activities compared to the home country technological activities.

This study builds upon a database constructed by the OECD, named "OECD/EPO patent citations database". The data set includes patent applications to the European Patent Office (EPO), from 1978

[3] For a more detailed discussion of patent citation analysis, readers are referred to Jaffe, Trajtenberg and Henderson (1993); Branstetter (2000); Almeida (1996); Frost (2001); Hall, Jaffe and Trajtenberg (2000) among others.

to 2006. For each published patent application, tables contain information about applicants and inventors (name, country and city), information about the patents (publication and application date and number, IPC code), and information about citations and cited patents (document type, citation lags, for further information, see Webb et al., 2005).

The EPO citations have been chosen because they are less noisy than the citations from the United States Patent and Trademark Office (USPTO). Indeed, in EPO applications, the applicant may optionally supply a list of references to patents. As a result, most of the citations (over 90%) have been added by the examiner. Their philosophy is to keep the number of citations to a minimum. Conversely, in the USPTO, applicants are legally required to provide a list of prior art. Thus, applicants tend to quote every reference even if it is only remotely related to what is to be patented (Michel and Bettels, 2001, p. 192).

Table 4 describes the origin of inventor(s) of cited patents by Swiss MNEs' patents (sample described in the previous section). Suppose a patent X applied for by a Swiss firm cites another patent Y. This last patent Y is a cited patent, and the patent X is the citing patent. In case of multiple cited patents, a fractional counting method is used. For example, if a patent cites 3 different patents A, B, and C, then a fraction (1/3) of the citing patent is assigned to patents A, B, C. With this method, a total of 6620 citations have been enquired from the 39281 patents described in the previous section[4]. Then, if the patent A has 2 inventors, every inventors accounted for 1/3 * 1/2.

The table shows, for example, that the share of cited patents invented in Germany (cited by Swiss MNEs) was 21.9 percent. According to the results, cited patents were mainly invented in Switzerland (24.7 percent). In other words, it appears that R&D activities in home country have a substantial value for the development of Swiss MNEs innovation activities.

[4] Citations received by a patent vary over time: an older patent might receive more citations than a younger patent, because it has been existed for a longer period (Criscuolo and Patel, 2003, p. 23). This effect was not controlled in this paper.

Table 4. Origin of inventor(s) of cited patents, 1978-2006

Country	Frequency	Percent	Cumulative Percent
CH	1637	24.7	24.7
DE	1449	21.9	46.6
US	1282	19.4	66.0
JP	849	12.8	78.8
FR	382	5.8	84.6
GB	379	5.7	90.3
IT	186	2.8	93.1
NL	102	1.5	94.7
Others	354	5.4	100.0
Total	6620	100.0	

We identify the origin of the most highly cited patents to examine the quality of the foreign technological activities compared to the home country technological activities. We define highly cited patents as patents which have been cited twice or more by Swiss MNEs. The 290 highly cited patents amount to 9.3% of overall cited patents. Table 5 shows that the most highly cited patents come from Switzerland. These results confirm those found in the previous table: the home country still matters in the development of innovative activities.

Table 5. Origin of the inventor(s) of highly cited patents, 1978-2006

Country	Frequency	Percent	Cumulative Percent
CH	320	52.2	52.2
US	110	18.0	70.2
DE	76	12.3	82.5
JP	31	5.1	87.6
GB	27	4.4	91.9
FR	17	2.8	94.7
IT	9	1.5	96.2
CA	5	.8	96.9
Others	18	2.9	100.0
Total	613	100.0	

c) Motives of decentralization and centralization of R&D activities

Next tables show the factors inciting and inhibiting MNEs to internationalize their R&D activities. The questions were quite similar to those of Granstrand (1999) to allow a comparison of results. Table 6 reports the motives or the driving forces of internationalisation of R&D. Table 7 reports the motives of

centralization of R&D in the home country.

The strongest driving forces in developed countries were perceived as more important than the strongest driving forces in developing countries and in China. This is consistent with the prominence of developed countries in the destination of Swiss R&D activities. However, the driving forces in China have the strongest tendencies to increase, followed by developing countries, showing the growing importance of China and developing countries as host countries.

Supporting local customers and markets is the strongest driving force in developed countries, developing countries and China. *Creating better access to high qualified labour* has the strongest tendency to increase in developed countries and in developing countries and *Creating better access to foreign science and technology* has the strongest tendency to increase in China. The narrowest motive was *country's regulation* in developed countries (while it was the second strongest motive in developing countries and China). *Being present in a cluster* was the narrowest motive in developing countries, and *local government incitations* was the narrowest motive in China.

These results show that asset-exploiting activities are the leading motives, confirming the results of many studies which suggest that the most frequent motivation for foreign R&D is the customization of existing products and technologies to local market needs (see Love, 2003; Balcet and Evangelista, 2005; Rose and Volker, 2005). Though, asset-augmenting activities have the strongest tendency to increase. "While asset-exploiting activities still predominate as a motivation, the tendency for firms to invest abroad in order to augment their existing assets is now also substantial, and forces scholars of international business to rephrase their enquiries." (Cantwell and Narula, 2001, p.158). See also Pearce, 1999). Furthermore, the results confirm the evolving role of overseas R&D labs shown by Asakawa (2001), from being a receiving point for technologies transferred from the parent company to being a development center for original technologies. According to him, the pace of this evolution is slower for subsidiaries located in developing countries, but in India and China, there is a good possibility that the role of R&D bases will evolve in a very short period of time (Asakawa, 2005). The analyse of Swiss MNEs data show that asset-augmenting activities have increased in developing countries and in China. However, it seems that this motive is already high in developed countries and that MNEs have no intention to increase this motive in these developed countries.

Table 7 lists the inhibiting factors to the internationalization of R&D activities by Swiss MNEs. First, economies of scale in R&D incite MNEs to centralize in the home country. Secondly, the costs of

coordination and communication were the second strongest inhibiting factors. However, the tendency to increase of these factors is generally weaker than those of internationalization. All trends are increasing or neutral in the case of driving forces (apart from *regulations in developed countries*). In addition, the strongest driving forces were perceived as more important than the strongest inhibiting forces. This is consistent with the actual increase in the internationalisation of Swiss R&D, which then could be expected to continue to amplify.

The questions asked was similar to those of Granstrand (1999) questionnaire survey with 24 and 23 responding large corporations in Japan and Sweden, respectively. *Creating access to foreign science and technology* was the strongest driving force in Japanese corporations, while *foreign acquisitions* and the *need for local market support* were the most important driving forces in Swedish corporations. This is different from the strongest driving force in Swiss MNEs, *Supporting local customers and markets*. Thus, it appears as if Swiss MNEs have more emphasis on demand side factors.

The strongest inhibiting factor in Japanese corporations was the *need for close supervision and control of R&D* and thereafter the *costs of coordination and communication*. In Swedish corporations, the strongest inhibiting factor was the *economies of scale*, followed by the *costs of coordination and communication*. In Swiss MNEs, *economies of scale* in R&D was the strongest inhibiting factor and thereafter the *costs of coordination and communication*. Swiss MNEs and Swedish corporations appear to have both the same concerns in the internationalisation of R&D activities.

Table 6. Motives of the internationalization of R&D by Swiss MNEs in developed countries

Motive	**Developed countries**		**Developing countries**		**China**	
	Imp.	Ten.	Imp.	Ten.	Imp.	Ten.
Supporting local customers and markets	2.48 (1)	.20	2.00 (1)	.39	2.40 (1)	.47
Creating better access to foreign science and technology	2.40 (2)	.00	1.11 (7)	.41	1.70 (6)	.68
Creating better access to high qualified labour	2.22 (3)	.47	1.53 (3)	.50	1.84 (3)	.56
Supporting local production	2.16 (4)	.00	1.50 (5)	.22	1.74 (4)	.38
Being present in a local cluster	1.95 (5)	.18	1.05 (9)	.41	1.58 (8)	.53
Local ambitions among subsidiaries	1.57 (6)	.21	1.50 (5)	.36	1.62 (7)	.46
Creating better access to cost-effective supply of R&D personnel	1.56 (7)	.25	1.53 (3)	.40	1.71 (5)	.38
Local government incitations	1.56 (7)	.06	1.06 (8)	.25	1.38 (9)	.31
Having a R&D operation in a foreign country makes this market more accessible due to country's regulations	1.50 (9)	-.06	1.58 (2)	.18	2.05 (2)	.35
	All countries					

	Degree of importance	Tendency
Acquisition of R&D units through the acquisition of a company (the first motivation was not to acquire the R&D capabilities)	2.13	.47
The first motivation of the acquisition was to acquire R&D capabilities	1.18	.53
Failure of the Swiss innovation system	0.63	-.06
Your R&D activities abroad are in technological areas or fields that are weak in Switzerland	1.10	.22

Notes: Each company was asked to indicate the relative importance of the motives and driving forces behind the company's internationalization of R&D.

Table 7. Motives of centralization of Swiss MNEs' R&D in the home country

Motive	**Degree of importance**	**Tendency**
Economies of scale in R&D	2.24	.21
Costs of coordination and communication	2.18	.10
Risk of imitation	2.09	.25
Need for close supervision and control of R&D	2.00	.05
Risk of leakage of information	2.00	.15
Embeddedness in the Swiss innovation system	1.85	.05
Government policies in host countries make R&D there difficult	1.23	.00
Government policies in Switzerland incite the centralization of R&D	.78	.00
Need to have R&D close to the Swiss market	.64	-.25

Notes: Each company was asked to indicate the relative importance of the inhibiting factors to internationalization of R&D.

This first section demonstrated that home country still matters in a context of high internationalisation of R&D and that Swiss MNEs have not relocated and do not intend to relocate their R&D activities. Indeed, the data show that firms have not decreased domestic R&D while increasing foreign R&D activities. Further, home activities contribute more to the innovative development of Swiss MNEs than foreign activities. However, the motives of internationalisation prevail the motives of centralization, confirming that Swiss MNEs locate a growing part of their R&D activities outside the home country and giving some concerns about a potential relocation. Nevertheless, *Supporting local customers and markets* was the strongest driving force, and this prevalence of asset-exploiting motives corroborates that home country contributes mostly to Swiss MNEs' innovation in the sense that foreign location exploit home R&D activities.

2) Transfer of knowledge

MNEs increase their productivity with their access to specific advantages of the host country, in

particular specific knowledge. This internationalization affects the country of origin through the knowledge transfers and increased demand for goods or services. In this section, we analyse the intra-firm reverse knowledge transfer (flow of knowledge from R&D subsidiaries to MNE's parent company) to take into account the integration of knowledge from foreign locations to home location. The responses show that the transfer of knowledge from parent company to foreign subsidiaries is higher than from foreign subsidiaries to parent company (see Table 8).

Table 8. Benefits of reverse knowledge transfer

Question	**Degree of importance**
Do your Swiss units use knowledge from your foreign R&D subsidiaries?	2.22
Do your foreign R&D subsidiaries use knowledge from your parent company?	3.11
Is the knowledge transferred from the parent company to the subsidiaries higher than the knowledge transferred from the subsidiaries to the parent company?	2.56

Notes: Each company was asked to rate to which extent it agrees with the propositions about the relationship between foreign R&D and Swiss R&D activities.

This situation is first related to the motive of internationalization. Indeed, as foreign subsidiaries adapt products to market, they exploit the innovations created at home. In this case, parent MNEs in Switzerland possess valuable capabilities that subsidiaries can exploit in local markets. This confirms the importance of the home country in the technological advancement of the firm and the leading motive of asset-exploiting activities found in the previous section. In consequence, the knowledge transferred from foreign locations should be related to local markets. Thus, Table 9 reports that the knowledge transferred is mostly related to *local customers and markets,* then *to local ideas*. The knowledge transfer about *local science and technology* has the strongest tendency to increase. Knowledge related to *local processes and local products* has the weakest degree of importance and tendency to increase.

Table 9. Type of intra-firm reverse knowledge transfer

Type of knowledge transfer	Degree of importance	Tendency
The knowledge transferred is related to local customers and markets	2.45	.21
The knowledge transferred is related to local ideas	2.10	.35
The knowledge transferred is related to local science and technology	1.95	.55
The knowledge transferred is related to local products	1.84	.17
The knowledge transferred is related to local processes	1.80	.06

Notes: Each company was asked to rate to which extent it agrees with the propositions about the types of knowledge which were transferred from the foreign subsidiaries to the parent company.

Secondly, reverse knowledge transfer is much more difficult than conventional transfer from parent to subsidiaries (Yang et al., 2008, p. 5). Table 10 shows the difficulties of intra-firm reverse knowledge transfer. *High specificity* was the most important difficulty, followed by *it does not have knowledge/technology relevant for the parent company*. These results coincide with the driving forces "home-base-exploiting" described in the previous section. Indeed, when MNEs adapt products to market, the knowledge is specific to the host market and is not relevant for the parent company.

Geographic distances, communication and coordination mechanisms, cost of adaptation, cultural differences and codifiabiliy are not important barriers to knowledge transfer. Thus, barriers to communication seem to be relatively weak within Swiss organizations.

This analysis of reverse knowledge transfer has a limit. According to Yang et al. (2008), knowledge characteristics are important in reverse flows to headquarters. This means that reverse knowledge transfer should be differentiated by asset-exploiting activities and asset-augmenting activities. In the study of Yang et al. (2008), subsidiaries whose knowledge is more relevant are able to transmit significantly larger outflows.

Table 10. Difficulties of intra-firm reverse knowledge transfer

Barriers to knowledge transfer	Degree of importance	Tendency
High specificity	2.07	0.15
It does not have knowledge/technology relevant for the parent company	1.81	0.08
Technological incompatibility with the parent company	1.50	0.00
It has competence/technology inferior to those available at the parent company	1.44	0.00
Resistance from the receiving unit	1.44	-0.36
Geographic distance makes the knowledge transfer difficult	1.37	0.00
Weak/poor communication and/or coordination mechanisms	1.19	0.00
Too high costs required to adapt the competence to the new context	1.06	-0.08
Cultural incompatibility with the parent company	1.06	-0.15
Low codifiability	0.67	-.10

Notes: Each company was asked to declare why the the subsidiaries' knowledge was not transferred to the parent company.

Conclusion

This paper provides empirical evidence for the hypothesis that home countries still matter in a context of high internationalisation of R&D, and that fears of "hollowing out" should be limited. It also provides evidence on the nature of knowledge transfer and classifies difficulties of transferring knowledge between units within the boundary of the MNE. Findings can be summarized as follows.

There appears to be a trend for Swiss MNEs to internationalise their R&D activities at increasingly high levels. The main countries of destination are developed countries, but companies invest strongly in China and Asian countries. Foreign activities are now as essential as domestic activities (in 2000-2006, 61 percent of Swiss inventions were undertaken in foreign subsidiaries). Furthermore, the inventions of Swiss MNEs made abroad have grown at a faster rate than their overall inventions (the inventions made at home have grown at a slower rate than their overall inventions). This situation could be regarded as an indication of a weakness of the Swiss technological competitiveness. However, the examination of patent citations to estimate the value of home and foreign innovations indicates that Switzerland is still the main source of knowledge for the global R&D activities of Swiss MNEs. Using the number of citations received by a patent to measure its technological value, we found that the most highly cited patents came from Switzerland. Furthermore, according to the responses of Swiss MNEs, Switzerland still remains the most innovative country for their innovative

activities, and the creation of R&D centres abroad by Swiss firms has not been accompanied by the closure of centres in Switzerland.

Concerning the motives of R&D internationalisation, asset-exploiting activities are the prevalent type of foreign R&D. Yet, asset-augmenting strategies are becoming increasingly important and create concerns about the technological capacity of Switzerland. Indeed, asset-exploiting activities use and enhance technologies developed at home, as core activities are concentrated in home countries. The analysis of reverse technology transfer has thus revealed that foreign subsidiaries benefit more from Swiss knowledge than Swiss parent companies benefit from knowledge developed in subsidiaries. This corroborates the result of the dominance of asset-exploiting activities, where knowledge consists of a one-way flow from parent company to foreign subsidiaries. High specificity was the most important barrier of knowledge transfer, because foreign R&D activities mostly adapt products to local market conditions.

Conversely, asset-augmenting activities have created mixed effects on home countries: on the one hand, MNEs access foreign knowledge and may make home countries profit from this new source of knowledge. On the other hand, the core of innovative activities could be decentralised and important innovations may be produced abroad, leading to a potential relocation of R&D. However, this concern cannot be upheld in the face of the facts. Swiss MNEs tend to consider Switzerland the ideal place for highly qualified functions. They can thus profit from the strengths of this country, which takes the leading position as the world's most competitive economy in 2006–2007 according to *The Global Competitiveness Report 2006-2007* (Lopez-Claros et al. 2006): world class capacity for innovation; highly sophisticated business culture; well developed infrastructure for scientific research; strong intellectual property protection; well-developed institutional framework; and excellent infrastructure facilities. As a result, the internationalisation of R&D cannot be considered a weakness in the national innovation system, but should be seen as an opportunity to access to complementary assets in foreign locations, which can be transferred to the home country through reverse knowledge flows and enhance the competitiveness of the economy.

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