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Working Paper

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Publication date:
2006

Permanent link:
https://doi.org/10.3929/ethz-a-005118434

Originally published in:
KOF Working Papers 127

KOF Konjunkturforschungsstelle
Swiss Institute for
Business Cycle Research

Arbeitspapiere/ Working Papers

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No. 127, January 2006

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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An Empirical Analysis Based on Firm-level Data

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This version: 20 January 2006

Abstract

Using the OLI paradigm as theoretical framework, we explain econometrically why a firm invests in foreign R&D (model A), and, if it does, which factors determine the level of foreign R&D expenditures (model B). It turns out that the pattern of explanation is quite similar for both types of decisions. In both cases, O- and I-advantages are the main drivers of foreign R&D, whereas L-disadvantages of the Swiss location do not play any role. A descriptive analysis of a series of motives of Swiss firms for performing R&D abroad shows that market-seeking is the most important motive. Knowledge-seeking and (human) resource-seeking are of intermediate importance as motives of foreign R&D, whereas efficiency-seeking objectives are hardly relevant. These results are fully in line with those of the econometric modelling. The findings of both approaches imply that foreign and domestic R&D are complements rather than substitutes. "Asset exploiting" is more prevalent as a strategy of foreign R&D than "asset augmenting".

Keywords: Foreign R&D, Determinants of foreign R&D, Motives of foreign R&D; OLI paradigm; Asset augmenting, Asset exploiting

JEL Classification: O30

1. Introduction

In the last twenty years internationalisation of Swiss firms strongly increased. In a first phase, this process pertained in particular to distribution and manufacturing activities, meanwhile it increasingly covers R&D as well. This holds true not only in terms of the funds invested abroad (in 1996 for the first time Swiss foreign R&D expenditures were higher than domestic ones),[1] but also for the number of firms performing foreign R&D (Arvanitis et al., 2005). Similar trends are observed in other countries (Veugelers et al., 2005; Narula & Zanfei, 2005).

As a reaction to these developments, there is increasing concern in the public opinion in Switzerland that foreign R&D activities may substitute for domestic ones ("relocation of R&D"), thereby reducing the growth potential of the economy ("substitution hypothesis"). However, it is also argued that internationalisation of R&D is a means to supporting production and sales activities in important foreign markets as well as to tapping into the world-wide pool of knowledge. In this view, foreign R&D is complementing and augmenting the domestic knowledge base, given that the transfer of knowledge to the (domestic) headquarters works sufficiently well ("complementarity hypothesis"). In this case, the internationalisation of R&D is considered as a "natural" further step in the ongoing process of globalisation.

Against this background, we, firstly, investigate econometrically the factors determining R&D activities of Swiss firms at foreign locations: why does a firm invest in foreign R&D at all, and, if it does, which factors explain the amount of its R&D expenditures? Secondly, in the frame of a descriptive analysis, we aim at identifying the importance of several motives for investing in R&D at foreign locations. In doing so, we are able to differentiate certain aspects of the econometric analysis. Thirdly, using the results of the previous steps we evaluate the relative merits of the two competing hypotheses with respect to the relationship between foreign and domestic R&D (substitution vs. complementarity).[2]

In order to investigate these three topics, we use firm-level data stemming from two waves of the Swiss Innovation Survey (1999, 2002), which is based on a sample stratified by 18 manufacturing industries and three industry-specific firm size classes.

The econometric investigation of the determinants of foreign R&D is based on the well-known OLI paradigm (see Dunning, 1993 and 2000). Taking this framework as a point of reference, we explain in a first model the probability of a firm to invest in R&D at foreign locations. To this end, we apply two estimation procedures using the data for the two cross-sections of 1999 and 2002, that is a probit model based on pooled data as well as a "random-effect" probit model based on panel data (unbalanced panel). In a second model, we determine the extent of foreign R&D expenditures, given the decision to perform or not perform R&D at foreign locations. In

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[1] Such a high degree of internationalisation of R&D is quite exceptional (see Benito, Grogaard, & Narula, 2003).

[2] In this paper we do not deal with the intra-firm organisation of international R&D, i.e. the different roles the headquarters and the (various) affiliates play in foreign R&D. This aspect is dealt with, for example, by Pearce (1999) or Manopoulos, Papanastassiou, & Pearce (2005).

this case, a Heckman selection model is an appropriate estimation procedure. By and large, we use in both models the same set of explanatory variables. In this way, we are able to test whether the basic decision "foreign presence yes/no" and the subsequent choice of the extent of foreign R&D are determined by the same variables.

The descriptive analysis of the motives of foreign R&D is based on the firms' assessment of the importance of seven "pull" and "push" factors that may induce foreign R&D. These are grouped into four categories representing different theoretical approaches (Dunning, 2000): cost-reducing/efficiency-seeking and resource-seeking motives (neo-classical theory), market-seeking motives (product cycle model) as well as asset-seeking/knowledge-seeking motives (evolutionary economics) representing a more dynamic, strategy-oriented view of international investment. The analysis of the motives of foreign R&D is a way of differentiating the O- and L-part of the econometric investigation.

Based on the results of the econometric and the descriptive analysis we are in a position to assess whether foreign and domestic R&D are complements or substitutes. In case of the econometric investigation, the "complementarity hypothesis" holds true if O-advantages turn out to be the dominant factors determining foreign R&D activities. The "substitution hypothesis" is supported, if we find that L-advantages outweigh O-advantages as explanatory variables. I-advantages are not related to the two hypotheses in a straightforward way; however, they certainly do not support the "substitution hypothesis". According to the descriptive analysis of the motives of investing in foreign R&D, the "substitution hypothesis" is adequate if cost-reducing/efficiency-seeking motives are dominating. Conversely, if market-seeking motives and/or asset-seeking/knowledge motives (given the technology transfer to the domestic headquarter works sufficiently well) are prevalent, foreign and domestic R&D are complements. Finally, the results for "resource-seeking" motives (in the present context: "ample supply of R&D personnel abroad") are inconclusive, since they may represent cost-reducing/efficiency-seeking motives (lower wages) as well as asset-seeking/knowledge strategies (access to exclusive knowledge in specific fields of technology). In sum, we think that an overall assessment of the two competing hypotheses is quite reliable as it is based on two different approaches.

To date, there is only little evidence regarding the home-country effect of foreign investment in R&D (see the reviews of Blomstrom & Kokko, 1998 and Veugelers et al., 2005). This paper adds to previous empirical work in several respects: firstly, the analysis covers not only large MNE's (as most other studies do), but also small- and medium-sized firms. Secondly, we conduct the analysis of foreign R&D at firm level using a large-scale database. To our knowledge, there are only few firm-level studies that are based on large samples and econometric analyses (e.g. Odagiri & Yasuda, 1996; Andersson, 1998).[3] Industry-level analyses, primarily based on patent data, are dominating (see the review of Veugelers et al., 2005). Thirdly, we analyse the topic based on an econometric model that covers the most important aspects of the broadly-based OLI paradigm. Fourthly, we explain, on the one hand, the decision to perform foreign R&D or to renounce to do so, on the other hand, the choice of the extent of foreign R&D expenditures taking account of a potential sample selection bias. To our knowledge, only the already mentioned paper of Andersson (1998) is dealing in this way with the matter.[4] Finally, since we combine two approaches, i.e. an econometric modelling based on the OLI paradigm and a descriptive analysis of the motives of foreign R&D, we are in a good position to reliably assess the controversial issue of whether foreign and domestic R&D are substitutes or complements.[5]

The set-up of the paper is as follows: In section 2, we shortly describe the database. Section 3 is devoted to the theoretical framework. In Section 4, we present the specification of the empirical model and the results from the econometric analysis. These are complemented and differentiated by means of the descriptive analysis of the pattern of motives for performing foreign R&D (Section 5). Based on the results of the previous two sections we assess whether foreign and domestic R&D are complements or substitutes (Section 6). Finally, we summarise the main findings and draw some conclusions.

2. Data

The firm data used in this investigation stem from two waves of the Swiss Innovation Survey conducted in 1999 and 2002 respectively. The survey is based on a sample (firms with at least five employees) stratified by 18 manufacturing industries and three industry-specific firm size classes, with full coverage of large firms. The questionnaire was sent out to 3113 firms in 1999 and 3052 in 2002. We got responses from 1049 firms in the first wave (34%) and 1361 (45%) in the second one. The response rates are quite satisfactory given the very demanding questionnaire.[6] The structure of the data set in terms of firm size and industry affiliation is similar to that of the underlying sample. For obvious reasons, the present analysis only refers to R&D performing companies. Item non-response, which is a problem arising in any complex survey, further reduced the number of observations we could use in model estimation. The final sample obtained from pooling the data of two waves contains 1137 firms, including 145

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3 At firm level, much of the research is characterised by small survey-based samples. Many of the studies are primarily descriptive and/or subject to simple statistical examination (e.g. Florida, 1997; Kuemmerle, 1999; Granstrand, 1999).

4 Odagiri & Yasuda (1996) estimated the “yes/no-equation” at the company level (probit), whereas the equation explaining the level of foreign R&D expenditures is estimated at the industry-area level (tobit). The two aspects are thus not jointly estimated and there is no correction for a selectivity bias.

5 There is, however, a caveat that refers to the fact that we could not draw on time series data.

6 The two questionnaires can be downloaded from www.kof.ethz.ch.

companies that perform R&D at foreign locations and reported the amount of R&D invested abroad. The sample structure by industry affiliation and firm size is shown in Table A1 of the appendix.

The available data are, to a high extent, qualitative in nature. Some of them are measured on a nominal (e.g. patenting yes/no, R&D co-operation yes/no, etc.), others on an ordinal scale (e.g. intensity measure for innovation inputs, obstacles to innovation). The ordinal variables, measured on a five point-Likert scale, throughout are transformed into dummy variables, with the value 1 representing the scores 4 or 5, and 0 standing for the scores 1 to 3.

3. Theoretical framework

There are basically three strands of theory to explaining international investments of firms. The classical theory of international trade stresses the factor endowment of an economy and implies that a firm's international investments follow the comparative advantages of different locations (see e.g. Mundell, 1957). According to the „new trade theory" firms exhibit specific capabilities (technology, marketing, etc.) that can be exploited at home as well as at foreign locations independently from the economic attractiveness of different countries (see e.g. Helpman, 1984; Ethier, 1986). Transaction cost theory, finally, hypothesises that a firm tends to engage in FDI whenever the costs of setting up and running a transnational hierarchical or network organisation are lower than those arising from external market transactions (see e.g. Buckley & Casson, 1985). In addition to these basic theoretical approaches, there is a whole number of partial hypotheses explaining specific aspects of internationalisation, which are rooted in different "sub-disciplines" of economics such as industrial organisation, management sciences, evolutionary economics, economic geography or finance (see Dunning, 2000).

It dates back to the seventies that Dunning hypothesised that no single approach is able to fully explain a firm's international activity. Therefore, he proposed as framework of analysis an eclectic theory of international production, the "OLI paradigm". In his understanding, it covers the most important theories in a way that it is more than just a sum of the constituent hypotheses. Originally developed to explain international production (Dunning, 1988 and 1993), its most recent version can be applied to foreign R&D as well (Dunning, 2000; see also Cantwell & Narula, 2001).

This extended version of the OLI paradigm stresses more explicitly the strategic aspects of internationalisation based on the "dynamic capability view of the firm" (Teece & Pisano, 1998). In this concept, a firm not only invests abroad in order to increase its efficiency (efficiency-seeking motives) or to get access to resources (resource-oriented motives) or to exploit at foreign locations the assets produced at home (market-oriented motives), but it also locates some activities abroad in order to complement and enrich domestic assets by tapping into the world-wide pool of knowledge (asset-seeking motives representing an "asset augmenting" R&D

strategy). This extension, which explicitly accounts for firm strategies designed for acquiring foreign knowledge and technology, qualifies the OLI paradigm as a comprehensive approach for explaining the internationalisation of manufacturing, R&D and other business functions. The extension of the OLI paradigm did not require a change of its basic structure (Dunning, 2000).

This extended view of the OLI paradigm serves as theoretical framework of the empirical analysis presented in this paper. Let us shortly recall the basic elements of this approach. It distinguishes three groups of variables that explain international engagements of a firm: „ownership-specific“ advantages (O), „location-specific“ advantages (L) and „internalising advantages“ (I)“. In accordance with the “dynamic capability view of the firm”, O-advantages refer to firm-specific capabilities and assets that make an MNE superior to local competitors irrespective of general location characteristics. Such advantages arise from the availability of firm-specific (mostly intangible) assets and capabilities such as human and knowledge capital, property rights as well as specific intangibles related to marketing, organisation, learning, management, governance and trust, finance, experience with foreign markets, etc. (see Teece & Pisano, 1998). L-advantages represent potential gains a firm can realise by optimising its activities along the value chain across locations. In the present context, this type of advantage primarily roots in differences among locations with respect to factors favouring or impeding knowledge creation and use (costs of R&D inputs, R&D-related taxes and subsidies, innovation-related regulatory framework, etc.). I-advantages can be realised through M&A activities or by forming R&D co-operations and alliances as means to internalising market transactions. In this way, transaction costs on the imperfect markets for knowledge and technology may be reduced, appropriability problems mitigated, access to knowledge sources facilitated, etc.

As already mentioned, O- and L-advantages are closely related to specific motives and strategies of foreign R&D activities. Market-seeking motives are reflect O-advantages. In case of this type of motives, which is stressed by the product cycle model of international trade and investment (Vernon, 1966), foreign R&D is a means to support local production and sales, primarily by adjusting and modifying products according to local market needs, based on ownership-specific assets created by the firm at home (“asset exploiting” strategy). Asset-seeking motives, which in the case of R&D activities are more or less equivalent to knowledge-seeking motives, are particularly emphasised in the literature dealing with “technology sourcing” (see, among many others, e.g. Cantwell, 1995; Kuemmerle 1999, Patel & Vega, 1999; Frost, 2001; Le Bas and Sierra, 2002). In this case, the domestically available ownership-specific competencies of a firm are complemented and augmented by assets created by R&D at foreign locations[7] that offer specific knowledge and a high potential for profiting from knowledge spillovers due to

[7] In principle, the development of these competencies would be possible at home as well; however, it would take more time and resources as knowledge production is path-dependent (Criscuolo, Narula, & Verspagen, 2005).

geographical proximity to universities and innovative firms.[8] Such "asset augmenting" R&D strategies also reflect O-advantages. In contrast, the more traditional cost-reducing/efficiency-seeking and resource-seeking motives, which are related to the neo-classical theory of international trade and investment (see e.g. Mundell, 1957), reflect L-advantages. In the present context, since resources primarily refer to the availability of R&D personnel, resource-seeking motives also may be an element of an "asset-augmenting" strategy (access to specific incorporated knowledge). Therefore, resource-seeking motives may also reflect, to some extent, O-advantages.

4. Econometric analysis: model specification and results

4.1 Model A

4.1.1 Specification and estimation procedure

Dependent variable and estimation procedure

In model A, the dependent variable is a dichotomous measure taking the values 1 and 0 (R&D at foreign locations yes/no). The estimation is based on data from two waves of the Swiss Innovation Survey (1999, 2002). We applied two estimation procedures, firstly, by simply pooling the data and inserting a time dummy we performed a pooled probit estimation. Secondly we considered random-effects to take account of heterogeneity and estimated a random effect probit model.

Explanatory variables

In the following, we specify the explanatory variables with the OLI paradigm serving as theoretical guideline (see Section 3). In addition to O-, L- and I-variables, we take account of a firm's market environment and a set of control variables such as firm age, ownership of the firm, sector affiliation, etc. Table 1 shows the specification and measurement of the explanatory variables as well as the expected signs. The correlation matrix of these variables is shown in the appendix (Table A2).

A first group of variables represents O-advantages that are expected to be positively related to performing foreign R&D. Since we deal with R&D activities, we (mainly) focus on knowledge-related O-advantages; other factors such as brand names, specific managerial skills, organisational capabilities are not explicitly taken into account. Firstly, we use measures related to innovation input and output. On the input side, we include a variable representing the intensity of product-related development activities (DPD). At an explorative stage, we also used an analogous measure related to research input that showed no significant effect when inserted

8 The importance of geographical proximity giving rise to knowledge spillovers (externalities) has been stressed in the "innovation literature" many years ago (see Jaffe, Trajtenberg, & Henderson, 1993). The relevance of this aspect is clearly shown in recent econometric studies (e.g. Cantwell & Piscitello, 2005a and b).

alone in the estimation equation. However, we had to drop it from our model because of strong multicollinearity with the variable DPD. In case of innovation output, we employ a measure for patenting activity (PAT). This variable captures, on the one hand, the outcome of R&D investment (and other types of innovation expenditures); on the other hand, patents are property rights that reflect a genuine form of ownership advantages.

Table 1

A second group of O-variables is related to a firm's use of external knowledge that directly enhances the internal knowledge base. In this way, we capture a firm's capacity to absorb external knowledge; this may strongly increase a firm's benefits from investing in foreign R&D (knowledge and technology transfer between foreign and domestic R&D units is more "profitable" if absorptive capacity of the headquarter firm is high). We expected that universities/research institutions and – if a firm is a member of a company group – the parent company and/or sister companies are the most valuable external knowledge sources. However, the variable measuring the intensity of use of university-related know-how had to be dropped from the specification again because of its disturbing influence on other variables. Therefore "knowledge from other group members" (GROUP) is the variable capturing the intensity of use of external knowledge.

We also included the (logarithm of) labour productivity (LQL), which is used as a proxy for O-advantages that cannot be explicitly taken into account due to lack of data (e.g. firm-specific skills in technology management, learning capacity, access to finance, etc.). We also envisaged capturing human capital representing a firm's endowment with firm-specific embodied knowledge. However, exploration showed that the use of this variable "disturbed" the impact of the productivity variable, so we decided to keep only LQL.

Finally, the (logarithm of) sales share of exports (LEXP) is included as an O-variable to capture a firm's experience in doing international business, which, according to the "stages view of internationalisation" (Johanson & Vahlne, 1977), raises the probability of investing at foreign locations. In many cases, going international starts with setting up distribution facilities, whereas R&D activities usually are the final step of this process.[9]

As already mentioned, I-advantages reflect the internalising of market transactions as a means to reduce transaction costs. In the present context such cost may primarily stem from high risks involved in imperfect markets for knowledge and technology (e.g. problems of access to (tacit) knowledge or appropriability problems, etc.). At the empirical level, I-advantages are difficult to measure. Since co-operation in R&D is a frequently used means for internalising knowledge-

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9 However, there is evidence for some weakening of the stepwise process of internationalisation, in particular in case of (small- and medium-sized) high-tech and knowledge-intensive firms; see the review of the literature based on the "network perspective of internationalisation" (Coviello & McAuley, 1999) and the "Born Global"-approach (Rialp, Rialp & Knight, 2005).

related market transactions, we use the dummy variable “R&D co-operation yes/no” (RDCOOP) as a proxy for I-advantages.

Firm size captures some (size-related) factors not explicitly included in the model due to lack of data. Some of them reflect O-advantages, while others are related to I-advantages. For example, large firms are in a better position than smaller ones with regard to international marketing and distribution, access to finance, risk-bearing capacity, etc. (O-advantages).[10] Large firms also are superior to small ones in terms of factors related to I-advantages such as international innovation management (an important instrument for internalising the outcome of foreign R&D activities). Firm size is measured by the number of employees (L); to allow for scale effects, we also include the quadratic term of L.

We use information on the relevance of nine obstacles to innovation in Switzerland (assessment of the firms on a five-point scale) as proxies for L-disadvantages. We hypothesise that a high relevance of a certain obstacle to innovation in Switzerland, is an incentive for Swiss firms to invest in foreign R&D. The nine variables representing obstacles to innovation (O1 up to O9) capture a whole range of (potential) weaknesses of Switzerland as a location for performing R&D (see Table 1). Some of them represent the regulatory framework (taxation, regulation of the domestic product markets, regulation of environment protection or land use), others are related to labour supply (shortage of R&D- and other highly qualified personnel, entry barriers for foreigners on the Swiss labour market); further hindrances taken account of are “acceptance to the use of new technology” and “low level of public support for private R&D”.

A further set of variables characterises a firm’s market environment. We assume that a firm‘s decision to perform foreign R&D is not independent of the market environment in which it operates. However, the impact of the intensity of price and non-price competition (IPC, INPC) is not straightforward. It may be the case that a very competitive market environment forces firms to move nearer to the customer, what may induce market-seeking (sales-supporting) R&D activities (positive sign). Since there are many other strategies to react to an increase of the intensity of competition, the presumed positive effect may be small. In addition to (direct measures of) the intensity of competition, we take account of market structure, which is measured by three dummy variables based on the number of principal competitors (5 or less, 6 to 15, 16-50 competitors, with more than 50 competitors as reference group). We hypothesise that firms operating in oligopolistic markets, either as a large enterprise among other multinational “global players” or as a SME in a ”niche” of highly specialised products, are more likely to perform foreign R&D. Since markets characterised by a large number of competitors are the reference category, we expect a positive sign of the three dummies, with the highest absolute

[10] According to Buckley (1989), restrictions with respect to risk bearing and management capacity as well as to information and access to finance are the most important factors impeding SME’s to become active at a foreign location. This hypothesis has been confirmed for the Swiss case in Hollenstein (2005).

value of the coefficient to be expected in case of the lowest numbers of competitors (up to 5 competitors).

Finally, we control for some (general) firm characteristics that may have an impact on the decision to engage in foreign R&D. Firstly, it may be the case that foreign-owned firms (FOR) are less likely to perform foreign R&D, since they often operate, in the first instance, for the Swiss market (negative sign). Secondly, one may expect that older firms a more likely to perform R&D at foreign locations than younger ones because they had more time to expand to foreign markets in general (what is helpful for the internationalisation of several business functions) or specifically in R&D; therefore we insert (the logarithm of) firm age as another explanatory variable. Thirdly, we add a sector dummy to control for industry effects as well as for a (potential) omitted variable bias; it takes the value 1, if a firm belongs to the high-tech sector, and 0 otherwise. We expect that high-tech firms are more inclined to engage in foreign R&D than low-tech companies.

4.1.2 Results

The results obtained from estimating model A are presented in Table 2. Column 1 shows the findings for the probit estimation with a time dummy (year 2002). The results of a reduced model after dropping the L-variables with insignificant coefficients are presented in column 2. Column 3 contains the results of the random effect probit estimation, column 4 those of the reduced model.

The two types of estimates yield practically the same results. The model fit is satisfactory, since a value of 0.21 for the pseudo R^2 (see columns 1 and 2) is quite high in case of a large number of observations (N=1137).

Table 2

An inspection of the model estimates shows that all variables representing O-advantages are positive and statistically significant. The evidence for innovation input and output is somewhat weaker than for the other O-variables. The use of external knowledge stemming from other companies of the same group seems to be a strong incentive to locate R&D abroad; this result may indicate that group-internal knowledge flows are well-managed, what is an advantage when it comes to an internationalisation of R&D. Export orientation (international business experience) is highly relevant as a factor inducing foreign R&D; this finding is in line with the "stages view of internationalisation". Moreover, labour productivity that captures several not explicitly specified O-advantages (some of them mentioned in the previous sub-section) is a highly important explanatory variable. The same holds for firm size, which captures, in a similar way as the variable "labour productivity", some unspecified (size-dependent) O-advantages, and also is related to I-advantages: we find strong evidence for a positive linear size-effect and a negative quadratic term (decreasing scale effect). "R&D co-operation yes/no", used as a proxy for I-advantages, is highly significant and shows the expected positive sign.

We could hardly find any evidence for L-disadvantages: only one of the nine variables representing a disadvantage of Switzerland as a location for R&D activities (obstacles to innovation) is statistically significant ("excessive regulation of domestic product markets").[11]

Among the variables describing a firm's market environment (intensity of price and non-price competition, market structure), only the first one is statistically significant; intensive price competition seems to push firms to move nearer to the customer inducing market-seeking R&D activities. Finally, neither foreign ownership nor firm age and sector affiliation turn out to be relevant determinants of foreign R&D.

The model estimates clearly show that O-advantages are the main drivers of an engagement in R&D at foreign locations; I-advantages seem to play an important role as well. These results largely confirm an earlier cross-section analysis based on data for 1996 (see Arvanitis & Hollenstein 2001). In particular, we get the same results with respect to the three components of the OLI paradigm (strong impact of O- and I-advantages, with no influence of L-disadvantages), with only minor differences regarding the individual variables.[12]

Odagiri & Yasuda (1996) got similar results for Japanese firms as far as O-advantages are concerned; however, a comparison with respect to I- and L-advantages is not feasible, since these categories of variables are not specified in their model.

4.2 Model B

4.2.1 Specification and estimation procedure

Dependent variable and estimation procedure

In model B, the dependent variable is the logarithm of foreign R&D expenditures. For obvious reasons, we could only use the information on firms that perform R&D at foreign locations. Consequently, we had to take into account a potential sample selection bias through the application of a procedure introduced by Heckman (1976) (Heckman selection model; maximum likelihood estimator). The selection equation (active vs. non-active in foreign R&D) was based on model A (only statistically significant variables).

Explanatory variables

The specification of the explanatory part of model B is a somewhat simplified version of that used in model A. Among the O-variables, we had to drop the innovation input variable DPD because of high multicollinearity with the variable PAT. The sales share of exports was also

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11 The expected negative impact of innovation obstacles may be smaller than one would expect at first glance, since engaging in foreign R&D involves various costs (e.g. co-ordination costs, costs of accessing the foreign location, etc.); therefore a firm may stay at home even if the obstacles to innovation are high (Gassmann & von Zedtwitz, 1999; Grünfeld & Sanna-Randaccio, 2005).

12 We found basically the same pattern of explanation in a study dealing with alternative internationalisation strategies, the most "developed" one including foreign R&D (Hollenstein, 2005).

excluded since experience in international business is relevant for deciding whether R&D activities should be extended to foreign locations, but is not relevant any more when the amount of foreign the R&D has to be determined. There is no difference between model A and B as far as I-advantages ("R&D co-operation yes/no") and L-advantages (obstacles to innovation) are concerned. Whereas firm size was measured by employment in model A, we now use sales (S) since the dependent variable (i.e. the extent of foreign R&D expenditures) is measured in nominal terms. Moreover, the variables representing the market environment and those controlling for firm age and foreign ownership were dropped right from the beginning as being irrelevant for the explanation of the level of R&D performed in foreign locations.

4.2.2 Results

Table 4 shows the results obtained from estimating model B. The first two columns show the two equations of the Heckman model (selection equation in column 1, intensity equation in column 2). The correlation coefficient ρ indicating the strength of the correlation between the selection equation and the equation for foreign R&D expenditures is small and statistically insignificant; hence, there is no evidence for a sample selection bias. The same holds for the reduced model, where the L-variables which were not significant in the full model, were dropped (column 3). Since there is no evidence for a selection bias, we also estimated OLS models based on pooled data with a time dummy (full model in column 4, reduced model in column 5) and an OLS random effect model (column 6). The pattern of explanation for the intensity equation (which is the essence of model B) is more or less the same for all estimation procedures and sets of explanatory variables (full vs. reduced model). Therefore, we comment the results on the whole.

Table 3

The general pattern of the estimates of model B do not differ very much from those for model A. O- advantages remain the most important category of variables explaining foreign R&D activity. I-advantages as measured by the variable RDCOOP are again highly relevant. Moreover, we find that L-disadvantages contribute to the explanation of foreign R&D activity even less than in model A, where at least one of the nine obstacles to innovation was statistically significant. Also with respect to firm size we obtain quite similar results as in model A. In contrast to model A, sector affiliation matters: high-tech firms invest much more in foreign R&D than other manufacturing companies.

To sum up, we find that a relatively small number of variables suffice to explain rather well the extent of foreign R&D investments (satisfactory model fit). Some of these variables represent explicitly specified O-advantages (science-related property rights; group-internal knowledge transfer) and I-advantages (R&D co-operation). At least as important, if not more influential are some structural variables (firm size, sector affiliation) or unspecific O-advantages as measured by labour productivity. We conclude that the main players in the internationalisation of R&D are large, highly productive, science-based high-tech firms that are strongly embedded in intra-group knowledge flows and are capable to internalise the risks involved in imperfect technology markets. Against this background, the firms investing large amounts in foreign R&D are a rather small and specific segment of the firms performing R&D as a whole.

5. Motives of foreign R&D activities

In this section, we present the results of a descriptive analysis of the importance of several (categories of) motives of foreign R&D as assessed by the firms' themselves. As can be seen from Table 4, we distinguished seven potential motives of foreign R&D whose importance the firms that perform foreign R&D had to assess.[13] The seven motives are grouped into the four categories distinguished in the literature (see Section 3): market-seeking, asset-seeking/ knowledge-seeking, cost-reducing/efficiency-seeking and resource-seeking motives. The two proximity-related motives (item 2 and 3) and the transfer of knowledge to the headquarter (item 4) reflect different aspects of the asset-seeking/knowledge-seeking motive; two further single motives, lower R&D costs (item 5) and higher government support for R&D at foreign locations (item 6), refer to two different dimensions of the cost-reducing/efficiency seeking motive. The individual items are aggregated to categories of motives by taking the mean of the corresponding percentages (see lower part of Table 4).

It turns out that market-seeking (item 1) and resource-seeking motives (item 7) are the most important drivers of foreign R&D. Knowledge-seeking motives (items 2 to 4) are of intermediate relevance; however, one element of this category, i.e. "geographical proximity to innovative firms (networks)" belongs to the most important motives. Efficiency-seeking motives (items 5 and 6) are less important than the other three categories; this holds true in particular for item 6 ("higher government support for R&D investments").

Table 4

The pattern of motives quite strongly differs by firm size, with that of large firms being particularly relevant, since they dominate in quantitative terms R&D investment flows to foreign locations. The table shows that market-seeking is by far the most important motive in this firm size class; resource-seeking and knowledge-seeking motives come next, whereas efficiency-seeking motives seem to be almost irrelevant. The results for medium-sized firms apparently hardly differ from the overall pattern, with the exception of knowledge-seeking motives that are of low importance. In case of small firms, market-seeking motives are clearly less important than for the other two size classes. On the other hand, efficiency-seeking motives are more important for small firms than for medium-sized and, in particular, for large firms.

From the pattern of motives we draw the following conclusions: Firstly, the low importance of cost reducing/efficiency seeking motives (in particular in case of large firms) is in line with the econometric analysis according to which L-disadvantages do not influence the level of foreign

[13] For obvious reasons we do not have such information for firms that are not engaged in foreign R&D.

R&D investments. Secondly, since market-seeking motives (in particular in case of large firms) definitely are more important than other motives, we conclude that "asset exploiting" R&D strategies are most prevalent. "Asset augmenting" strategies, though increasingly becoming important (see Section 3), are less relevant, in particular in case of large and medium-sized enterprises. Thirdly, to the extent that resource-seeking motives ("ample supply of R&D personnel" at foreign locations) are related to asset-seeking/knowledge-seeking motives (i.e. facilitating the access to specific knowledge in certain technological fields), "asset augmenting" strategies are more important than it looks at first glance. The same holds true to the extent that resource-oriented motives (R&D personnel) are related to cost-reducing/efficiency seeking motives; in this case, L-disadvantages (R&D labour costs) may be more relevant than suggested above.

6. Are foreign and domestic R&D activities substitutes or complements?

According to the econometric analysis O- and I-advantages are the main drivers of foreign R&D activities, whereas there is hardly any evidence of L-disadvantages. These results indicate that the "complementarity hypothesis" holds true. The analysis of the motives of foreign R&D investments confirms the results of the econometric investigation. Cost-reducing/efficiency seeking motives are quite rare, what corresponds to the result of the irrelevance of L-disadvantages. On the other hand, market-oriented motives ("asset exploiting" strategies) are the most prominent ones, what is in line with O-advantages being the main drivers of foreign R&D. The fact that knowledge-seeking motives reflecting "asset augmenting" strategies are quite relevant as well, at least more important than cost-reducing/efficiency-seeking motives, is again in line with the dominance of O-advantages as drivers of foreign R&D activities.

In sum, there is evidence for the "complementarity hypothesis", whereas we cannot find any evidence for the "substitution hypothesis". In view of these clear results, we are justified to expect that an extended analysis based on time series information, i.e. the evolution of foreign and domestic R&D investment, would lead to the same conclusions.

How do our results compare with those of other investigations? As already mentioned, there are two further studies based on Swiss data that support the present findings (Arvanitis & Hollenstein, 2001; Hollenstein, 2005). There is some more evidence confirming our conclusions from four cross-country studies, in which Switzerland is included. Three of them are based on the analysis of patent data of MNE's: Patel & Vega (1999), who investigated the relative importance of several R&D strategies, conclude that in the Swiss case "asset exploiting" and "asset augmenting" are the dominant strategies, whereas there are hardly any Swiss MNE's characterised by "(pure) technology sourcing" (i.e. sourcing combined with a weak domestic knowledge base). According to this study, "asset augmenting" is by far the most important strategy. Le Bas & Sierra (2002), who used the same approach but had a broader database at their disposal, also concluded that "asset exploiting" and "asset augmenting" are much more relevant than other strategies for Swiss MNE's; in contrast to Patel & Vega (1999), the two strategies are found to be of about the same importance. Cantwell & Janne (1999), who looked at the ranking of countries in terms of technological performance in selected industry groups, obtained the same result. Particularly, they found that "asset augmenting"-strategies are dominating in the Swiss chemical and pharmaceutical industry, whereas "asset exploiting" is characteristic for the Swiss metal and machinery sector (and probably the rest of the manufacturing sector). Since the shares of Swiss foreign R&D expenditures are almost the same for the two industry groups, we conclude that both strategies are of similar importance. Driffield & Love (2003) show that firms investing in the UK, in the first instance those from technologically leading countries (USA, Switzerland, Sweden), benefit from the host country's knowledge base, in particular in case of investments in spatial clusters of R&D intensive firms; in other words: "asset augmenting" strategies positively impact on the knowledge base of the home country.[14]

7. Summary and Conclusions

The econometric analysis of the factors determining a firm's investment in foreign R&D is based on the well-known OLI paradigm. It turned out that "ownership-specific" advantages (O) and "internalising"-advantages (I) as well as the related variable "firm size" are the most prominent factors determining the decision to be involved or not involved in foreign R&D (model A). In contrast, we hardly found any evidence for "location-specific" advantages (L). We got quite similar results in explaining the extent of R&D investments at foreign locations (model B). O-advantages remain the most important category of explanatory variables. I-advantages and firm size are highly relevant as well. L-advantages did even less contribute to the explanation of foreign R&D than in case of model A. Science-based high-tech firms invested significantly more in foreign R&D than other firms, whereas the basic decision to perform foreign R&D is independent of a firm's sector affiliation.

The descriptive analysis confirmed the basic findings of the econometric investigation. It turned out that market-seeking, which is based on O-advantages and points to "asset exploiting" R&D strategies, is the leading motive for performing foreign R&D. This is particularly the case for large firms, which dominate foreign R&D investment in quantitative terms. The resource-seeking motives (making use of an ample supply of R&D personnel), which, on the one hand side, reflect efforts to reduce costs, on the other hand, knowledge-seeking motives (access to knowledge in specific technological fields), is the second most important motive for investing in R&D. Quite important are also asset-seeking/knowledge-seeking motives, which represent "asset

14 The evidence of recent studies for other countries is mixed (Veugelers et al., 2005). A main message is that the spillovers to the home country crucially depend on the type of R&D activity performed by foreign affiliates; a high "research content" of foreign R&D might be most beneficial to the home country (Iwasa & Odagiri, 2004). Further, economies with a high absorptive capacity benefit most of R&D activities at foreign locations.

augmenting" R&D strategies building on O-advantages. Least relevant are cost-reducing/efficiency-seeking motives, what is in line with the econometric analysis that yielded no evidence for disadvantages of Switzerland as a location for performing R&D. The results imply that "asset exploiting" R&D strategies are more prevalent than "asset seeking" strategies.

The results of both approaches support the hypothesis of foreign and domestic R&D being complements.

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Table 1: Specification of the Explanatory Variables

Variable	Description	Expected sign Model A	Expected sign Model B
O-advantages			
Innovation input/output			
DPD	Intensity of product-related development input (Dummy variable based on a five point intensity scale: value 1 for scores 4 or 5, otherwise 0)	+	///
PAT	Patenting (yes/no; dummy variable)	+	+
External knowledge (Dummy variable based on a five point intensity scale: value 1 for scores 4 or 5, otherwise 0)			
GROUP	Knowledge flows from other companies of the group	+	+
Other O-variabes			
LQL	Logarithm of labour productivity (value added per employee)	+	+
LEXP	Logarithm of sales share of exports (%)	+	+
I-advantages			
RDCOOP	Firm involved in R&D co-operations (yes/no; dummy variable)	+	+
Firm size			
L, L^2	Number of employees and its square	+ / -	///
S, S^2	Sales and its square	///	+ / -
L-Disadvantages (of home location)			
Obstacles to innovation as disadvantage of Switzerland as a location for R&D (Dummy variables based on a five point intensity scale: value 1 for scores 4 or 5, otherwise 0			
O1	High taxation	+	+
O2	Insufficient supply of R&D personnel	+	+
O3	Insufficient supply of qualified manpower in general	+	+
O4	Problems of acceptance of new technologies	+	+
O5	Excessive regulation of the domestic product market	+	+
O6	Restrictive access of foreigners to the domestic labour market	+	+
O7	Strict environmental regulations	+	+
O8	Strict regulation of land use and building as well as intricate administrative processes in order to comply with those regulations	+	+
O9	Insufficient public support of private R&D	+	+
Market conditions			
Intensity of competition on the firm's principal markets (Dummy variables based on a five point intensity scale: value 1 for scores 4 or 5, otherwise 0)			
IPC	Intensity of price competition	(+)	///
INPC	Intensity of non-price competition	(+)	///
Number of competitors on the firm's principal markets (Three dummy variables based on the number of principal competitors on the product market; reference group: firms with more than 50 competitors			
	5 or less; 6-15; 16-50 competitors	(+)	///
Control variables			
FOR	Foreign-owned firm (yes/no; dummy variable)	-	///
LAGE	Logarithm of firm age (time elapsed since the foundation of the firm)	+	///
High-tech manufacturing	Pharmaceuticals, chemicals, plastics, non-electrical machinery, vehicles, electrical machinery, electronics, instruments (reference group: other manufacturing industries)	+	+
Year 2002	Dummy variable for the year 2002 (reference group: year 1999)	?	?

Table 2: Model A: Determinants of R&D at Foreign Locations 1999-2002

Explanatory variables	Dependent variable: R&D at foreign locations (yes/no)			
	Pooled probit	Pooled probit	Probit random effects	probit random effects
O-advantages				
DPD	0.191*	0.204*	0.254*	0.275*
	(0.109)	(0.108)	(0.149)	(0.149)
PAT	0.190*	0.181*	0.223	0.211
	(0.114)	(0.109)	(0.154)	(0.154)
GROUP	0.453***	0.460***	0.581***	0.595***
	(0.120)	(0.120)	(0.167)	(0.169)
LQL	0.366***	0.349***	0.495***	0.482***
	(0.137)	(0.137)	(0.185)	(0.186)
LEXP	0.211***	0.207***	0.276***	0.276***
	(0.044)	(0.043)	(0.066)	(0.066)
I-advantages / firm size				
RDCOOP	0.621***	0.634***	0.792***	0.818***
	(0.109)	(0.109)	(0.171)	(0.173)
L	3.2E-04***	3.0E-04**	4.0E-04**	3.9E-04**
	(1.2E-04)	(1.2E-04)	(1.9E-04)	(1.9E-04)
L2	-2.2E-08**	-2.1E-08**	-2.8E-08)*	-2.7E-08*
	(1.0E-08)	(1.0E-08)	(1.6E-08)	(1.6E-08)
L-disadvantages				
Innovation obstacles:				
O1	0.033	//	-0.039	//
	(0.187)		(0.253)	
O2	0.034	//	0.029	//
	(0.131)		(0.165)	
O3	0.118	//	0.121	//
	(0.142)		(0.185)	
O4	0.060	//	0.085	//
	(0.154)		(0.214)	
O5	0.102**	0.120**	0.133*	0.154**
	(0.052)	(0.051)	(0.076)	(0.072)
O6	-0.001	//	-0.013	//
	(0.163)		(0.233)	
O7	0.222	//	0.295	//
	(0.193)		(0.277)	
O8	-0.187	//	-0.210	//
	(0.185)		(0.267)	
O9	0.025	//	0.043	//
	(0.184)		(0.255)	
Market conditions				
IPC	0.238**	0.250**	0.310*	0.325*
	(0.118)	(0.118)	(0.171)	(0.173)
INPC	-0.051	-0.046	-0.048	-0.045

	(0.109)	(0.109)	(0.144)	(0.144)
Number of competitors:				
5 or less	0.015	0.013	-0.029	-0.031
	(0.192)	(0.192)	(0.257)	(0.258)
6-15	-0.027	-0.030	-0.119	-0.122
	(0.182)	(0.182)	(0.244)	(0.245)
16-50	0.138	0.135	0.139	0.138
	(0.210)	(0.209)	(0.286)	(0.288)
Control variables				
FOR	0.017	0.010	0.052	0.047
	(0.139)	(0.137)	(0.186)	(0.187)
LAGE	0.001	-0.004	0.005	0.001
	(0.065)	(0.065)	(0.088)	(0.088)
High-tech manufacturing	0.058	0.065	0.100	0.107
	(0.120)	(0.118)	(0.164)	(0.165)
Year 2002	0.111	0.110	//	//
	(0.110)	(0.109)		
Constant	-7.163***	-6.931***	-9.443***	-9.311***
	(1.675)	(1.666)	(2.413)	(2.429)
N	1137	1137	1137	1137
Pseudo R^2	0.215	0.213		
Wald χ^2 (17)	200***	184***	49***	47***
τ			0.429***	0.442***

τ: share of variance that can be traced back to heterogeneity; heteroskedasticity–robust standard errors in brackets (White procedure); the statistical significance of the parameters are indicated with ***, ** and * respectively, representing the 1%, 5% and 10% test level respectively.

Table 3: Model B: Determinants of R&D Expenditures at Foreign Locations 1999-2002

Explanatory variables	R&D at foreign locations (yes/no)	Log (R&D) expenditures at foreign locations	Log (R&D) expenditures at foreign locations	Log (R&D) expenditures at foreign locations	Log (R&D expenditures at foreign locations	Log (R&D expenditures at foreign locations
	selection equation	intensity equation	intensity equation	pooled OLS	pooled OLS	OLS random effects
O-advantages						
DPD	0.195*	//	//	//	//	//
	(0.114)					
PAT	0.240**	1.010***	1.083***	0.887***	0.856***	0.850***
	(0.119)	(0.368)	(0.376)	(0.337)	(0.325)	(0.320)
GROUP	0.471***	0.550	0.670*	0.457	0.501*	0.490*
	(0.115)	(0.347)	(0.352)	(0.295)	(0.291)	(0.293)
LQL	0.266*	0.670*	0.721*	0.630	0.587	0.570*
	(0.141)	(0.387)	(0.388)	(0.417)	(0.394)	(0.348)
LEXP	0.284***	//	//	//	//	//
	(0.049)					
I-advantages / firm size						
RDCOOP	0.502***	0.812**	0.848**	0.662*	0.592	0.559*
	(0.115)	(0.393)	(0.391)	(0.375)	(0.367)	(0.286)
S	//	2.9E-09***	2.9E-09***	2.9E-09***	2.9E-09***	2.9E-9***
		(0.6E-09)	(0.6E-9)	(0.6E-09)	(0.8E-09)	(0.6E-9)
S2	//	-2.3E-19***	-2.4E-19***	-2.3E-19***	-2.5E-19***	-2.5E-19***
		(0.9E-19)	(0.9E-19)	(0.9E-19)	(0.8E-19)	(0.9E-19)
L	2.5E-04*	//	//	//	//	//
	(1.4E-04)					
L2	-1.6E-08	//	//	//	//	//
	(1.2E-08)					
L-disadvantages						

Innovation obstacles						
O1	//	0.033	//	0.011	//	//
		(0.536)		(0.643)		
O2	//	-0.160	//	-0.236	//	//
		(0.321)		(0.322)		
O3	//	0.230	//	0.231	//	//
		(0.373)		(0.411)		
O4	//	-0.451	//	-0.455	//	//
		(0.412)		(0.326)		
O5	0.096*	-0.224	//	-0.183	//	//
	(0.056)	(0.164)		(0.172)		
O6	//	-0.225	//	-0.177	//	//
		(0.481)		(0.577)		
O7	//	-0.024	//	-0.162	//	//
		(0.610)		(0.576)		
O8	//	-0.382	//	-0.287	//	//
		(0.622)		(0.540)		
O9	//	0.179	//	0.009	//	//
		(0.521)		(0.471)		
Market conditions						
IPC	0.287**	//	//	//	//	//
	(0.138)					
Control variables						
High-tech manufacturing	0.051	0.663*	0.728**	0.790**	0.805**	0.801**
	(0.122)	(0.361)	(0.362)	(0.379)	(0.371)	(0.347)
Year 2002	0.184	0.213	0.258	0.150	0.15	//
	(0.117)	(0.325)	(0.331)	(0.355)	(0.354)	
Const.	-6.363***	1.964	0.341	2.745	2.831	3.169
	(1.676)	(5.230)	(5.241)	(4.887)	(4.669)	(4.114)
N	1137		1137	145	145	145
N (uncensored)	145		145			

R^2				0.544	0.556	
ρ	0.072		0.217			
LR test of indep. eqns. (ρ=0)	0.04		0.36			
R^2 overall						0.555
Wald χ^2 (7)						77***
τ						0.376

One-step Heckman selection model (maximum likelihood estimation); ρ: correlation coefficient; τ: share of variance that can be traced back to heterogeneity; the statistical significance of the parameters are indicated with ***, ** and * respectively, representing the 1%, 5% and 10% test level respectively.

Table 4: Motives for Performing R&D at Foreign Locations 2002
(Share of firms assessing a specific motive as important (value 4 or 5 on a five-point Likert scale) as a percentage of firms with foreign R&D)

Motive	Firm size (number of employees)			
	5 - 99	100 - 499	500 and more	Total
Motives 1 to 7				
1. Supporting local production and sales	33.3	41.8	66.7	43.1
2. Geographical proximity to leading edge universities	29.4	21.8	25.0	25.4
3. Geographical proximity to innovative firms (local networks of excellence)	52.9	20.0	33.3	35.4
4. Transfer of knowledge/technology to the Swiss headquarter	29.4	16.4	29.2	23.9
5. Lower R&D costs	37.3	23.6	16.7	27.7
6. Higher government support for R&D investments	15.7	12.7	4.2	12.3
7. Ample supply of R&D personnel	41.2	32.7	37.5	36.9
Group of motives (averages)				
Market-seeking (1)	33.3	41.8	66.7	43.1
Knowledge/asset-seeking (2, 3, 4)	37.2	19.4	29.2	28.2
Cost-reducing/efficiency-seeking (5, 6)	26.5	18.2	10.5	20.0
Resource-seeking (7)	41.2	32.7	37.5	36.9

Manufacturing firms (N=130). Source: Swiss Innovation Survey 2002.

APPENDIX:

Table A1: Composition of the Data Set by Industry and Firm Size Class

Industry	Number of observations: firms with *domestic* R&D activities	Percentage	Number of observations: firms with *foreign* R&D activities	Percentage
Food, beverage, tobacco	94	8.3	6	4.1
Textiles	38	3.3	5	3.3
Clothing, leather	13	1.2	2	1.6
Wood processing	34	3.0	2	1.2
Paper	26	2.3	2	1.2
Printing	40	3.5	3	2.1
Chemicals	96	8.4	18	12.3
Plastics, rubber	59	5.2	8	5.8
Glass, stone, clay	37	3.3	4	2.5
Metal	21	1.8	1	0.8
Metalworking	124	10.9	16	10.7
Machinery	234	20.6	42	29.2
Electrical machinery	62	5.4	8	5.3
Electronics, instruments	134	11.8	23	15.6
Watches	46	4.0	3	2.1
Vehicles	17	1.5	1	0.8
Other manufacturing	47	4.1	2	1.2
Energy	15	1.3	0	0.0
Firm size				
5 to 19 employees	170	14.9	10	6.6
20-49 employees	220	19.3	18	12.8
50-99 employees	219	19.2	25	17.3
100-199 employees	235	20.7	32	22.2
200-499 employees	190	16.7	28	19.3
500-999 employees	65	5.7	17	11.9
1000 employees and more	39	3.4	14	9.9
Year 1999	504	44.3	69	47.8
Year 2002	633	55.7	76	52.2
Total	1137	100	145	100

Source: Swiss Innovation Survey 1999 and 2002.

Table A2: Correlation Matrix of the Explanatory Variables

	DPD	PAT	GROUP	LQL	LEXP	RD-COOP	O1	O2	O3	O4	O5	O6	O7	O8	O9	IPC	INPC	5 or less comp.	6-15 comp.	16-50 comp.	FOR
PAT	0.21																				
GROUP	0.06	0.09																			
LQL	0.09	0.08	0.16																		
LEXP	0.19	0.33	0.14	0.13																	
RDCOOP	0.13	0.23	0.12	0.14	0.18																
O1	-0.03	-0.06	-0.06	-0.07	-0.11	-0.06															
O2	0.12	0.08	0.05	0.00	0.08	0.09	0.08														
O3	0.03	0.01	0.00	-0.06	-0.04	0.03	0.11	0.30													
O4	0.09	0.08	0.00	-0.01	-0.01	0.05	0.10	0.15	0.08												
O5	-0.03	-0.08	-0.02	-0.02	-0.14	-0.06	0.26	0.08	0.15	0.14											
O6	0.05	0.07	0.07	0.02	0.03	0.07	0.26	0.22	0.12	0.11	0.21										
O7	-0.02	-0.10	0.03	0.00	-0.14	0.04	0.25	0.10	0.15	0.10	0.25	0.23									
O8	-0.02	-0.09	0.02	0.00	-0.17	0.03	0.24	0.11	0.19	0.11	0.24	0.27	0.58								
O9	0.04	0.02	0.02	-0.06	0.01	0.03	0.22	0.16	0.11	0.14	0.23	0.27	0.22	0.02							
IPC	0.02	0.04	0.04	0.01	-0.02	0.06	0.01	0.03	0.03	0.06	-0.01	0.03	0.06	0.05	0.01						
INPC	0.13	0.01	0.06	0.09	0.10	0.02	0.02	0.06	0.00	0.01	-0.02	0.04	0.00	-0.02	-0.02	-0.02					
5 or less comp.	0.06	0.07	0.04	0.07	0.05	-0.01	-0.04	0.00	-0.01	-0.03	0.00	0.04	-0.07	-0.06	-0.01	-0.10	-0.05				
6-15 comp.	0.00	0.04	0.03	0.02	0.06	0.04	-0.04	-0.01	0.00	0.01	-0.07	-0.03	0.01	0.00	-0.03	0.04	0.02	-0.60			
16-50 comp.	-0.04	-0.06	-0.01	-0.05	-0.04	0.00	0.04	-0.02	-0.01	0.02	0.04	-0.01	0.04	0.04	0.05	0.05	0.01	-0.23	-0.37		
FOR	0.05	0.07	0.33	0.17	0.23	0.06	-011	0.03	-0.03	-0.05	-0.05	0.03	-0.07	-0.06	-0.03	-0.01	0.08	0.05	0.06	-0.07	
LAGE	-0.08	0.03	0.04	0.03	-0.07	0.09	-0.04	-0.02	-0.03	-0.04	-0.04	-0.02	-0.01	0.00	-0.06	0.07	-0.06	-0.10	0.08	0.04	-0.10