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Martin Berger, Heinz Hollenstein

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Martin Berger [*] and Heinz Hollenstein [§,*]

[*] POLICIES - Centre for Economic and Innovation Research, JOANNEUM RESEARCH, Vienna

[§,*] KOF Swiss Economic Institute, ETH Zurich

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Abstract

The paper complements entry mode research by dealing with the choice of alternative modes of governance in the specific case of foreign R&D and its impact on a parent firm's performance. Firstly, we identify the factors that determine whether a firm locates abroad any R&D activities, and, if it does so, whether it chooses an equity-based rather than a non-equity co-operative mode of governance. The OLI paradigm is used as theoretical background of this analysis. Secondly, we determine the impact of foreign R&D on a parent firm's performance in terms of innovation output and labour productivity, and investigate whether this effect differs among firms using the one or the other governance mode. The study is based on separate estimations for Switzerland and Austria using comparable firm data and model specifications. The two countries are interesting cases as they strongly differ in terms of level and pattern of internationalisation.

Keywords: Internationalisation of R&D; Governance of foreign R&D; International R&D co-operation; Foreign R&D and performance; OLI paradigm and R&D

JEL classification: F23, L22, L24, O31

Corresponding author

Dr. Heinz Hollenstein
KOF Swiss Economic Institute
ETH Zurich, WEH D4
Weinbergstrasse 35
CH-8092 Zurich, Switzerland

E-mail hollenstein@kof.ethz.ch
Phone: +41 44 6324238
Fax: +41 44 6321218

1 Introduction

Over the last twenty years internationalisation of R&D strongly increased and its pattern changed quite considerably (OECD, 2008). Several studies highlighted that R&D investments at foreign locations are motivated not only by traditional market and cost considerations but, more and more, by the intention to gain access to specific knowledge not available at home (see, among many others, Cantwell, 1995; Kuemmerle, 1999). Besides, relatively small and young companies as well as service firms started to invest in foreign R&D in recent years. Moreover, it became increasingly attractive to choose non-equity R&D co-operations rather than equity-based modes of governance of foreign R&D (Hagedoorn, 1996; Dunning, 1997).

It is the last-mentioned aspect on which this contribution is focused. We aim, firstly, at identifying the determinants of a firm's choice between equity-based and non-equity co-operative governance modes of foreign R&D, taking as starting point the explanation of the overall propensity for R&D at foreign locations (yes/no decision). The equity-based mode, as defined in this paper, covers wholly-owned foreign affiliates and joint ventures where the parent firm holds a majority or minority equity stake. This governance mode is contrasted with non-equity R&D co-operation (excluding contract R&D).[1] Secondly, we analyse the impact of foreign R&D on a parent firm's performance, and investigate whether this effect differs among the two modes of foreign presence.

To empirically analyse the choice of the governance mode of foreign R&D we estimate a model consisting of two probit equations (Model A). The first one serves to identify the factors determining the choice to invest or not invest abroad in R&D ("propensity equation"), the second one to explain a firm's choice between the two governance modes of foreign R&D ("mode equation"). The propensity equation, in addition to its significance of its own, serves to correct a (potential) selection bias of the estimated coefficients of the mode equation due to the use of a truncated sample containing only firms with foreign R&D (Heckman selection model). Theoretical framework for the empirical analysis of model A is the OLI paradigm (Dunning, 2000).

In the second part of the study we analyse whether a parent firm achieves a higher performance as a result of its R&D activities at foreign locations, and whether this effect differs among the two modes of organising foreign R&D (model B). To this end we specify two (separately estimated) performance equations, the first one using as dependent variable a firm's innovativeness, measured by the sales of innovative products per employee ("innovation equation"), the second one using as performance indicator a firm's labour productivity ("productivity equation"). In both equations we use as explanatory variables, in addition to the standard factors determining the innovation output and productivity respectively, the propensity for foreign R&D and, alternatively, a dummy variable representing the equity-based mode of foreign R&D with the co-operative mode as reference. In estimating the performance equations we account for the (potential) endogeneity of the propensity and the governance mode of foreign R&D.

A special feature of the paper is its comparative approach. We separately estimate model A and B for the Swiss and the Austrian economy using cross-sectional firm-level survey data. The two countries are interesting cases for a comparison of the drivers and the performance effects of foreign R&D as the Swiss economy is internationalised to a much higher degree in terms of outward FDI in general and even more

[1] A further differentiation of the equity-based mode (e.g. wholly-owned subsidiary vs. equity stake joint venture) is not feasible in view of the limited number of observations.

so with respect to R&D. Moreover, FDI of Swiss companies, since long, are highly diversified in terms of target regions, whereas in Austria they are strongly concentrated on Western and Eastern Europe.

The study complements previous research in several respects. Firstly, we analyse a firm's choice of the governance mode of foreign activity in the specific field of R&D – an issue so far practically not investigated.[2] Secondly, we examine the impact of the mode choice on a *parent* firm's performance, whereas previous work dealt with the success of a company's foreign unit. Thirdly, we account for some econometric problems hardly ever addressed in entry mode research, that is, a (potential) selection bias in explaining the choice of the governance mode and the (potential) endogeneity of the propensity and the mode of foreign R&D as variables explaining a parent firm's performance. Finally, we perform a comparative analysis for two (structurally different) countries using the same theoretical framework and specification of the empirical models. This approach might yield more reliable insights than comparisons of results from stand-alone country studies that mostly differ in terms of database, model specification, etc.

The set-up of the paper is as follows: In the Sections 2 and 3 we present the conceptual framework of the study and the related empirical literature as well as the hypotheses to be tested (model A and B). Section 4 describes sources and composition of the two datasets. Section 5 deals with model specification, variable construction and some econometric problems. In Section 6 we present the empirical results. Finally, we summarise and assess the findings with special reference to the comparison of the two countries.

[2] Exceptions are Brouthers et al. (2001) and Penner-Hahn (1998). Both studies, however, are based on a very small number of observations.

2 Model A: Conceptual framework and related empirical literature

2.1 General theoretical background

Since Hymer (1976) the theory of international investment of firms is based on the assumption of imperfect markets. In these conditions firm-specific capabilities become a key element that can be successfully exploited abroad independently of the economic attractiveness of different locations ("new trade theory", see e.g. Helpman, 1984). Moreover, "transaction cost theory" hypothesises that a firm engages in FDI whenever the costs of setting up and running a transnational organisation of activities, whatever its specific character, are lower than external market transactions (Williamson, 1985; Rugman, 1981, Hennart, 1982; Buckley and Casson, 1985). In addition, 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, finance, etc. (Dunning, 2000).

It was already in the 1970s that Dunning argued that no single approach is able to fully explain a firm's international activity. He proposed as a framework of analysis an eclectic theory of international production, the "OLI paradigm", which he further developed over the years to take account of changing features of the international economy and new theoretical approaches. In its most recent version (Dunning and Lundan, 2008), it can be applied not only to the internationalisation of production but of foreign R&D as well. Moreover, it now clearly considers the network character of the international economy as partnerships and alliances gained in importance compared to hierarchical governance modes. The OLI paradigm now also emphasises more explicitly the strategic aspects of internationalisation based on the "resource-based view" (Wernerfelt, 1984) or "dynamic-capability view" of the firm (Teece et al., 1997), and, similarly, the concept of the "knowledge-based company" (Kogut and Zander, 1993). Accordingly, firms locate part of their R&D activities abroad with the objective to augment its knowledge base by tapping into foreign "National Systems of Innovation" (what does not mean that "traditional" market-oriented motives for foreign R&D are not relevant anymore).

2.2 The OLI paradigm

We posit that the OLI paradigm is well-suited as theoretical background for explaining why a firm performs R&D at foreign locations and, if it decides to become active abroad, why it chooses a high-control rather than a low-control governance mode.

The OLI approach basically accounts for three groups of explanatory variables: "ownership-specific advantages" (O), "location-specific advantages" (L) and "internalising advantages" (I). O-advantages refer to firm-specific capabilities that make a company superior to local competitors irrespective of general location characteristics. Such advantages arise from the availability of firm-specific knowledge, human and physical capital as well as intangibles related to property rights, marketing, organisation, managerial skills, finance, international experience, etc. 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 between foreign and domestic locations with respect to factors favouring or impeding knowledge creation and use (regulatory framework in general, institutional regime

of knowledge protection, availability of R&D personnel, cultural distance, etc.).[3] I-advantages can be realised by investing in foreign subsidiaries (extension of existing facilities, M&A, greenfield ventures) and, to a lesser extent, by forming equity-based joint ventures. In this way, the high costs of transactions on the imperfect markets for knowledge and technology can be reduced, appropriability problems mitigated and access to knowledge sources facilitated. This also may be true, though less pronounced, for non-equity co-operations, particularly if the partners commit themselves on a continuing basis.

There are some additional variables related to one or more of the three "basic elements" of the OLI model. A first one is firm size that captures size-related elements of O- (e.g. privileged access to capital markets) and I-advantages (e.g. superiority of large firms related to international technology management). Secondly, specific strategic goals of firms ("motives of foreign R&D activities"), depending on their type, represent either L-advantages of host countries (e.g. cost-reducing foreign R&D) or a mix of O- and L-advantages (e.g. market-seeking foreign R&D). Thirdly, the market environment (intensity of competition, etc.) may enforce a firm to extend its activities to foreign locations, or, in a more general view, to set incentives to translate some OLI-type advantages into a competitive edge of the firm at the international level. Finally, it has to be taken into account that the relevance of certain O-, L-, or I-advantages varies across industries and/or sectors (e.g. the importance of proprietary knowledge is likely to differ among industries).

The OLI model incorporates the "transaction cost approach" of explaining the choice among alternative modes of entering foreign markets. In a seminal paper Anderson and Gatignon (1986) postulated, based on transaction cost theory, six core variables as factors explaining entry mode choice. These determinants, widely used in empirical entry mode research, represent either (firm-specific) O- and I-advantages (proprietary knowledge, intangible knowledge, reputation-related assets, international experience) or (location-specific) L-(dis)advantages (firm-external uncertainty, cultural distance). Moreover, some empirical studies add to these "transaction cost variables" one or several of the mentioned variables extending the core of the OLI paradigm such as, for example, the motives of foreign presence or sector affiliation (for a review of the theoretical and empirical entry mode research see Sarkar and Cavusgil, 1996; Datta et al., 2002; Zhao et al., 2004; Brouthers and Hennart, 2007; Morschett et al., 2010).

The OLI model basically implies that firm-specific O- and I-advantages as well as L-advantages of foreign locations positively affect the likelihood of a firm to be present at foreign locations or to extend such activities. Moreover, the positive relationship between OLI variables and foreign presence is presumed to be stronger in case of high-control governance modes (subsidiaries, equity-based JV) compared to low-control organisational arrangements (non-equity co-operations).

2.3 State of empirical evidence

2.3.1 Propensity for foreign R&D

There are some empirical studies having *explicitly* used the OLI approach for analysing the propensity for foreign R&D. Arvanitis and Hollenstein (2007) and Hollenstein (2005) found that all three components of the OLI model significantly influence Swiss firms' propensity for foreign R&D, with O- and I-advantages being the dominant drivers. Rammer and Schmiele (2008) and Schmiele (2012), using a similar approach, got basically the same results based on large samples of German firms. Using Swedish and/or Japanese data some other firm-level studies not explicitly referring to the OLI paradigm yielded evidence for O-advantages (e.g. Odagiri and Yasuda, 1996; Andersson, 1998) or for O- and L-advantages (Ito and

[3] In our case, L-advantages reflect differences between domestic locations and those of foreign countries *as a whole*; we do not differentiate between alternative foreign locations.

Wakasugi, 2007).[4] All in all, we may expect that the propensity for foreign R&D can be explained by variables representing the OLI model.

2.3.2 Choice of the governance mode

To our knowledge, Brouthers et al. (2001) is the only study applying the OLI framework to investigate the choice of the governance mode in the specific case of R&D. However, as the very small database (about thirty observations) precluded the use of adequate empirical methods, the results (bivariate correlations) are not reliable; nevertheless, there is some indication of the relevance of O- and L-variables.

There are some studies explicitly using the OLI paradigm to explain the choice of the entry mode in general, thus not differentiating by business functions such as R&D. The majority of these studies confirm the ability of the OLI variables for determining the mode choice; in some instances, there is also evidence for interactions between O- and L-variables.

More specifically, Tatoglu and Glaister (1998), using data on foreign firms' with investments in Turkey (full ownership vs. JV), as well as Nakos and Brouthers (2002), based on data for the presence of Greek companies in Central and Eastern Europe (equity vs. non-equity entry mode), find a quite significant impact of OLI variables on entry mode choice. The same holds true for Tsai and Cheng (2002) which used data related to Taiwanese investments in the USA (full ownership vs. JV); these authors additionally dealt with some strategic aspects of the mode choice (market-oriented motives are positively related to full ownership) and the influence of the intensity of competition (no significant impact on the mode decision). Erramilli et al. (1997) explaining the choice between four equity-based entry modes ("minority stake" up to "full ownership") based on data for Korean outward FDI confirmed the OLI approach and showed that OL-interactions significantly add to the explanatory power of the model. Agarwal and Ramaswami (1992) analysed the choice between four modes of market entry (domestic market vs. exporting vs. JV vs. wholly-owned subsidiary) based on data for US leasing firms. They got quite strong evidence for the OLI model as the explanatory variables discriminated among all four categories of firms. Finally, Padmanabhan and Cho (1999) found only a weak effect of the OLI variables on the choice between full ownership and JV in case of Japanese firms. Interestingly, it is mode-specific foreign experience that significantly determines the mode choice rather than general or country-specific knowledge from foreign activities.

Based on these results, although they pertain to the entry mode choice *in general*, we expect that the OLI model is also a suitable framework for analysing in the *specific case of foreign R&D* why firms choose an equity-based rather than a co-operative governance mode.

2.4 Hypotheses related to model A

Model A implies the following *general* hypotheses that are tested for Swiss and Austrian companies in subsection 6.1:

H1a: The likelihood of a firm to perform R&D at foreign locations is positively related to its O- and I-advantages as well as to the L-advantages of host countries.

H1b: The OLI-variables are more closely related to the choice of an equity-based than a non-equity co-operative mode of governance.

[4] For some older studies dealing with the drivers of foreign R&D see the overview of Granstrand et al. (1993).

3 Model B: Foreign R&D and firm performance

Model B is used to analyse the impact of foreign R&D on a *parent* firm's performance and to determine whether this effect differs among firms relying on an equity-based rather than a non-equity co-operative governance mode. To this end we estimate independently two performance equations which differ in terms of the indicator of firm performance. In model B1 ("innovation equation") firm performance is measured by the sales of innovative products per employee, in model B2 ("productivity equation") labour productivity is used as dependent variable.

3.1 State of empirical research

3.1.1 General remarks

There is some empirical literature dealing with the impact of overall foreign R&D on the parent firm's performance captured by innovativeness (see subsection 3.1.2) and productivity (see subsection 3.1.3). However, the effect of alternative governance modes on the *parent* company's performance was hardly ever investigated; in the entry mode literature performance typically refers to the achievements of a firm's *foreign* unit (subsidiary, JV) or specific investment projects. However, in line with Kim and Hwang (1992), we argue that the goal of foreign activities is to enhance the overall performance of a company rather than the success of individual foreign ventures. For the specific case of foreign R&D there are practically no studies investigating the relationship between governance modes and a parent firm's performance.[5]

The results of the research dealing with the performance effects of the entry mode choice *in general* (thus not related to R&D), for several reasons, are inconclusive (for a detailed discussion see e.g. Datta et al., 2002). The results are difficult to compare as such studies used very different performance measures and entry mode variables. Moreover, it was hardly ever accounted for the potential endogeneity of the entry mode variable (a rare exception is Shaver, 1998).[6] And, in particular in older studies, the analysis focused on the bivariate relationship between entry mode choice and performance implying an omitted variable bias (e.g. Woodcock et al., 1994).

3.1.2 Innovation output

In model B1, we use innovation output as indicator of firm performance. There is some empirical work dealing with the innovation effect of *overall* foreign R&D, whereas, to our knowledge, the impact of alternative R&D governance *modes* on a parent firm's innovativeness so far has not been investigated.

Previous studies dealing with the relationship between (overall) foreign R&D and a parent firm's innovativeness mostly find a positive effect. Peters and Schmiele (2010) showed that German firms with foreign R&D activities are significantly more innovative than those investing in R&D only at home. Mansfield and Romeo (1984), using US manufacturing data, concluded that about 50% of the technologies generated by foreign R&D were transferred back to the parent company, thereby enlarging its innovation capacity. Arvanitis and Hollenstein (2011) found that knowledge-seeking foreign R&D

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5 The only study we are aware of is based on data for just sixteen firms (Brouthers et al., 2001).

6 Chen and Hu (2002) and Brouthers et al. (1999, 2003) consider "endogeneity" as well but in a very specific way not to be mixed up with an endogeneity correction as postulated in econometric theory. These authors compare the average performance of firms having selected the entry mode as prescribed by the transaction cost theory (or the OLI model) with that of firms whose choice is determined by other variables.

raised innovation output of Swiss companies, whereas market- or efficiency-oriented foreign R&D had no such an effect. Moreover, Ambos et al. (2006), based on data from European MNEs, showed that the size of the innovation effect differs according to a parent firm's absorptive capacity. Finally, Iwasa and Odagiri (2004), using Japanese data, found that only "research-oriented" foreign R&D activities positively affect a parent company's innovation performance, what is not the case if foreign R&D is "application-oriented". In spite of these differentiations, we expect that foreign R&D as a whole raises a firm's innovation performance.

Moreover, in absence of empirical work, we posit that the effect of foreign R&D on a parent firm's innovation output is larger in case of an equity-based than a co-operative governance arrangement. We argue that in a high-control environment foreign R&D activities are well integrated in the innovation process of the parent company, thus contributing more or less directly to its innovation output. Conversely, a low-control mode, such as a non-equity R&D co-operation with a foreign partner, is often used as a means to get access to highly specialised knowledge. In this way the firm may enhance its overall knowledge base, thereby improving the environment for generating innovations. But we presume that the positive innovation effect will materialise only in the medium run because, among other things, the additional knowledge first has to be absorbed by the parent company.

3.1.3 Productivity

In model B2, labour productivity is used as indicator of a parent firm's performance. We already mentioned that, whereas there are some empirical analyses of the effect of overall foreign R&D on a parent firm's productivity, we are not aware of any work dealing with the productivity effect of alternative modes of governance in the specific case of R&D.

The empirical evidence with respect to the impact of overall foreign R&D on a parent company's productivity is mixed. Fors (1997) could not detect any significant effect for a sample of Swedish MNEs. Conversely, Todo and Shimizutani (2008), using a large panel dataset of Japanese manufacturing firms, found that overseas R&D aiming at the acquisition of knowledge raised a parent firm's productivity, whereas foreign R&D focusing on the adaptation of products to the requirements of foreign markets did not change the productivity level. Griffith et al. (2004) identified, using time series patent data, positive productivity effects of knowledge-seeking R&D activities of UK multinationals at US locations. In contrast, Arvanitis and Hollenstein (2011), using panel data for the Swiss business sector, showed that market- and cost-oriented R&D at foreign locations positively influence a parent company's productivity growth, whereas knowledge-oriented foreign R&D did not have such an effect. Rammer and Schmiele (2008), using a large sample of German firms, identified a positive relationship between foreign R&D and a parent company's employment growth but, astonishingly, without finding such an effect on the growth of sales. All in all, although the empirical results of these studies are not unambiguous, we hypothesise that foreign R&D as a whole enhances a parent firm's productivity.

Besides, we expect that the (positive) productivity effect is larger in case of an equity-based than a co-operative mode of governance of foreign R&D. To substantiate this proposition we argue in the same way we did when considering the effect of the mode choice on the innovation output. We presume that equity-based foreign R&D is integrated to a higher extent in the value creating process of the parent company than non-equity foreign R&D co-operation, implying a more pronounced impact on firm productivity in case of a high-control governance mode.

3.2 Hypotheses related to model B

The models B1 and B2 imply the following general hypotheses that are tested for Swiss and Austrian companies in subsection 6.2:

H2a: Foreign R&D activities raise a parent company's innovation output.

H2b: The positive effect on innovation output is larger in case of an equity-based than a non-equity co-operative mode of governance.

H3a: Foreign R&D activities raise a parent company's labour productivity.

H3b: The positive effect on labour productivity is larger in case of an equity-based than a non-equity co-operative mode of governance.

4 Data

4.1 Data collection

In the Swiss case, the firm data stem from the "Swiss Survey on Internationalisation" conducted in spring 2010, which was based on a random sample of firms (five or more employees) disproportionally stratified by 29 manufacturing and services industries and three industry-specific firm size classes, with full coverage of large firms. The questionnaire was sent to 4533 companies, of which 1921 provided valid information. The response rate of 42.4% is satisfactory given the very demanding questionnaire. In the reference period 2007-2009, 659 of the responding firms performed R&D. 152 of these companies (23.1%) also invested abroad in R&D, with the majority having chosen an equity-based governance mode (see the Tables 1 and A1). The final sample, after deleting observations with missing values for one or more explanatory variables, contains – depending on the specific model to be estimated – between 472 and 525 R&D performing firms, with the sample size reduced to 100 till 110 observations in case of models referring only to companies engaged in foreign R&D.

Similar data were collected in spring 2010 by means of the "Austrian Survey on R&D Internationalisation" addressed to all companies of the business sector that applied for public support of their innovation activities in the period 2005-2009. The questionnaire has been sent out to 5702 firms, of which 410 returned viable information. The response rate of 7.2% is low, partly due to the fact that many of the companies that applied for innovation subsidies do not perform any R&D. Nonetheless, the composition of the dataset by industry and firm size class does not much differ from the official R&D statistics. Excluding firms with less than five employees (to get a dataset comparable to the Swiss one) we ended up with 284 R&D performing firms, of which 140 (49.3%) also invested abroad in R&D, with the majority having chosen a non-equity governance mode (see the Tables 1 and A1). To get the final dataset some observations had to be dropped because of missing values. Hence, the econometric analysis is based on a dataset that contains – depending on the specific model to be estimated – between 198 and 237 R&D performing firms, of which 95 to 107 can be included for estimating models referring only to the firms with foreign R&D.

As the data were collected in 2010 one may worry that the model estimates are distorted because of the impact of the recent economic crisis on core variables. However, such a bias seems not very likely as the few quantitative measures (employment, sales, value added, R&D expenditures), (partly) reacting with a time lag, refer to an early phase of the recession (Switzerland: 2008; Austria: average of 2007/09), while the other variables (mostly qualitative measures) change only slowly as they mostly reflect structural firm characteristics.

Table 1 (about here)

4.2 Composition of the dataset and incidence of foreign R&D

The composition of the dataset in terms of *R&D performing firms* by industry and firm size classes significantly differs among the two countries (see Table A.1 in the appendix, column 6 vs. 12). The share of knowledge-intensive services is much higher in Austria (31% vs. 12% in the Swiss case), whereas in the Swiss sample the weight of high-tech manufacturing is particularly large (50% vs. 41% in Austria). The share of small firms is clearly higher in Austria (48% vs. 26% in Switzerland); in the Swiss sample medium-sized companies are of particular significance (44% vs. 26% in Austria). Firms performing *foreign R&D* (Table A.1, columns 5 and 11) again are strongly concentrated, in Austria on knowledge-

intensive services and small companies, in Switzerland on high-tech manufacturing. Besides, the share of large companies, in both countries, is larger in case of firms with foreign R&D than it is for all R&D performing companies. This pattern shows up in particular in the Swiss data. In Austria, every second R&D performing company is also active in R&D at foreign locations against a quarter in Switzerland (see Table 1, column 4 vs. 1). The difference is most accentuated in case of low-tech manufacturing and knowledge-intensive services as well as for small firms. Moreover, a vast majority of Swiss firms – an exception are small ones – prefer equity-based modes of foreign R&D (column 3 vs. 2), whereas in Austria the opposite is true (column 6 vs. 5). The prevalence of non-equity foreign R&D co-operation in Austria primarily reflects the strong preference for this governance mode by knowledge-intensive service firms and small companies.

All in all, we find for the two countries four major differences. Firstly, the share of knowledge-intensive service firms is significantly larger in the Austrian dataset, while in the Swiss case high-tech manufacturing stands out. This pattern holds true for R&D performing firms as a whole, and even more so for firms with foreign R&D. Secondly, the weight of small firms among the R&D performing firms is very high in Austria, whereas in Switzerland medium-sized firms are most prominent. Thirdly, the share of firms having invested abroad in R&D as a percentage of all R&D performing companies is significantly higher in the Austrian sample. Finally, in Switzerland, the equity-based mode of foreign R&D is much more prevalent than non-equity R&D co-operations, whereas the opposite is true in Austria.

As the sample of the two surveys is constructed in a different way (random sample in Switzerland vs. firms having applied for subsidies for innovation projects in Austria), it is not surprising that the composition of the dataset used for model estimation quite strongly differs. As a consequence, it is indispensable to control in all model estimates for firm size and industry affiliation.

5 Model specification, variable measurement and estimation procedure

5.1 Model A: Foreign R&D propensity and the choice of the governance mode

5.1.1 Dependent variables

Model A is made up by two equations. The "propensity equation" determines the likelihood of a firm to invest in foreign R&D represented by the binary variable "foreign R&D yes/no" (RDFOR). The "mode equation" explains, given that a firm is active in foreign R&D, why it chooses an equity-based rather than a non-equity co-operative mode of governance (binary variable RDFOR_EQ, with value 1 for the equity-based and value 0 for the co-operative mode). The probit procedure is appropriate for estimating both the propensity and the mode equation as the two dependent variables are binary measures. However, since the mode equation can be estimated only for firms performing foreign R&D, the estimated coefficients may be biased. We account for this problem by using a Heckman selection model (Heckman, 1979). The selectivity problem was hardly ever addressed in previous entry mode research.[7]

5.1.2 Independent variables

According to hypotheses H1a and H1b, the variables RDFOR and RDFOR_EQ are explained by three sets of variables which capture O-, L- and I-advantages, complemented by some general controls such as foreign ownership, firm age and industry/sector affiliation. The *mode* equation, additionally, contains three variables representing a firm's motives of foreign R&D.[8] In the *propensity* equation we inserted two additional variables to ensure identification of the Heckman model, i.e. "basic international experience" and "market structure". "The former is measured by a firm's export intensity (high and intermediate sales share of exports (X3, X2), with "no exports/low export intensity" as reference group). In line with the "learning perspective of internationalisation" (Johanson and Vahlne, 1977) we argue that *some* international experience is a necessary prerequisite for locating R&D abroad, whereas in choosing the governance mode more specific aspects of experience are relevant (see below). "Market structure", captured by the number of a firm's principal competitors (COMP), is used as a second identifying variable as we presume that foreign presence in R&D may be a means to escaping, to some extent, intensive competition.[9] For the two identifying variable we expect a positive effect on RDFOR.

In the following we discuss the specification of the (other) independent variables used in the propensity and the mode equation. The exact definition of the variables and the respective sign expectations are shown in Table 2.

Table 2 (about here)

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[7] Implicitly, Agarwal and Ramaswami (1992) took account of the problem as they used "firms without any foreign activity" as reference category of one of their alternative specifications of the multinomial entry mode variable.

[8] From an econometric point of view these variables should also be used in the *propensity* equation; however, as the respective information, for obvious reasons, is available only for firms performing foreign R&D, this is not feasible.

[9] Competitive pressure may also be relevant for the mode choice. However, in this case, one should account for multi-dimensional strategies of competition, which can be analysed only in a dynamic setting (panel data analysis); therefore, we do not include competition variables in the mode equation.

O-advantages

O-advantages of the parent firm are expected to be positively related to RDFOR and RDFOR_EQ. In accordance with the (dynamic) capability view of the firm and the transaction cost theory we consider a parent firm's R&D intensity (LRDS; sales share of R&D expenditures, logarithm) and human capital intensity (LHC; share of employees with a tertiary degree, logarithm) as variables capturing strategic asset availability and transaction specificity.[10] Besides, we include a dummy variable representing the use of patent rights (PAT) to capture proprietary knowledge and another binary measure to account for some weaker instruments of protecting firm-specific assets such as brands and copyrights (BRANDCOPY). The variable PAT does not only capture a way of preventing "free riding" but it also is an indicator of a firm's technological capabilities. Finally, we account for physical capital intensity (LCL; gross capital income as a percentage of value added, logarithm) since machinery also may contain a firm-specific element.

L-advantages

Firstly, we consider two directly R&D-related L-disadvantages of host locations, that is, "insufficient protection of intellectual property rights" (IPR) and "insufficient local availability of R&D personnel" (STAFF). Secondly, we include a general measure of institutional restrictions imposed on the foreign companies' economic activities (REGUL). According to a detailed inspection, this overall variable also captures, to a large extent, the information contained in several very specific institutional hindrances such as "enforced technology transfer", "minimum local content of value added required", etc. A special case among the L-variables is "cultural distance" (CULTDIST) as it explicitly is a "relational variable" rather than (solely) a characteristic of host countries. The four variables are binary measures with value 1 in case of high L-disadvantages of host countries and large cultural distance between home and host country.

The OLI model and the transaction cost theory predict that L-*dis*advantages of foreign locations reduce the propensity for foreign R&D activities. Moreover equity-based governance modes are less attractive than co-operative arrangements as they require larger resource commitments implying higher risks. Although the same may be true in case of CULTDIST (in particular in the propensity equation) there are theoretical arguments implying a positive correlation between this variable and foreign R&D (in particular in the mode equation). If a foreign unit is not sufficiently able to absorb the knowledge transferred by the parent firm (Morschett et al., 2010), or if the parent company is in a position to enforce its specific way of operating to the foreign unit (Anderson and Gatignon, 1986), an equity-based governance mode may be superior. It is thus not surprising that the empirical literature, according to the meta-analysis of Tihanyi et al. (2005), is inconclusive in this matter. Consequently, we do not formulate an *a priori* sign expectation for CULTDIST.

I-advantages

To account for I-advantages of a parent company we include in the model a firm size variable (LL; number of employees, logarithm). Firm size captures I-advantages (e.g. advantages of large firms in international R&D management that is an important instrument for internalising the outcome of R&D activities), but this variable also represents size-related factors not explicitly included in the model which reflect O-advantages (e.g. easier access to capital markets for large firms). We thus expect that large firms

[10] In a strict sense, asset specificity is suitable for explaining high- vs. low-control entry modes only in case of vertical relationships. Information asymmetry is more relevant as an explanatory variable than asset specificity if the relationship between the domestic firm and the foreign unit is horizontal. In empirical practice, however, R&D and human capital intensity are used as indicators of asset specificity as well as information asymmetry (see Brouthers and Hennart, 2007). In addition, the two variables also are core element of the OLI model (O-advantage). The various concepts are thus "observational equivalent".

are more likely than small companies to invest abroad in R&D and to choose an equity-based governance mode. We also account for the costs of coordinating foreign and domestic R&D activities (COORD; high vs. low costs), expecting a deterring effect of high costs in case of RDFOR (negative sign). In contrast, co-ordination costs should be positively related to RDFOR_EQ as they can be lowered by choosing a high-control governance mode (reduced monitoring costs, etc.; see e.g. Brouthers and Hennart, 2007).

Motives

As argued in subsection 2.2, the OLI model, implies that the *mode choice* also is influenced by a parent company's motivation for investing abroad in R&D. This aspect got some attention in the entry mode literature only in recent years. It was found that market-seeking motives (if related to market expansion rather than to the defence of markets) are positively associated with high-control entry modes (Tsai and Cheng, 2002; Gil et al., 2006); this result, however, is not very robust (Morschett et al., 2010). The same applies for cost-reducing motives; for example, Shi et al. (2001) did not find a significant relationship between this type of motive and entry mode choice. Moreover, the results of studies where cost-reducing objectives are one element of an aggregated variable reflecting resource-seeking motives are ambiguous; some authors found a positive association with high-control entry modes (e.g. Shan, 1991), whereas others got the opposite result (e.g. Gil et al., 2006).

In this study we distinguish market-oriented (RDMARK), cost-reducing (RDCOST) and knowledge-seeking (RDKNOW) foreign R&D (binary measures; high vs. low importance). RDMARK captures the importance of foreign R&D as a means to supporting foreign production and sales. The cost-reducing motive (RDCOST) represents the relevance of lower labour and capital costs of R&D and higher R&D-specific subsidies/tax allowances at foreign locations. The knowledge-seeking motive (RDKNOW) reflects the intention of firms to capitalise on an ample supply of R&D personnel in host countries, the proximity to top universities and/or to highly innovative firms as well as the relevance of the (reverse) technology transfer to the parent firm.

We hypothesise that RDMARK, primarily reflecting O-advantages of the parent firm but also L-advantages of host countries (large and/or strongly expanding markets), is positively related to RDFOR_EQ. By choosing a high-control mode a firm can appropriate the entire gains resulting from additional sales due to sales-supporting foreign R&D. RDCOST, indicating L-advantages of host countries, may also have a positive effect if they are a means to improving a firm's competitive position; however, if they only are a substitute for domestic R&D there is not much incentive for preferring the one to the other mode of governance. Consequently, we have no a priori sign expectation with respect to this type of motive. Finally, as RDKNOW basically captures L-advantages of host countries one would expect a positive effect on RDFOR_EQ. However, there also are good reasons for expecting a negative sign. If a firm seeks to access knowledge residing in a foreign firm by means of M&A activities it may also has to buy undesired assets and capabilities not suited to its objectives; moreover, it may be difficult to extract knowledge from the target firm's R&D activities as these are embedded in a unique company culture. Hence, acquiring complementary knowledge through M&A can be very costly (for these arguments see Hennart and Reddy, 1997 as well as Reuer and Koza, 2000). Besides, firms often seek to acquire very specific pieces of knowledge that can be accessed in a flexible and efficient way through co-operative agreements (see e.g. Dunning, 1997). In view of these opposite effects we expect that RDKNOW, on balance, is not or even negatively correlated to RDFOR_EQ.

Region-specific experience

As mentioned before, we use basic international experience (export intensity) as O-variable explaining foreign R&D propensity ("identifying variable in the frame of the Heckman model"). In the *mode* equation, we differentiate foreign experience by target regions, presuming that the likelihood of choosing a high-control rather than a low-control governance mode depends on the specific regional relatedness on which a firm's foreign experience is based. We hypothesise that experience gained from target regions which are, geographically and/or in terms of language/culture, particularly distant from the home country (e.g. Asia) creates larger O-advantages than experience stemming from transactions with more nearby countries (e.g. Western Europe).[11]

We assume that a firm benefits from experience with a specific foreign region if it is present there through exports and/or FDI (value 1 of the respective region dummy); EU15/EFTA is used as reference region (value 0) as practically all firms export their products to this nearby, culturally similar area. Consequently, we expect a positive sign for the dummies representing experience from transactions with the four, more distant regions distinguished in this paper, that is, EAST (Eastern Europe), ASIA (Asian Countries), NAFTA (North America/Mexico) and ROW (rest of the world). We presume that the preference for an equity-based governance mode is highest in case of ASIA and ROW (the two most "distant" regions). Whether the coefficient of EAST (different culture, short distance) or NAFTA (similar culture, long distance) is larger, is a priori not clear. Besides, we expect that region-specific experience effects are larger in the Austrian case than for (multilingual) Switzerland whose economy since long is internationalised to a very high degree; in the Swiss case a positive experience effect is most likely in case of EAST as economic relations with this region were intensified only in recent years.

General controls variables

We expect that foreign-owned companies (dummy variable FOR) are less likely to perform foreign R&D than domestic firms since they often only produce for the domestic market and may benefit from knowledge obtained from their parent company. If foreign-owned firms are active abroad in R&D they probably seek, in the first place, very specific knowledge (not available within the company group) that can be sourced through R&D co-operations.[12] Besides, we take account of firm age (LAGE; number of years, logarithm) which, as it also may reflect international experience, should be positively related to RDFOR and RDFOR_EQ. Finally, we control for a firm's affiliation to a specific industry (propensity equation; nine dummies) or sector (mode equation; three dummies)[13] to account for an "omitted variable bias" (for definition of the industries/sectors see Table 2). The relevance of industry/sector effects is demonstrated by Zhao et al. (2004) in their meta-analysis of empirical studies. It turned out that "industry type" significantly moderates the influence of the core explanatory variables postulated in the seminal paper of Anderson and Gatignon (1986).[14]

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[11] For econometric reasons the variables representing region-specific foreign experience are also included in the propensity equation (in addition to "export intensity" representing "basic foreign experience").

[12] Equity-based governance modes are likely to be considered only if a foreign-owned firm has explicitly a group-wide R&D mandate in a specific field of competence.

[13] In case of the mode equation, a disaggregation by industry (instead of sectors) was not feasible given the relatively low number of observations.

[14] More specifically, Brouthers and Brouthers (2003) and Erramilli and Rao (1993) showed that the determinants of the mode choice significantly differ between manufacturing and service firms.

5.2 Model B: Effect of foreign R&D and its governance mode on firm performance

5.2.1 Innovation equation (Model B1)

As dependent variable of the equation explaining a firm's innovation performance in the home country ("innovation equation") we used "sales of innovative products" (new or considerably improved products) per employee (LINNL; logarithm). In this case, the tobit procedure is an adequate estimation method. RDFOR and RDFOR_EQ are the explanatory variables we are interested in. We expect that firms performing R&D at foreign locations are more innovative than those without such activities (positive sign of RDFOR; hypothesis H2a) and presume that this effect is larger in case of an equity-based governance mode than a non-equity co-operative mode (positive sign of RDFOR_EQ; hypothesis H2b).

To get reliable estimates of the impact of RDFOR and RDFOR_EQ on innovation performance (LINNL), we also inserted the "standard variables" used in the literature for explaining a firm's innovativeness (for exact definitions of these variables see Table 3).[15] Such variables are physical and human capital input (LCL, LHC) representing a firm's resource endowment; the appropriability of a firm's knowledge (PAT, BRANDCOPY); the competitive environment captured by the market structure (COMP) as well as the intensity of price and non-price competition (IPC, INPC; high/low intensity). Finally, we insert controls for firm size (LL; logarithm of the number of employees), foreign/domestic ownership (FOR), firm age (LAGE; logarithm) and industry/sector affiliation. Based on the standard empirical evidence from the innovation literature we expect positive innovation effects of resource endowment (LCL, LHC), appropriability (PAT, BRANDCOPY), intensity of non-price competition (INPC) and foreign ownership (FOR). A positive effect of IPC, if it actually exists, is expected to be small since this type of competition favours process rather than product innovations. Finally, there is no clear sign expectation with respect to market concentration (COMP), firm size (LL) and firm age (LAGE).

Table 3 (about here)

5.2.2 Productivity equation (Model B2)

As dependent variable of the productivity equation we use a parent firm's average labour productivity in the home country measured by value added per employee (LQL, logarithm). In this case, OLS is an appropriate estimation procedure. We expect that RDFOR positively affects a parent firm's productivity (hypothesis H3a), and that this effect is larger in case of an equity-based governance mode than a non-equity co-operative mode (positive sign of RDFOR_EQ; hypothesis H3b).

To get reliable estimates of the productivity effect of RDFOR and RDFOR_EQ, we additionally have to include the standard input factors of a production function, that is, physical and human capital (LCL, LHC) as well as "knowledge capital" (LRDL; R&D expenditures per employee, logarithm). The three input factors are expected to positively affect a parent firm's labour productivity. We further include the same general control variables we used in the innovation equation (LL, FOR, LAGE, industry/sector dummies). Based on the literature we expect a positive sign for foreign ownership (FOR), but have no a priori sign expectations with respect to LL and LAGE.

[15] To be clear, these variables are only used as controls and not for testing an innovation model.

5.3 Methodological problems

5.3.1 Sample selection bias

RDFOR_EQ is measured only for firms having actually invested abroad in R&D (truncated sample) what may give rise to a selection bias in estimating the "mode equation" in Model A. We accounted for this problem by applying a Heckman correction (Heckman, 1979). Hence, to get unbiased estimates of the coefficients of the "mode equation" (dependent variable RDFOR_EQ) we used the "propensity equation" (dependent variable RDFOR) as selection equation.

Estimation of the Heckman model showed, however, that selectivity *effectively* is not a problem; the correction term ("inverse mills ratio") inserted in the mode equation is statistically insignificant at the 10% test level in the Swiss as well as the Austrian case (see Table 4, columns 2 and 5). Therefore, we can estimate the propensity and the mode equation of model A independently (two separate probit estimations).

5.3.2 Endogeneity

The analysis is based on cross-sectional data what is characteristic for entry mode research (rare exceptions are Barkema, et al., 1996 or Chen and Chang, 2011), and, to a lesser extent, also for studies dealing with the determinants of overall foreign R&D as well as with the impact of overall foreign R&D on firm performance. As a consequence, all explanatory variables are, in a strict sense, suspicious of being endogenous. A specific issue of endogeneity arises in case of the governance mode which is our variable of interest in explaining firm performance. This problem is hardly ever accounted for in entry mode research although it is relevant also in empirical terms.[16] Although we control in all performance equations (Model B) for a potential endogeneity of RDFOR and RDFOR_EQ we also cannot evade the (general) endogeneity problem which is inherent in any cross-sectional analysis. Therefore, rather than making causal claims, we interpret the estimated coefficients as partial correlations. This still allows to assessing whether the results are in line with our hypotheses.

We tested for endogeneity of RDFOR and RDFOR_EQ in the performance equations (model B1: innovation output; model B2: productivity) by applying the procedure proposed by Rivers and Vuong (1988).[17] In the Austrian case, the coefficients of the residuals (predicted value of the instrumented variables minus value of the original variables) were not significant at the 10% test level; there is thus no evidence for an endogeneity of the two explanatory variables in any of the estimated performance equations. For Switzerland, endogeneity cannot be rejected in the innovation equation but only when RDFOR is used as explanatory variable; the estimates of the other three equations, that is, RDFOR_EQ in the innovation model as well as RDFOR and RDFOR_EQ in the productivity model do not point to endogeneity. Given these results we proceeded as follows: If there is no indication for an endogeneity bias, we used the equations based on the original variables. In the one case where the test pointed to an endogeneity problem we performed a two stage IV-tobit estimation where the predicted value of the variable RDFOR was used as explanatory variable in the second stage equation (see Wooldridge, 2002).

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[16] Shaver (1998), to our knowledge the only study in entry mode research which adequately dealt with this problem, found that performance differences of M&A and greenfield entry disappeared as soon as model estimation accounted for the endogeneity of the mode variable.

[17] Throughout, the endogeneity tests were based on *strong* instruments. For all potentially endogenous variables of model A and B the estimates of the instrumental equations and the tests of significance of the coefficients of the residuals are documented in detail and are available on request.

This procedure yielded the final estimate of the coefficients of RDFOR in the innovation equation (see Table 5, column 1).

We also tested for the endogeneity of the variables “export intensity” (X2, X3) and “R&D intensity” (LRDS) that are used in model A to explain the propensity for foreign R&D. For both variables the Rivers Vuong test did not indicate an endogeneity problem (10% test level) neither for the Swiss nor the Austrian sample.

6 Empirical results

6.1 Results of model A: Determinants of the propensity and the governance of foreign R&D

6.1.1 Propensity for foreign R&D

Hypothesis H1a postulates that the propensity for foreign R&D (RDFOR) can be explained by variables representing O-, L- and I-advantages. The model estimates (see Table 4, columns 1 and 4) show that this is largely the case. The explanatory power of the OLI model is high for the Swiss as well as the Austrian case. Hypothesis H1a is thus confirmed for both countries.

More specifically, it turns out that the (majority of) O-variables show the expected positive sign for both countries: R&D intensity (LRDS), human capital intensity (LHC), brands/copyrights (BRANDCOPY; Austria only), basic foreign experience (X2, X3) and experience from (part of) region-specific transactions. L-disadvantages of host countries are relevant but not to the same extent as O-advantages. We find statistically significant effects only for two out of the four indicators, that is, cultural distance (data for Switzerland only) and "insufficient protection of property rights" (IPR). The latter L-disadvantage of host countries significantly deters Austrian firms from investing in foreign R&D (negative sign); in the Swiss case, we find for IPR, in contrast to the expectations, a positive sign, meaning that an insufficient legal protection of knowledge (IPR) is a restriction primarily for companies that already have located abroad some R&D activities. Firms may become aware of this L-disadvantage, or effectively suffer from it, not until they have invested in R&D at foreign locations.[18] Besides, a positive sign of IPR also may reflect the fact that it is quite natural that firms complement already existing production facilities with R&D activities, even if the local IPR regime is not satisfactory ("stages view of internationalisation"). Cultural distance (CULTDIST) is positively related to the propensity for foreign R&D, reflecting, for example, that a direct presence abroad, in many instances, is superior to an export strategy as a means to develop foreign markets (R&D-based product adaptation to local needs). I-variables also influence the likelihood of foreign R&D as large firms (LL; Austria only) are more inclined to invest in foreign R&D, and high coordination costs (COORD; Switzerland only) deter companies from locating R&D abroad. Finally, a competitive market environment (COMP), as expected, favours investments in foreign R&D. All in all, we find for both countries that the three building blocks of the OLI model significantly contribute to the explanation of RDFOR, with O-advantages as the dominant driver.

Table 4 (about here)

6.1.2 The choice of the governance mode

Hypothesis H1b postulates that O-, L- and I-advantages are stronger related to the equity-based governance mode than to the non-equity co-operative mode. The model estimates support this proposition for *both countries* (see Table 4, columns 3 and 6).[19] In the Swiss case, all categories of explanatory variables (although not all covariates) significantly contribute to correctly predicting the mode choice

[18] For a similar argument see the empirical innovation literature dealing with the relationship between "obstacles to innovation" and "innovation output" which, for many obstacles, persistently finds a positive sign (see, for example, D'Este et al., 2012).

[19] We do not comment the estimates of the Heckman model as the inverse mills ratio is statistically insignificant (see Table 4, columns 2 and 5).

(RDFOR_EQ): O-variables including regions-specific experience and market-oriented motives as well as L- and I-variables. The estimates for Austria only confirm the OL-part of the model, but the overall model fit is high in this case as well.

A thorough inspection of the results shows that, among the O-variables, resource use (human capital), region-specific foreign experience and market-oriented strategic motivations are significantly determining RDFOR_EQ. Human capital (LHC) and market-orientation (RDMARK) are relevant for the firms of both countries, whereas region-specific experience, as expected, is more influential in case of Austria. In view of the very large and regionally highly diversified FDI stock of the Swiss economy, it is not surprising that for Swiss firms only experience from transactions with the "relatively new" target region Eastern Europe (EAST) is relevant. In contrast, region-specific foreign experience is a highly important factor for explaining RDFOR_EQ in case of Austria (ASIA, NAFTA, EAST).[20] This pattern is characteristic for an early phase of internationalisation where firms are forced to gain experience successively building up relationships with specific little-known host regions. The relative importance of the different region-specific experience variables, with ASIA coming first, is in line with the expectations. The results for the strategy variables – in addition to the already mentioned positive effect of market-seeking motives (RDMARK) – also do not contradict the expectations. Cost-reducing motives (RDCOST) are neutral with respect to RDFOR_EQ and knowledge-seeking R&D (RDKNOW) is negatively related to RDFOR_EQ in the Austrian case, and, as a tendency, in Switzerland as well.

Among the L-disadvantages of host countries, we found, as expected, a negative sign for "restrictive regulatory framework" (REGUL; Austria only); in the Swiss case, "insufficient protection of property rights" (IPR) *tends* to negatively affect the propensity to choose an equity-based governance mode but this effect is statistically not significant at the 10% test level. Moreover we find that Swiss companies seek to overcome the uncertainties entailed by cultural distance (CULTDIST; no data for Austria) by opting for an equity-based governance mode (i.e. the net effect of the opposite forces mentioned in subsection 5.1.2 turns out to be positive). I-advantages only are statistically significant in the Swiss case (positive sign). This holds true, as expected, for firm size (LL) as well as for high coordination costs (COORD) that can be reduced by choosing a high-control mode of governance (lowering monitoring costs, etc.). Finally, industry/sector affiliation significantly influences the mode choice in both countries what indicates the importance of controlling for unobserved heterogeneity among industries/sectors.

6.2 Results of model B: Impact on firm performance of the propensity and governance of foreign R&D

6.2.1 Model B1: Innovation performance

Hypothesis H2a postulates that innovation performance is higher in parent firms locating some R&D abroad than in companies not doing so. This proposition is *confirmed* for *both countries* as we find a significant positive effect of RDFOR on a firm's innovativeness (LINNL), having accounted for endogeneity where it is required and having controlled for the standard determinants of innovation, some structural firm characteristics and industry effects (see Table 5, columns 1 and 3). The contribution of foreign R&D to a firm's innovativeness is significantly stronger in Switzerland than in Austria.

In the *Swiss* case, almost all variables for which there are a priori sign expectations show the presumed effect on innovation output: resource use (LCL, LHC), appropriability (PAT only) and foreign ownership (FOR); the only exception is the intensity of non-price competition (negative sign of INPC). Interestingly, smaller and younger firms are more innovative than larger and older ones. The estimates based on

[20] We have no explanation for the negative sign of ROW.

Austrian data show a very similar pattern. Compared to Switzerland the effect of resource use is weaker, whereas the opposite is true in case of appropriability. The impact of structural firm characteristics does not much differ between the two countries.[21]

Table 5 (about here)

Hypothesis H2b states that the contribution of foreign R&D to a parent firm's innovation performance is higher in case of an equity-based than a non-equity co-operative mode of R&D governance. For *both countries*, this hypothesis is *not supported* as the coefficient of RDFOR_EQ is statistically insignificant, having controlled for the explanatory variables of a standard innovation model and some structural firm characteristics (see Table 5, columns 2 and 4).

We found some evidence for the expected effects of the standard determinants of innovativeness but it is not very strong. A parent firm's innovation output is influenced by human capital input and the market environment in the Swiss case, whereas in Austria appropriability and physical capital intensity (negative sign, meaning that capital-intensive firms are less innovative than other companies) are relevant. Moreover, some of the structural characteristics of firms (superior innovation performance of foreign-owned firms) and industries (Austria only) are statistically significant.

All in all, we conclude from the estimates of model B1 that, in both countries, foreign R&D raises a parent firm's innovation output (in line with hypothesis H2a); however, the (positive) innovation effect seems to be independent of the choice of the one or the other governance mode (contrary to hypothesis H2b).

6.2.2 Model B2: Labour Productivity

Hypothesis H3a postulates that a parent firm which locates some R&D abroad is more productive than a company not doing so. This proposition is confirmed *only for Switzerland*. In this case, RDFOR exerts a positive and statistically significant influence on a company's labour productivity (LQL), having controlled for the standard factor inputs (production function), some structural firm characteristics and industry effects (see Table 6, column 1).

In the *Swiss* case we found, in line with production theory, that the coefficients of all input factors, i.e. the intensity of use of physical (LCL), human (HCL) and "knowledge capital" (LRDL), are positive and significant at the required test level. Besides, foreign-owned companies (FOR) are more productive than domestic ones. In the *Austrian* case, the production function part of the model fails as none of the factor inputs is statistically significant (see Table 6, columns 3).

Table 6 (about here)

Hypothesis H3b postulates that the contribution of foreign R&D on a parent firm's labour productivity is higher in case of an equity-based than a non-equity co-operative mode of governance. This hypothesis is not confirmed for the two countries. However, in the *Swiss case*, the positive coefficient of RDFOR_EQ *nearly* passes the test of significance at the 10% test level (p=.12), having controlled for the standard factor inputs, some structural firm characteristics and sector effects (see Table 6, column 2). Hence we may conclude that, in Switzerland, parent firms using an *equity-based* governance mode *tend* to benefit more from their foreign R&D activities in terms of labour productivity than companies relying on a co-operative mode. Consequently, the Swiss results, at least as a *tendency*, seem to be in line with hypothesis H3b. In contrast, hypothesis H3b is clearly *rejected* in the *Austrian case* (see Table 6, column 4).

[21] The superiority of foreign-owned firms in terms of innovativeness is more pronounced in Austria than in Switzerland what may reflect the very high significance of German companies in that country.

All in all, we conclude from the estimates of model B2 that, in Switzerland foreign R&D raises a parent firm's labour productivity (in line with hypothesis H3a) and that the equity-based governance mode *tends* to be superior in this respect to a non-equity co-operative mode (confirming, though only as a *tendency*, hypothesis H3b). In the Austrian case, both H3a and H3b are rejected.

7 Summary and conclusions

Over the last two decades internationalisation of R&D not only strongly increased but also changed its pattern quite considerably. One of these structural changes was the increasing significance of less hierarchical modes of control of foreign activities such as JV and non-equity co-operations with foreign partners. Against this background we analysed two issues: (1) Which factors drive a firm to locate R&D activities abroad, and why some parent companies choose an equity-based rather than a non-equity co-operative mode of R&D governance? (2) What is the impact of foreign R&D on a parent firm's innovativeness and labour productivity, and are there differences in this respect between the two governance modes?

The econometric analysis of these topics is based on cross-sectional firm data stemming from comparable surveys conducted in the business sector of the Swiss and the Austrian economy in the year 2010. We separately estimated for the two countries almost identically specified empirical models. Switzerland and Austria are interesting cases as they strongly differ with respect to level and pattern of internationalisation of R&D.

The paper complements previous research, firstly, by analysing the choice among alternative governance modes and their differential effect on the parent firm's performance (innovation, productivity) for the specific case of foreign R&D. Secondly, we account for potential problems arising from a selection bias in explaining the mode choice and from endogeneity in identifying the performance effects of foreign R&D. Thirdly, we provide a comparative analysis for two structurally different countries, using the same theoretical framework and model specification as well as very similar data. Therefore, we are able to identify country-specific patterns what might be more difficult by comparing results from "stand-alone" country studies.

The results of the empirical tests of the hypotheses are summarised in Table 7.

Table 7 (about here)

For both countries the OLI model is well suited to explain the likelihood of a firm to perform R&D at foreign locations as well as to choose an equity-based rather than a non-equity cooperative governance mode (model A). The *propensity* to invest abroad in R&D (*hypothesis H1a*) is positively affected by a parent firm's O-advantages (knowledge-related capabilities, proprietary knowledge, general and region-specific international experience) and I-advantages (firm size, coordination costs), whereas L-(dis)advantages (weak IPR's in host countries, cultural distance) are a less important factor determining foreign R&D. Besides, investments in foreign R&D are more likely in a highly competitive market environment. This overall pattern of explanation is largely in line with the results of previous research (see subsection 2.3.1).

In concordance with *hypothesis H1b*, all categories of variables of the OLI model – in the Austrian case only the OL-part – contribute to correctly predicting the choice of the *governance mode* of foreign R&D. Most influential are O-advantages of the parent firm (resource endowment, appropriability of knowledge, region-specific international experience, market-oriented motives of foreign R&D). The remaining statistically significant determinants of the mode choice are positively related to high-control governance in the Swiss case (L-advantages: large cultural distance; I-advantages: high coordination costs, firm size), whereas the opposite is true for Austrian firms (L-(dis)advantages: unfavourable regulatory framework in host countries; knowledge-seeking motives).

All in all, the OLI model is a robust framework for analysing the determinants of foreign R&D and the respective choice of the governance mode as we find many similarities of the basic pattern of explanation among the two countries. This could not be taken for granted given the significantly higher degree and (regional) diversification of internationalisation of the Swiss compared to the Austrian economy and the differences with respect to the industry and firm size structure of the two samples (although partly controlled for by dummy variables). Nevertheless, there also are important divergences which, however, seem to be quite plausible in view of the disparities in the level and pattern of internationalisation of the two countries. Experience from transactions with distant regions is a highly relevant factor only in the Austrian case, what reflects the fact that many Swiss firms (already) are accustomed to interact with partners all over the world. The long-standing international experience may also explain why only Swiss firms are capable to a significant degree to internalise the risks and uncertainties of R&D at foreign locations (arising from large cultural distance, weak IPR's or high coordination costs).

Model B deals with the effect of foreign R&D activities on firm performance measured by innovation output (model B1) and, alternatively, labour productivity (model B2). In both countries, overall foreign R&D significantly raises a parent firm's *innovation* performance. This effect is much stronger in the Swiss case. These results are in line with *hypothesis H2a* and confirm the findings of previous research (see subsection 3.1.2). However, none of the two modes of R&D governance is superior in terms of the impact on innovation output; hence, *hypothesis H2b* postulating a higher innovation effect of the equity-based governance mode has to be rejected for both countries.

In the Swiss case, overall foreign R&D also raises a parent firm's *labour productivity*, whereas such an effect could not be detected for Austrian companies. The results for Switzerland are thus in line with *hypothesis H3a* and the majority of previous research (see subsection 3.1.3). However, we could not find a statistically significant difference among the two governance modes of foreign R&D with respect to a parent firm's productivity. This holds true without any doubt for Austria, whereas in the Swiss case, at least as a tendency, the contribution to productivity is quite clearly higher in case of an equity-based mode of operation. Hence, *hypothesis H3b* – in our judgement – gets some support for Switzerland but has to be rejected for Austria.

The differences between the two countries with respect to the impact of foreign R&D on the parent firms' innovativeness and productivity may again be due to the much stronger presence of Swiss firms at foreign locations and the respective long-standing experience. In these circumstances, foreign R&D might be well integrated in the knowledge and value creating process of parent firms implying relatively strong performance feedbacks of foreign activities.

Although our analysis goes beyond previous research in important respects, there obviously remain several limitations. Firstly, we could not fully exploit the potential of a one-two-one comparative approach since the Swiss and the Austrian sample could not be constructed according to the same statistical principles (random vs. non-random sample); nevertheless, this problem is mitigated as we controlled in all model estimates for firm size and industry affiliation. Secondly, the analysis is based on cross-sectional data (like almost all entry mode studies). Therefore, it is not feasible to analyse dynamic aspects (sequence and path-dependency of the mode choice; time-lag of performance effects) what implies that, in a strict sense, it is not possible to identify causalities. Finally, it is implicitly assumed that a firm selects a specific governance mode of foreign R&D independent of respective choices made by other companies, and that the mode choice is not influenced by other strategic decisions of the own company (optimisation of the whole portfolio of foreign activities, etc.). This deficiency can probably be tackled only by extending the analytical approach (see, for example, the perspective given in Asmussen et al., 2009).

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Table 1: Share of Firms with Foreign R&D by Mode of Foreign R&D [1]
(% of all R&D performing firms)

	SWITZERLAND			AUSTRIA		
	Firms with			Firms with		
	Foreign R&D	Non-equity-based mode of foreign R&D	Equity-based mode of foreign R&D	Foreign R&D	Non-equity-based mode of foreign R&D	Equity-based mode of foreign R&D
	% of *all* R&D performing firms (N = 659)			% of *all* R&D performing firms (N = 284)		
	(1)= (2)+(3)	(2)	(3)	(4)= (5)+(6)	(5)	(6)
Industry / Sector						
High-tech manufacturing	31.2	9.8	21.4	48.3	24.1	24.1
Chemicals / Pharma (20, 21)	27.3	14.6	12.7	47.6	23.8	23.8
Electronics (26, 27)	36.8	12.3	24.6	59.5	21.4	38.1
Machinery (28)	32.7	7.1	25.7	38.5	28.2	10.3
Other (22, 29, 30)	17.8	4.4	13.3	42.9	21.4	21.4
Low-tech manufacturing	11.7	2.4	9.3	55.0	23.3	31.7
Metalworking (24, 25)	15.4	6.2	9.2	55.6	27.8	27.8
Other (10-19, 23, 31, 32, 33)	10.0	0.7	9.3	54.8	21.4	33.3
Knowledge-intensive Services	22.2	8.6	13.6	50.0	39.8	10.2
ICT / R&D (61- 63, 74, 85)	24.0	20.0	4.0	50.0	33.3	16.7
Finance / HQ (64, 65, 70)	26.3	0.0	26.3	50.0	50.0	0.0
Business services. (71, 72)	18.9	5.4	13.5	50.0	42.9	7.1
Other industries [2]	17.4	4.4	13.0	35.0	15.0	20.0
Firm Size (number of employees)						
5 to 49	14.0	8.8	5.3	43.4	35.3	8.1
50-249	18.9	4.8	14.1	40.0	18.7	21.3
250 and more	37.1	8.6	28.4	69.9	24.7	45.2
Total	23.1 (N = 152)	7.0 (N =46)	16.1 (N = 106)	49.3 (N = 140)	28.2 (N = 80)	21.1 (N = 60)

Source: Swiss Survey on Internationalisation 2010; Austrian Survey on R&D Internationalisation 2010.

[1] The two modes of foreign presence exclude each other. Firms belonging to the category "Non-equity-based mode of foreign R&D (co-operation)" are *exclusively* operating in this mode of foreign R&D activities. The other category contains firms with "equity-based mode of foreign R&D", i.e. R&D in wholly-owned foreign affiliates or joint ventures (majority or minority capital stake), which, in some cases, also maintain *additionally* an R&D co-operation with a foreign partner.

[2] Agriculture (A); Electricity, etc. (D); Water supply, etc. (E); Construction (F); Wholesale and retail trade (G); Transportation and storage (H); Accommodation and food services (I); Real estate (L); Administrative and support service activities (N).

Table 2: Specification of the Explanatory Variables in Model A: Foreign R&D

Explanatory variables	Description	Foreign R&D yes/no RDFOR	Equity- vs. non-equity-based mode of foreign R&D RDFOR_EQ
O-advantages			
LRDS	R&D expenditures as a percentage of sales (logarithm)	+	+
LHC	Personnel with tertiary degrees as a percentage of total employment (logarithm)	+	+
LCL	Investment in physical capital per employee (logarithm); (Switzerland: firm level; Austria: industry level)	+	+
Knowledge protection (Dummy variables with value 1 if the specific protection instrument is used (Austria) or is highly effective (Switzerland); otherwise 0)			
PAT	Patents	+	+
BRANDCOPY	Brands, copyrights	+	+
International experience (Dummy variables with value 1 for a specific range of the sales share of exports; otherwise 0)			
X2, X3	Share of exports of 26-70% and 71-100% resp.; reference group: X1, i.e. 0-25%	+	/
Region-specific foreign experience (through exports and/or FDI) (yes/no; dummy variables with EU/EFTA as reference group)			
EAST	Eastern Europe	+	+
ASIA	China, India, other Asian countries	+	+
NAFTA	USA, Canada, Mexico	+	+
ROW	Rest of the World (excl. Western Europe)	+	+
L-disadvantages of the host location Obstacles to foreign R&D in (potential) host countries (Dummy variables with 1 for high importance of a specific obstacle; otherwise 0)			
REGUL	Excessive regulation of economic activity	-	-
IPR	Insufficient protection of intellectual property rights	-	-
STAFF	Insufficient supply of R&D personnel	-	-
CULTDIST	Large cultural distance (Switzerland only)	?	?
I-advantages / Firm size			
LL	Number of employees (logarithm)	+	+
COORD	High coordination costs	-	+
Market environment Market structure (number of principal competitors)			
COMP	*Switzerland*: Share of firms with more than 15 principal competitors (3-digit industry level); *Austria*: Dummy variable with value 1 for more than 15 competitors; otherwise 0 (firm level)	+	/

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Explanatory variables	Description	Foreign R&D yes/no RDFOR	Equity- vs. non-equity-based mode of foreign R&D RDFOR_EQ
Motives of foreign R&D (Dummy variables with 1 for high importance of a specific motive; otherwise 0)			
RDMARK	Market-oriented foreign R&D	/	+
RDCOST	Cost-oriented foreign R&D	/	?
RDKNOW	Knowledge-seeking foreign R&D	/	(-)
Control variables			
FOR	Foreign-owned firm (yes/no; dummy variable)	-	-
LAGE	Firm age (number of years; logarithm)	+	+
IND_1, …, IND_9	Nine industry dummy variables with ”other industries” as reference group (for definition see Table 1)	yes	/
S1, S2, S3	Three sector dummy variables (S1: high-tech manufacturing, S2: knowledge-intensive services, S3: other industries) with low-tech manufacturing as reference group (for definition see Table 1)	/	yes

Variables not used in the one or the other equation are marked with /.

Table 3: Specification of the Explanatory Variables in Model B: Firm Performance

		Innovation equation	Productivity equation
Explanatory variables	Description	Sales of innovative products per employee (logarithm) LINNL	Value added per employee (logarithm) LQL
Foreign R&D			
RDFOR *or* ***alternatively***	Foreign R&D yes/no (dummy variable)	+	+
RDFOR_EQ	Equity-based mode of foreign R&D (value 1) vs. non-equity mode of foreign R&D (value 0))	+	+
Resource use			
LCL	Investment in physical capital per employee (logarithm); (Austria: industry level)	+	+
LHC	Personnel with tertiary degrees as a percentage of total employment (logarithm)	+	+
LRDL	R&D expenditures per employee (logarithm)	/	+
Appropriability (Dummy variables with value 1 if the specific protection instrument is used (Austria) or is highly effective (Switzerland); otherwise 0)			
PAT	Patents	+	/
BRANDCOPY	Brands, copyrights	+	/
Market environment			
Market structure (number of principal competitors)			
COMP	*Switzerland*: Share of firms with more than 15 principal competitors (3-digit industry level); *Austria*: Dummy variable with value 1 for 15 or more competitors; otherwise 0 (firm level)	?	/
Intensity of competition on the firm's principal markets worldwide (Dummy variables with value 1 for high intensity of competition; otherwise 0; Austria: firm level; Switzerland 3-digit industry-level)			
IPC	Intensity of price competition	?	/
INPC	Intensity of non-price competition	+	/
Control variables			
LL	Number of employees (logarithm)	?	?
FOR	Foreign-owned firm (yes/no; dummy variable)	+	+
LAGE	Firm age (no. of years; logarithm)	?	?
IND_1, …, IND_9	Nine industry dummy variables with "other industries" as reference group (for definition see Table 1)	yes	/
S1, S2, S3	Three sector dummy variables (S1: high-tech manufacturing, S2: knowledge-intensive services, S3: other industries) with low-tech manufacturing as reference group (for definition see Table 1)	/	yes

Variables not used in the one or the other equation are marked with /.

Table 4: Results for Model A: Determinants of Foreign R&D

	SWITZERLAND			AUSTRIA		
Explanatory Variables	Foreign R&D yes / no (RDFOR)	Equity- vs. non-equity-mode of R&D governance (RDFOR_EQ)		Foreign R&D yes / no (RDFOR)	Equity- vs. non-equity-mode of R&D governance (RDFOR_EQ)	
	Probit	Heckman	Probit	Probit	Heckman	Probit
O-advantages						
LRDS	.125*	-.028	-.063	.151**	-.225	-.193
	(.068)	(.150)	(.125)	(.064)	(.146)	(.140)
LHC	.242**	.623*	.601*	.064*	.477**	.489**
	(.123)	(.344)	(.337)	(.036)	(.237)	(.233)
LCL	.096	-.096	-.115	.145	-.311	-.290
	(.090)	(.119)	(.123)	(.200)	(.328)	(.343)
PAT	.085	-.316	-.337	.082	-.258	-.257
	(.184)	(.366)	(.358)	(.217)	(.442)	(.447)
BRANDCOPY	.120	-.185	-.226	.578***	1.13*	1.24***
	(.178)	(.429)	(.415)	(.207)	(.582)	(.471)
X2	.581**	/	/	.589**	/	/
	(.264)			(.288)		
X3	.684***	/	/	.655**	/	/
	(.251)			(.311)		
Region-specific foreign experience						
EAST	.134	1.28***	1.29***	.425*	.767	.878**
	(.216)	(.474)	(.480)	(.217)	(.531)	(.396)
ASIA	.566***	.780	.598	-.241	2.38***	2.41***
	(.210)	(.528)	(.426)	(.255)	(.730)	(.748)
NAFTA	.343	.250	.109	.100	1.10**	1.13**
	(.225)	(.544)	(.452)	(.276)	(.505)	(.511)
ROW	.704***	.183	-.007	.439*	-1.43**	-1.36**
	(.219)	(.500)	(.376)	(.255)	(.644)	(.542)

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	SWITZERLAND			AUSTRIA		
Explanatory Variables	Foreign R&D yes / no (RDFOR)	Equity- vs. non-equity-mode of R&D governance (RDFOR_EQ)		Foreign R&D yes / no (RDFOR)	Equity- vs. non-equity-mode of R&D governance (RDFOR_EQ)	
	Probit	Heckman	Probit	Probit	Heckman	Probit
L-disadvantages						
REGUL	-.097	.417	.430	-.192	-2.84**	-2.87**
	(.188)	(.390)	(.388)	(.380)	(1.22)	(1.208)
IPR	.694***	-.525	-.681	-.596***	-.561	-.649
	(.210)	(.494)	(.441)	(.221)	(.494)	(.452)
STAFF	-.211	.511	.501	-.132	-.486	-.521
	(.225)	(.438)	(.438)	(.289)	(.445)	(.426)
CULTDIST	.514**	2.15***	2.08***	na	na	na
	(.215)	(.514)	(.499)			
I-advantages /Firm size						
LL	.081	.396***	.363***	.183**	.083	.115
	(.070)	(.138)	(.139)	(.087)	(.143)	(.144)
COORD	-.494**	.841	.936*	.064	-.396	-.402
	(.223)	(.531)	(.548)	(.203)	(.456)	(.459)
Market environment						
COMP	.020*	/	/	.480*	/	/
	(.011)			(.246)		
Motives of foreign R&D						
RDMARK	/	1.08**	1.09**	/	.901**	.895**
		(.432)	(.436)		(.446)	(.443)
RDCOST	/	-.322	-.309	/	.247	.256
		(.411)	(.400)		(.351)	(.353)
RDKNOW	/	-.463	-.472	/	-3.25***	-3.26***
		(.343)	(.344)		(.799)	(.794)

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	SWITZERLAND			AUSTRIA		
Explanatory Variables	Foreign R&D yes / no (RDFOR)	Equity- vs. non-equity-mode of R&D governance (RDFOR_EQ)		Foreign R&D yes / no (RDFOR)	Equity- vs. non-equity-mode of R&D governance (RDFOR_EQ)	
	Probit	Heckman	Probit	Probit	Heckman	Probit
Control variables						
FOR	-.037	-.213	-.302	-.047	-.109	-.110
	(.198)	(.465)	(.438)	(.285)	(.411)	(.411)
LAGE	.045	-.375	-.346	.079	.552**	.552**
	(.118)	(.297)	(.301)	(.106)	(.215)	(.219)
INDUSTRY	sign. **	/	/	not sign.	/	/
SECTOR	/	sign. **	sign. **	/	sign. **	sign. **
Constant	-4.40***	-.2.92	-1.75	-3.30	.415	-.152
	(1.154)	(2.68)	(1.78)	(2.01)	(2.93)	(2.79)
Inverse mills ratio	/	.403	/	/	-.363	/
		(.762)			(1.22)	
Statistics						
N	478	110	110	223	107	107
Wald χ^2	166.9***	53.9***	54.9***	58.0***	39.2**	38.3**
Pseudo R^2	.412	.415	.413	.229	.564	.563
Correctly assigned (%)	86	82	82	73	88	88

Variables not used in the one or the other equation are marked with /. The estimates of the industry dummies have been throughout omitted; we only show the joint significance of all industry dummies.

Heteroskedasticity–robust standard errors in brackets (White procedure). The statistical significance of the parameters are indicated with ***, ** and * representing the 1%, 5% and 10% test level respectively.

Table 5: Results for Model B1: Impact of Foreign R&D on the Innovation Performance of the Parent Firm (LINNL)

	SWITZERLAND		AUSTRIA	
	Impact on LINNL of		Impact on LINNL of	
Explanatory variables	RDFOR (TSLS IV-Tobit)	RDFOR_EQ (Tobit)	RDFOR (Tobit)	RDFOR_EQ (Tobit)
Foreign R&D				
RDFOR	.939***	/	.343**	/
	(.288)		(.162)	
RDFOR_EQ	/	-.037	/	.100
		(.261)		(.200)
Resource use				
LCL	.106**	.180	-.086	-.358*
	(.043)	(.156)	(.165)	(.198)
LHC	.086**	.448**	.046**	-.010
	(.044)	(.197)	(.019)	(.025)
Appropriability				
PAT	.245*	-.084	.435***	.601**
	(.131)	(.238)	(.164)	(.265)
BRANDCOPY	.085	.024	.233	.218
	(.115)	(.276)	(.157)	(.218)
Market environment				
COMP	-.005	-.044***	-.081	-.223
	(.008)	(.015)	(.183)	(.312)
IPC	-.002	.0345**	.053	-.006
	(.008)	(.017)	(.171)	(.226)
INPC	-.012*	-.035***	.256	.170
	(.007)	(.010)	(.175)	(.304)
Control variables				
LL	-.115**	.123	-.105*	-.021
	(.049)	(.097)	(.055)	(.085)
FOR	.449***	.571**	.698***	.741***
	(.141)	(.225)	(.200)	(.264)
LAGE	-.184**	-.381**	.130	.142
	(.086)	(.165)	(.093)	(.149)
INDUSTRY	sign. *	/	sign. **	/
SECTOR	/	not sign.	/	sign. **

(continued on next page)

(continued)

	SWITZERLAND		AUSTRIA	
	Impact on LINNL of		Impact on LINNL of	
Explanatory variables	RDFOR (TSLS IV-Tobit)	RDFOR_EQ (Tobit)	RDFOR (Tobit)	RDFOR_EQ (Tobit)
Constant	1.58***	8.328***	3.015*	5.569***
	(.980)	(2.307)	(1.595)	(2.083)
Statistics				
N	415	100	237	102
F-Value		3.17***	5.39***	4.91***
Wald χ^2	81.3***			
Pseudo R^2		.093	.084	.093

In the equation tabulated in column 1, RDFOR is endogenous. To correct for endogeneity we used as instrument a dummy variable indicating several kinds of activity at foreign locations (distribution, production, sourcing). Moreover, the instrumental equation contained the explanatory variables from model A.

Variables not used in the one or the other equation are marked with /. The estimates of the industry dummies have been throughout omitted; we only show the joint significance of all industry dummies.

Heteroskedasticity–robust standard errors in brackets (White procedure). The statistical significance of the parameters are indicated with ***, ** and * representing the 1%, 5% and 10% test level respectively.

Table 6: Results for Model B2: Impact of Foreign R&D on the Labour Productivity of the Parent Firm (LQL)

	SWITZERLAND		AUSTRIA	
	Impact on LQL of		Impact on LQL of	
Explanatory variables	RDFOR (OLS)	RDFOR_EQ (OLS)	RDFOR (OLS)	RDFOR_EQ (OLS)
Foreign R&D				
RDFOR	.121*		-.069	
	(.066)		(.096)	
RDFOR_EQ		.248		.165
		(.162)		(.141)
Resource use				
LCL	.044**	.080	.125	.144
	(.019)	(.105)	(.078)	(.119)
LHC	.046***	.252**	.019	.022
	(.016)	(.101)	(.013)	(.021)
LRDL	.095***	.135	-.058	-.142*
	(.027)	(.106)	(.042)	(.083)
Control variables				
LL	-.006	-.043	-.009	-.091
	(.020)	(.075)	(.062)	(.099)
FOR	.198***	.220	.307***	.576***
	(.057)	(.140)	(.111)	(.146)
LAGE	-.047	-.047	.039	-.134
	(.035)	(.140)	(.055)	(.088)
INDUSTRY	sign. ***	/	not sign.	/
SECTOR	/	not sign.	/	not sign.
Constant	11.14***	9.587***	2.427***	2.852***
	(.325)	(2.044)	(.833)	(1.054)
Statistics				
N	525	106	200	95
F-value	5.39***	2.49**	3.06***	3.56***
R^2	.212	.229	.203	.301

Variables not used in the one or the other equation are marked with /. The estimates of the industry dummies have been throughout omitted; we only show the joint significance of all industry dummies.

Heteroskedasticity–robust standard errors in brackets (White procedure). The statistical significance of the parameters are indicated with ***, ** and * representing the 1%, 5% and 10% test level respectively.

Table 7: Results from Hypotheses Testing at a Glance

Hypothesis	SWITZERLAND	AUSTRIA
Foreign R&D (*model A*)		
Dependent variable		
H1a: foreign R&D *propensity*	yes	yes
H1b: equity- vs. non-equity *mode* of foreign R&D	yes	yes
Innovation output (*model B1*)		
Independent variable		
H2a: foreign R&D *propensity*	yes	yes
H2b: equity- vs. non-equity *mode* of foreign R&D	no	no
Labour productivity (*model B2*)		
Independent variable		
H3a: foreign R&D *propensity*	yes	no
H3b: equity- vs. non-equity *mode* of foreign R&D	(yes ?)	no

Model A explains "foreign R&D propensity yes/no" (H1a) and "equity-based governance mode of foreign R&D yes/no" (H1b) using OLI-variables as determining factors.

Model B explains firm performance, measured, alternatively, by innovation output (model B1) and labour productivity (model B2), using "foreign R&D propensity yes/no" (H2a, H3a) and "equity-based governance mode of foreign R&D" (H2b, H3b) as explanatory variables. Model B1 contains as explanatory variable also some standard determinants of a firm's innovativeness, while model B2 controls for the factor inputs contained in a standard production function.

Appendix: Table A.1: Composition of the Dataset by Industry/Sector and Firm Size Class

	SWITZERLAND						AUSTRIA					
	Firms investing in R&D						Firms investing in R&D					
	only at home (1)	abroad as well (2)	total (1)+(2)	only at home (1)	abroad as well (2)	total (1)+(2)	only at home (1)	abroad as well (2)	total (1)+(2)	only at home (1)	abroad as well (2)	total (1)+(2)
	Number of firms			Percentage distribution			Number of firms			Percentage distribution		
Industry / Sector												
High-tech manufacturing	*225*	*102*	*327*	*44.4*	*67.1*	*49.6*	*60*	*56*	*116*	*41.7*	*40.0*	*40.8*
Chemicals / Pharma (20, 21)	40	15	55	7.9	9.9	8.3	11	10	21	7.6	7.1	7.4
Electronics (26, 27)	72	42	114	14.2	27.6	17.3	17	25	42	11.8	17.9	14.8
Machinery (28)	76	37	113	15.0	24.3	17.1	24	15	39	16.7	10.7	13.7
Other (22, 29, 30)	37	8	45	7.3	5.3	6.8	8	6	14	5.6	4.3	4.9
Low-tech manufacturing	*181*	*24*	*205*	*35.7*	*15.8*	*31.1*	*27*	*33*	*60*	*18.8*	*23.6*	*21.1*
Metalworking (24, 25)	55	10	65	10.8	6.6	9.9	8	10	18	5.6	7.1	6.3
Other (10-19, 23, 31, 32, 33)	126	14	140	24.9	9.2	21.2	19	23	42	13.2	16.4	14.8
Knowledge-intensive services	*63*	*18*	*81*	*12.4*	*11.8*	*12.3*	*44*	*44*	*88*	*30.6*	*31.4*	*31.0*
ICT / R&D (61, 62, 63,74, 85)	19	6	25	3.7	3.9	3.8	18	18	36	12.5	12.9	12.7
Finance / HQ (64, 65, 70)	14	5	19	2.8	3.3	2.9	5	5	10	3.5	3.6	3.5
Business services. (71, 72)	30	7	37	5.9	4.6	5.6	21	21	42	14.6	15.0	14.8
Other industries [1]	*38*	*8*	*46*	*7.5*	*5.3*	*7.0*	*13*	*7*	*20*	*9.0*	*5.0*	*7.0*
Firm Size (number of employees)												
5 to 49	147	24	171	29.0	15.8	25.9	77	59	136	53.5	42.1	47.9
50-249	236	55	291	46.5	36.2	44.2	45	30	75	31.3	21.4	26.4
250 and more	124	73	197	24.5	48.0	29.9	22	51	73	15.3	36.4	25.7
Total	507	152	659	100.0	100.0	100.0	144	140	284	100.0	100.0	100.0

Source: Swiss Survey on Internationalisation 2010; Austrian Survey on R&D Internationalisation 2010.

[1] Agriculture (A); Electricity, etc. (D); Water supply, etc. (E); Construction (F); Wholesale and retail trade (G); Transportation and storage (H); Accommodation and food services (I); Real estate (L); Administrative and support service activities (N).

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JOANNEUM RESEARCH
Forschungsgesellschaft mbH

Leonhardstraße 59
8010 Graz

Tel. +43 316 876-0
Fax +43 316 876-1181

pr@joanneum.at
www.joanneum.at

oef mfg 12 008

JOANNEUM RESEARCH
Forschungsgesellschaft mbH

Leonhardstraße 59
8010 Graz

Tel. +43 316 876-0
Fax +43 316 876-1181

pr@joanneum.at
www.joanneum.at

oef mfg 12 008