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## Original Article

# Does foreign ownership facilitate cooperation on innovation? Firm-level evidence from the enlarged European Union

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**Abstract** Innovation is generally a combination of productive means that are internal and external to a firm. Some of the external resources can be obtained locally, but for some of them firms need to venture abroad. Arrangements to cooperate on innovation facilitate access to the external sources of knowledge. Using a large data set of firms in 12 countries from the third Community Innovation Survey, including seven new European Union members, we examine whether foreign ownership promotes cooperation on innovation with non-affiliated partners at home, abroad or both. An estimate of a probit model indicates that foreign affiliates are more likely to channel knowledge through innovation cooperation, although important differences have been found in this relationship between countries at different levels of economic development.

L'innovation est généralement une combinaison de moyens productifs internes et externes à une firme. Certaines des ressources externes peuvent être obtenues localement, mais d'autres ne peuvent être obtenues qu'à l'étranger. Certaines mesures de coopération concernant l'innovation peuvent faciliter l'accès à des sources externes de connaissance. À partir d'une base de données sur les firmes de douze pays, provenant de la troisième enquête sur l'innovation communautaire, comprenant sept nouveaux membres de l'UE, nous examinons si l'appartenance étrangère encourage la coopération avec des partenaires non-associés à la maison-mère, que ce soit dans le pays d'origine de la firme, à l'étranger, ou les deux. Une évaluation d'un modèle probit indique que les filiales étrangères ont plus tendance à canaliser des connaissances innovatrices à travers la coopération, bien que des différences importantes existent dans cette relation entre pays de différents niveaux de développement économique.

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## Introduction

Innovation requires a new combination of productive means. Some of them are within the firm whereas others need to be obtained externally. A purely 'off-the shelf' purchase of some of these external resources is not efficient, because transfer of knowledge often requires interactive learning between users and producers (von Hippel, 1976; Lundvall, 1988). Firms are not islands separated by deep waters of market transactions, but are linked together in patterns of cooperation, especially as far as the development of new products and processes is concerned (Richardson, 1972). Arrangements to cooperate on innovation facilitate exchange of knowledge and offer new opportunities for sharing complementary resources with other organizations (Sachwald, 1998), making firms more likely to come out with the new combinations.

As knowledge is imperfectly appropriable and strong uncertainty is inherent for innovation projects, complete contracts for innovation cooperation cannot be written and these arrangements are likely to generate knowledge spillovers (De Bondt, 1996). Innovation cooperation is therefore the mechanism through which knowledge spills between organizations. If partners from different countries are involved, innovation cooperation channels knowledge over national borders. Given the pivotal role of knowledge spillovers in generating economic growth (Romer, 1990), it is imperative to improve our understanding of the factors that influence cooperative arrangements on innovation.

Another essential aspect of business organization that channels knowledge is foreign ownership (Blomström and Kokko, 1998), so that it is natural to consider a link between them. Multinational corporations tend to limit spillovers of their knowledge to non-affiliated firms in order to protect their ownership advantages (Dunning, 1988; Caves, 1996), which may curtail cooperation of foreign affiliates with local firms, but at the same time foreign ownership may give rise to significant side effects that catalyse knowledge flows abroad. As foreign ownership provides organizational proximity to distant locations (Lundvall, 1988), one of the positive effects can be better access of the affiliates to foreign partners for innovation cooperation.

Availability of direct evidence on innovation cooperation in the Community Innovation Surveys triggered a growing body of empirical research about these arrangements (Arora and Gambardella, 1994; Colombo, 1995; Veugelers, 1997; Nooteboom, 1999; Tether, 2002; Miotti and Sachwald, 2003; Becker and Dietz, 2004; Negassi, 2004). Nevertheless, studies that consider the effect of foreign ownership remain scarce. Using micro-data from this survey in Belgium, Cassiman and Veugelers (2002) and Veugelers and Cassiman (2004) showed that it is possible to analyse mechanisms of knowledge flows directly, instead of relying on more indirect measures as those used by the production function approach, although they focused on the effect of foreign ownership on arms-length purchase of technology from abroad. Knell and Srholec (2004), based on micro-data from this survey in the Czech Republic, suggested that a similar framework can be used to study patterns of innovation cooperation. Yet, no attempt has been made to compare the effects of foreign ownership on innovation cooperation across countries.

The aim of this paper is to contribute to this debate by providing new evidence from a large data set of firms in a number of European countries. Our main interest is in the role of foreign ownership for flows of knowledge through innovation cooperation and whether this effect differs across countries. Using micro-data from the third Community Innovation Survey in 12 countries, including seven new EU members, we examine econometrically whether foreign affiliates are more or less likely to engage in cooperation on innovation compared with domestic-owned firms. The results indicate that foreign ownership facilitates cooperation with non-affiliated partners, especially with those located abroad. Even more important is the finding that there seems to be a tendency for this effect to increase along a decreasing development level of the country.

## **Why do Firms Cooperate on Innovation?**

Innovation cooperation unlocks the internal constraints for innovation. Arrangements to cooperate on innovation facilitate access to external sources of knowledge, spread costs and risks among the partners and allow firms to benefit from division of labour in innovation (Gulati, 1998; Sachwald, 1998; Miotti and Sachwald, 2003). By networking,

firms can pool complementary resources with other organizations and make use of resources owned by others. Although some of these external resources can be purchased when needed on markets for technology (Arora *et al*, 2001), others are embodied in the people and organizations concerned, and are therefore hard to transfer through market transactions (Lundvall, 1988; Maskell and Malmberg, 1999).

Strong uncertainty runs throughout the process of innovation (Dosi, 1988; Verspagen, 2004). The outcome and running of innovation activity is, by definition, unpredictable. Innovation costs are initially unknown, and so are the needs for knowledge that may become required for successful completion of the project as well as new knowledge that is generated during the process. Innovation cooperation is not a device to reduce uncertainty; quite the opposite is in fact likely to occur. As more actors and different kinds of knowledge become pooled together in the collaborative innovation projects, uncertainty about the outcome increases. Firms can try to reduce the uncertainty, but can never come close to eliminating it.

If it is difficult to foresee *ex-ante* the outcome, property rights cannot be clearly defined. Innovation cooperation is therefore the best example of a situation that offers a paramount scope for opportunistic behaviour. As agreements on innovation cooperation are perhaps the most imperfect contracts around, unintentional leaks of knowledge between the partners are difficult to prevent (De Bondt, 1996). If any knowledge spillovers exist in reality, they are channelled through innovation cooperation.

According to the transaction cost theory, a firm should resort to hierarchical forms of organization exactly in situations like these. Because transaction costs to prevent knowledge spillovers through innovation cooperation are extreme, optimization of these costs implicitly predicts cooperation on innovation to be rarely observed in the economy, if transaction costs were all that matters. As shall be seen below, although spillovers are inevitable, firms engage in these arrangements quite frequently. A different perspective is therefore necessary to understand why firms actually cooperate on innovation. Such a point of view should place benefits from sharing of knowledge into the spotlight.

Building on evolutionary perspectives, the interactive nature of the innovation process has been elaborated in the literature on national innovation systems (Lundvall, 1992; Nelson, 1993; Edquist, 1997). From this perspective, the ability of firms to capitalize on external knowledge embedded in social networks is crucial for a successful innovation process. The localized nature of interactive learning has been further emphasized in the literature on regional innovation systems, which highlights relationships among the internal organization of firms, their connections to one another and to the social structures and institutions of their particular localities (for overview, see Asheim and Gertler, 2004).

It is important to understand, furthermore, that international business does not undermine the role of local innovation systems (Narula, 2003). Quite the contrary is in fact the outcome of globalization of production (Maskell and Malmberg, 1999; Rugman and D’Cruz, 2003). Free access to international markets in capital goods and other inputs, including codified knowledge that, for a given price, becomes available to everybody, strengthens the role of idiosyncratic strategic capabilities. Even if firms invest and cooperate abroad to tap into foreign sources of tacit knowledge (Chesnais, 1992; Cantwell, 1995), these strategic capabilities of firms remain by their very nature embedded in – possibly multiple but still – local innovation systems (Pavitt and Patel, 1999). And the deepening specialization of firms in these core competencies within the globally dispersed production networks even more reinforces the need to pool complementary resources among various partners for innovation.

At the centre of interest in this study is the effect of foreign ownership of firms, a major symptom of globalization, on their propensity to cooperate on innovation. An important matter of concern, yet often neglected in the literature, is the difference between cooperation with local and foreign partners. Some of the partners for innovation cooperation are close, whereas others can only be found abroad. It is likely that firms favour cooperation with partners in their proximity, if anything, to avoid the costs and obstacles of venturing far away. From this it follows that firms should choose local over foreign partners for cooperation if there are partners with the needed complementary resources present in the local innovation system.

Although going abroad for cooperation may not be easy, as all kinds of institutional and cognitive barriers stand in the way, other aspects of international business, such as being linked to a foreign group of firms, can lubricate access to the foreign partners. As observed by Lundvall (1988), organization proximity through foreign ownership may overcome geographical and cultural distances. Foreign affiliates should therefore have an inherent advantage to access foreign sources of knowledge through other firms in the group and parents abroad.

However, on the other hand, foreign affiliates often remain poorly embedded in the local innovation system, especially in countries behind the technology frontier (Lall, 1980; Kokko *et al.*, 1996; UNCTAD, 2001). As foreign affiliates have direct access to knowledge from their parents abroad that is often superior to most of the local firms, they have proportionally stronger incentives to protect their knowledge from spilling over to the host economy. As it is close to impossible to prevent knowledge spillovers in innovation cooperation, foreign affiliates might be reluctant to engage in cooperation with local partners, even if there are firms with complementary resources in the local innovation system.

Does foreign ownership facilitate transfer of knowledge through innovation cooperation? Are there any differences in the effect of foreign ownership on cooperation with partners at home and abroad? And does this relationship differ in countries at different stages of development? Such questions are central to the following empirical analysis.

## Overview of the Data Set

The empirical analysis is based on a large sample of firms from the third Community Innovation Survey provided by Eurostat, which asked firms about various aspects of their innovation activity from 1998 to 2000 (Eurostat, 2007).<sup>1</sup> Following the Oslo Manual (OECD, 1997), a harmonized questionnaire and methodology was used to collect the data. Firms from the following 12 European countries, including 7 new EU members, are in the data set: Belgium, Bulgaria, Czech Republic, Estonia, Germany, Latvia, Lithuania, Norway, Portugal, Romania, Slovakia and Spain.<sup>2</sup> After omitting observations with missing data, the data set provides information for about 46 000 firms in industry and market services.

All firms have been asked to provide information about structural characteristics with regard to their size, affiliation to a group, distance of the main market, whether the firm was established over the period and industry. The size of firms is problematic to measure in the data set. No data are available for the number of employees. Size categories by small, medium and large classes based on employment are provided, but even these are combined for more than two-thirds of firms. The only available measure of size is the

micro-aggregated value of turnover in EUR at the beginning of the period, which, in natural logarithm, is the SIZE variable.<sup>3</sup>

Foreign ownership is derived from the question of whether the firm is part of an enterprise group and where the head office is located. A dummy FO for foreign ownership has value 1 if the firm is affiliated to a group with the head office abroad. All other firms are DOM, which means they are domestic-owned. Firms were asked about the distance of their most significant market. A dummy EXPORT for foreign market has value 1 if the firm's main market is international (and with a distance of more than 50 km). The age of firm is captured by the dummy NEW, which refers to the question of whether the firm was established during the reference period. Industry classification broadly follows Alphabetical NACE, rev. 1.1 structure with 17 categories in industry and market services at a two-digit level.<sup>4</sup>

INNOV is a dummy for innovation activity that refers to firms that introduced a new product, a new process or reported not yet completed or abandoned innovation activities. Only these innovating firms were asked for further details of their innovation activities, such as innovation cooperation, research and experimental development (R&D) activity or information sources for innovation. This implies that analysis using these variables must be restricted to a sub-sample of about 15 000 innovating firms, which introduces a potential sample selection bias that needs to be treated in econometric estimates below.

Innovation cooperation means active participation in joint R&D and other innovation projects with other organizations. Pure contracting out of work, where there is no active collaboration, is not regarded as cooperation. Firms were asked to indicate the location (national or abroad) and type of the partner organization (other enterprises in the group, suppliers, customers, competitors, consultants, commercial R&D laboratories, universities or public research institutes). Because we are interested in the impact of foreign ownership, we focus on cooperation with (external) partners non-affiliated within a group. From this it follows that the variable of national cooperation COOPnat is a dummy with value 1 if the firm has at least one cooperation arrangement with a national non-affiliated partner, whereas the variable of international cooperation COOPint is a dummy with value 1 if the firm cooperates with a non-affiliated partner abroad. COOPnat&int is their cross product (COOPnat\*COOPint), so that this dummy has value 1 if the firm cooperates with both national and foreign partners at the same time.

Furthermore, the innovating firms were asked about the number of other aspects of their innovation activity. A traditional measure of innovativeness is the extent of resources devoted to R&D that represents not only the ability of firms to generate new knowledge but also the capacity to absorb relevant knowledge from outside (Cohen and Levinthal, 1990). A dummy for R&D has value 1 if the firm continuously engaged in intramural R&D activity. Another relevant question for our analysis refers to the openness of firms to information from outside, which captures their absorptive capacity from a different angle (Veugelers and Cassiman, 1999). Firms were asked to indicate the importance of information for their innovation projects from suppliers, customers, competitors, universities, research institutes and various professional meeting places. As these answers tend to be strongly correlated, we use factor analysis to generate the INFO variable, which is a factor score on the perceived importance of these external sources of information.<sup>5</sup> PATENT is a dummy that takes value 1 if the firm had any valid patents at the end of the reference period. Apart from capturing appropriability conditions of firm's technology (Cassiman and Veugelers, 2002), this variable reflects (codified) knowledge accumulated by the enterprise.

**Table 1:** Descriptive overview of the data set

	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Observations</i>
<i>All firms (INNOV=1∧0)</i>					
INNOV	0.33	0.47	0	1	46 176
SIZE	14.02	2.43	0	24.30	46 176
FO	0.09	0.28	0	1	46 176
EXPORT	0.25	0.43	0	1	46 176
NEW	0.04	0.20	0	1	46 176
<i>Innovating firms (INNOV=1)</i>					
COOPnat	0.26	0.44	0	1	15 087
COOPint	0.16	0.37	0	1	15 087
COOPnat&int	0.13	0.33	0	1	15 087
SIZE	15.07	2.47	0	24.30	15 087
FO	0.15	0.35	0	1	15 087
EXPORT	0.32	0.47	0	1	15 087
NEW	0.04	0.19	0	1	15 087
R&D	0.32	0.47	0	1	15 087
INFO	0.00	0.87	-1.50	2.52	15 087
PATENT	0.18	0.39	0	1	15 087
FUNloc	0.11	0.31	0	1	15 087
FUNnat	0.14	0.34	0	1	15 087
FUNeu	0.07	0.25	0	1	15 087

Source: Eurostat (2007).

Finally, the survey provides evidence on public funding of innovation. Firms were asked whether they received any public financial support for innovation activities in terms of grants, loans or loan guarantees. The question is divided into funding from local or regional authorities, the central government (including institutions working on behalf of the central government) and financial support from the European Union (EU). A dummy variable FUNloc, FUNnat and FUNeu for each of these geographical levels has value 1 if the firm reported to receive funding from the respective source.

Table 1 provides a descriptive overview of the data set. About a third of the firms engaged in innovation activity, of which 26 per cent cooperated with a partner at home, 16 per cent ventured for cooperation abroad and 13 per cent cooperated with both national and foreign partners. Arrangements on cooperation with partners at home are therefore significantly more prevalent than with those abroad. Around four-fifths of firms that cooperate abroad, moreover, also have a national partner. Although geography (or distance) clearly matters for the frequency of cooperation, so that the distinction between national and foreign partners makes sense, there also seems to be a substantial overlap between them, which is represented by the combined variable.

Table 2 gives details on the cooperation variables, which are the dependent variables in the following econometric analysis, by ownership and location of the innovating firm. A brief look at the comparison between the propensity to cooperate by foreign affiliates and domestic-owned firms reveals, first, that the former generally tend to cooperate more often and, second, that the difference is most prevalent in cooperation with (non-affiliated) partners abroad. It seems, furthermore, that this difference tends to increase with the decreasing development level of the country. Along the ownership divide, the largest difference was observed in Bulgaria and Romania, whereas the smallest gap was observed in Belgium, Germany and Spain. Another important pattern in the data is that foreign

**Table 2:** Average propensity to cooperate by ownership and location of the innovating firm

	<i>COOPnat</i>		<i>COOPint</i>		<i>COOPnat&amp;int</i>		<i>Observation</i>	
	<i>FO</i>	<i>DOM</i>	<i>FO</i>	<i>DOM</i>	<i>FO</i>	<i>DOM</i>	<i>FO</i>	<i>DOM</i>
Belgium	0.30	0.24	0.26	0.19	0.21	0.14	263	468
Germany	0.34	0.26	0.15	0.10	0.14	0.09	175	1568
Norway	0.37	0.38	0.29	0.19	0.22	0.16	265	1259
Portugal	0.25	0.23	0.22	0.12	0.17	0.09	107	699
Spain	0.22	0.18	0.13	0.09	0.11	0.08	556	3004
Czech Republic	0.27	0.27	0.21	0.14	0.16	0.11	312	1030
Slovakia	0.32	0.33	0.36	0.23	0.26	0.21	69	330
Estonia	0.34	0.28	0.36	0.20	0.26	0.16	165	712
Latvia	0.55	0.39	0.45	0.33	0.37	0.26	51	438
Lithuania	0.55	0.35	0.57	0.28	0.36	0.21	53	569
Bulgaria	0.15	0.17	0.35	0.13	0.13	0.09	40	1155
Romania	0.39	0.21	0.58	0.12	0.33	0.10	142	1657
Western Europe	0.28	0.24	0.19	0.12	0.16	0.10	1366	6998
Central Europe	0.28	0.29	0.24	0.16	0.18	0.13	381	1360
Baltics	0.42	0.33	0.42	0.26	0.30	0.20	269	1719
Balkans	0.34	0.19	0.53	0.13	0.29	0.10	182	2812
All countries	0.30	0.25	0.26	0.14	0.19	0.12	2198	12889

Source: Eurostat (2007).

affiliates tend to be more likely to engage with foreign partners with decreasing development level of the country, which seems to suggest that a lack of relevant local partners in less developed countries induces firms to search for partners in distant locations, especially if they can benefit from the organizational proximity to other firms in the group abroad.

As the number of innovating firms (and particularly of foreign affiliates) is relatively low in some countries, which poses a serious problem for estimation of some of the regression models outlined below, we will analyse the data on the basis of regional groupings. About half of the sample come from the ‘old’ EU/EFTA member countries (Belgium, Germany, Norway, Portugal and Spain), which are grouped together under the heading of ‘Western Europe’. Firms from the new EU member countries are divided into ‘Central Europe’ (the Czech Republic and Slovakia), ‘Baltics’ (Estonia, Latvia and Lithuania) and ‘Balkans’ (Bulgaria and Romania). This grouping divides the sample into several relatively coherent geographical areas and, most importantly, still allows us to detect broad differences in the estimated coefficients along the level of economic development.

Although the descriptive analysis shows that foreign affiliates are superior, other firm-level factors might be, in fact, equally or even more important for explaining these differences than the ownership itself. Scale advantages are essential in this respect. It is well known that foreign affiliates tend to be larger than their domestic counterparts.<sup>6</sup> Because the cooperation variables refer to firms having at least one cooperation arrangement, larger firms are by principle more likely to report a positive answer, and other firm-level factors such as the differences in capabilities of firms, public funding of innovation and perhaps more importantly the propensity to export might be equally relevant. In addition, foreign affiliates may concentrate in industries, where cooperation tends to be more prevalent because of the nature of the technology and other industry-specific characteristics.

It is virtually impossible to properly investigate the impact of such a large number of relevant factors by a descriptive overview of the data. The main purpose of the following analysis is therefore to isolate the effect of foreign ownership in an econometric framework. Does the difference between foreign- and domestic-owned firms stand out even if we control for the influence of the other relevant factors? And does the role of foreign ownership differ between countries?

## Econometric Model

Following the framework outlined above, we develop an empirical model that predicts cooperative behaviour of the innovative firms. Explanatory factors include the structural features of the firm SIZE, FO and EXPORT, a vector of the other relevant firm-level predictors  $Z_{COOP} \in (R\&D, INFO, PATENT, FUNloc, FUNnat \text{ and } FUNeu)$  and the country and industry dummies. Because the dependent variable COOP, which is either COOPnat, COOPint or COOPnat&int, is binary, we need to estimate a probit regression model. The structure of the model is as follows:

$$\begin{aligned} INNOV = & a_m + b_m SIZE + c_m FO + d_m EXPORT \\ & + e_m NEW + f_m COUNTRYdummies \\ & + g_m INDUSTRYdummies + e_{INNOV} \end{aligned} \quad (1)$$

$$\begin{aligned} COOP = & a_n + b_n SIZE + c_n FO + d_n EXPORT \\ & + e_n Z_{COOP} + f_n COUNTRYdummies \\ & + g_n INDUSTRYdummies + \lambda_{INNOV} + e_{COOP} \end{aligned} \quad (2)$$

As already noted, the analysis can be influenced by a sample selection bias, which arises when the dependent variable is observed only for a non-randomly restricted sample. For our analysis, the source of the potential bias is the fact that only the innovative firms provided details of their activities in the survey. To correct for the possible bias, we estimate the model by the probit-specific Heckman's procedure (Heckman, 1976), which involves two equations. First, we predict the probability of the firm to be included in the restricted sample, in other words to be innovative, in equation (1). And in the second stage, we use the so-called inverse Mills' ratio ( $\lambda_{INNOV}$ ) derived from the previous estimate to control for the potential selection bias in equation (2), which predicts the probability of the innovative firms to cooperate on innovation.<sup>7</sup>

Because the main interest of the analysis is in the relationship delineated by equation (2), let us concentrate on the interpretation of this part of the model. SIZE is important to control for the scale advantages of various kinds involved in the decision of firms to venture into innovation cooperation, so that the estimated coefficient is expected to be positive. At the centre of our interest is the estimated effect of the variable FO for foreign ownership. As the explanatory variable of COOPnat, foreign ownership captures the embeddedness of foreign affiliates in the national innovation system. Because the impact of foreign ownership on national cooperation is likely to be a mixture of positive and negative effects conditional on the innovation strategy of the multinational company and the attractiveness of the local milieu for cooperation, our expectation for sign of the coefficient in this relationship is ambiguous. As argued above, however, foreign affiliates should have a superior access to (even non-affiliated) partners for cooperation abroad

through connections of their parent and other firms in the foreign group and we therefore expect a strongly positive coefficient of FO if the dependent variable is COOPint.

Similarly, information that comes along with sales to the foreign market captured by the EXPORT variable should at least partly help to overcome the disadvantages given by geographical distance of partners for COOPint, and therefore exporters are expected to be in a better position to engage in cooperation arrangements abroad. Somewhat less obvious is the link between EXPORT and COOPnat, which should be positive if the arguably more competitive environment in international markets urges firms to intensify cooperation with relevant partners in the local milieu, but the export orientation may also have the opposite effect if exporters are prone to choose foreign over domestic partners for cooperation.

Although the group of the other predictors  $Z_{COOP\ int}$  (R&D, INFO, PATENT, FUNloc, FUNnat and FUNeu) is included in the model mainly to control for these effects in order to isolate the impact of FO, results for some of them might be of interest on their own. R&D, INFO and PATENT, which capture various aspects of firms' capabilities, are obviously expected to be positively associated to cooperativeness of firms. For policy-makers, the estimated coefficients of FUNloc, FUNnat and FUNeu might be of interest. It will be particularly interesting to see whether funding from EU has a different impact than support from the national sources. And finally, the battery of INDUSTRY and COUNTRY dummies is included to control for the context-specific effects.

An important limitation of the model that needs to be mentioned is that not much could have been done about a potential endogeneity of the estimated coefficients mainly because of a lack of valid instruments in the data set. Any interpretation in terms of causality between the explanatory and the dependent variables should therefore be put forward with caution. Another related limitation given by the data set in hand is the cross-sectional nature of the analysis. It remains an important challenge for future research to address these caveats, if better sources of data become available.

## Results

Table 3 presents the first set of results. We start by estimating the model on the full sample of firms from all countries together, which shows general patterns in the data. The results of the selection equation are according to the expectations. All of the predictors of INNOV in equation (1) have highly significant and positive signs, including the coefficient of NEW, which confirms that the sample selection is identified by this variable. It should be noted, furthermore, that this variable does not appear to be a significant explanatory variable in equation (2), if included, so that NEW proves to be a valid instrument. But there does not seem to be a serious sample selection bias, because the inverse Mills' ratio does not turn out to be statistically significant in most of the estimates.

To explore whether the results differ along the definition of the dependent variable, equation (2) is estimated separately for COOPnat, COOPint and COOPnat&int, respectively. Let us focus on the coefficient of FO, which is our focal point. Studies using large samples of firms from innovation surveys for selected countries, such as the analysis of Belgian data by Veugelers and Cassiman (2004) and the Czech data by Knell and Srholec (2004), found that foreign ownership tends to be negatively associated with national cooperation. Our results do not support this finding. Foreign ownership turns out to be positively associated with national cooperation, although the magnitude of the coefficient

**Table 3:** Regression results for the full sample

<i>Dependent variable</i>	<i>Equation (1)</i>		<i>Equation (2)</i>	
	<i>INNOV</i>	<i>COOPnat</i>	<i>COOPint</i>	<i>COOPint&amp;nat</i>
Constant	-2.272*** (22.95)	-3.191*** (5.02)	-3.006*** (4.16)	-3.862*** (4.91)
SIZE	0.125*** (25.27)	0.112*** (4.88)	0.088*** (3.40)	0.119*** (4.25)
FO	0.187*** (7.65)	0.081* (1.78)	0.326*** (6.28)	0.218*** (3.96)
EXPORT	0.185*** (11.09)	0.070* (1.65)	0.340*** (6.90)	0.248*** (4.66)
R&D	—	0.408*** (14.10)	0.374*** (11.36)	0.385*** (10.96)
INFO	—	0.208*** (13.89)	0.196*** (11.59)	0.265*** (14.52)
PATENT	—	0.252*** (7.89)	0.238*** (6.83)	0.280*** (7.65)
FUNloc	—	0.303*** (7.21)	0.067 (1.36)	0.081 (1.58)
FUNnat	—	0.583*** (16.67)	0.337*** (8.60)	0.383*** (9.47)
FUNeu	—	0.445*** (9.10)	0.736*** (14.65)	0.668*** (12.97)
NEW	0.148*** (4.22)	—	—	—
Country dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Inverse mills ratio	—	0.478* (1.71)	0.085 (0.26)	0.272 (0.76)
Wald $\chi^2$	7635.89	2438.31	2115.58	1955.67
Number of observations	46 176	15 087	15 087	15 087

*Note:* Absolute value of robust *z*-statistics in parentheses and \*\*\*, \*\* and \* indicate significance at the 1, 5 and 10 per cent levels, respectively.

is very small and the effect is only weakly statistically significant. It should be noted, however, that the aforementioned studies used a somewhat different framework and the estimated coefficients of the foreign ownership variables in these studies were sensitive to the specification of the model. Evidence on the link between FO and COOPnat therefore remains ambiguous, as anticipated above, depending on the particular context.<sup>8</sup>

As far as international cooperation arrangements (with non-affiliated partners) are concerned, we are in agreement with Knell and Srholec (2004), who found a positive impact of foreign ownership in the Czech context.<sup>9</sup> As expected, the results of the second estimate, where the dependent variable is COOPint, strongly support the thesis that foreign affiliates capitalize on connections of their parent company and other firms in the group. Because most firms that cooperate abroad tend to have a domestic partner for cooperation at the same time, as pointed out above, it is not surprising to see in the results for COOPint&nat that foreign affiliates are also more likely to cooperate both with national and with foreign partners. It appears to be essential to take into account foreign ownership of firms in order to understand cooperation on innovation, especially if foreign partners are involved.

Let us briefly consider results for the other explanatory variables. *SIZE* is statistically significant and positively associated with cooperation, which is well in line with our expectations. *EXPORT* yielded results very similar to the effect of *FO*, which shows that access to the foreign markets is important as much as the ownership structure of the firm. *R&D*, *INFO* and *PATENT* yielded highly significant coefficients and the expected signs across the board. There were not many changes in the magnitude of these coefficients, which confirms that firm's capabilities are equally important for national and international cooperation on innovation.

Also, the variables for public funding turned out to be highly significant and positive, with the only exception of *FUNloc*, which is statistically significant at the conventional levels only if foreign partners for cooperation are not involved in the definition of the dependent variable. But this is reassuring, because funding from the local authorities is typically directed to fostering of local rather than international linkages. It is further in line with our expectations that *FUNnat* yielded a higher coefficient than *FUNeu* in the estimate for *COOPnat* whereas it is the reverse in the estimate for *COOPint*. For brevity, we do not report results for the industry and country dummies, although these are included in all of the estimates.

Table 4 presents the results if the model is estimated for the different regional groupings of firms. The aim is to explore the heterogeneity of the estimated coefficients depending on the context that spans from the most advanced group of 'Western Europe' to the least developed 'Balkans'. Because of space constraints, we report these estimates only for the overall dependent variable *COOPnat&int*, which refers to the most favourable situation of a firm that cooperates both at home and abroad and therefore channels knowledge through these arrangements within the local innovation system and, at the same time, across national borders. However, the main differences in the results for *COOPnat*, *COOPint* along these lines are explained below.

Our expectations that the coefficient of *FO* differs across these estimates is firmly supported by the results. It turns out that the effect of *FO* edges up from a statistically non-significant and negligible coefficient of 0.018 in the context of the most developed 'Western Europe' to a highly statistically significant coefficient in the context of the new EU members, for which the magnitude increases to 0.375 in 'Central Europe', to 0.640 in the 'Baltics' and even to 1.427 in the 'Balkans'. Foreign ownership seems to facilitate transfer of technology through cooperation arrangements on innovation, particularly in less developed countries, and increasingly so with the decreasing development level of the country. Similarly, the statistical significance of the *EXPORT* dummy increases for less developed countries, but there does not seem to be a clear pattern in the magnitude of this coefficient.

Another important finding that emerged from this exercise is that the effects of the 'capability' variables of *R&D*, *INFO* and *PATENT* broadly follow an opposite tendency compared with the *FO* variable. All of these 'capability' variables yielded a roughly twofold higher magnitude of the estimated coefficients in the context of 'Western Europe' as compared with the 'Balkans'. *R&D* and *INFO* remain highly significant across the board, but the statistical significance of the *PATENT* variable weakens with the decreasing level of economic development. The *SIZE* of firms seems to be a much more relevant explanatory factor than the capability variables in the context of the less developed countries.

Funding from the EU showed a strongly positive and a highly statistically significant effect. Without doubt, this is good news for the European Commission, because this result

**Table 4:** Regression results by region

<i>Dependent variable</i>		<i>COOPint&amp;nat</i>			
<i>Region</i>	<i>Western Europe</i>	<i>Central Europe</i>	<i>Baltics</i>	<i>Balkans</i>	
<i>Equation (2)</i>					
Constant	-2.899*** (2.98)	-7.040** (2.35)	-8.199*** (2.87)	-15.506*** (3.23)	
SIZE	0.083** (2.58)	0.231** (2.55)	0.333*** (2.70)	0.444*** (3.33)	
FO	0.018 (0.26)	0.336*** (2.58)	0.640*** (2.92)	1.427*** (4.46)	
EXPORT	0.129 (1.12)	0.514** (2.12)	0.254*** (3.05)	0.274*** (2.81)	
R&D	0.442*** (8.61)	0.366*** (3.85)	0.330*** (4.06)	0.276*** (3.12)	
INFO	0.338*** (12.26)	0.226*** (4.60)	0.196*** (4.85)	0.210*** (5.24)	
PATENT	0.345*** (7.07)	0.237** (2.02)	0.244** (2.45)	0.176* (1.81)	
FUNloc	0.065 (1.11)	0.030 (0.13)	0.019 (0.08)	-0.148 (0.67)	
FUNnat	0.358*** (6.99)	0.648*** (5.50)	0.449*** (3.23)	0.156 (1.28)	
FUNeu	0.726*** (11.37)	0.682*** (2.82)	0.614*** (3.41)	0.517*** (4.21)	
Country dummies	Yes	Yes	Yes	Yes	
Industry dummies	Yes	Yes	Yes	Yes	
Inverse Mills ratio	-0.294 (0.55)	1.293 (1.16)	1.831** (2.01)	4.118** (2.64)	
Wald $\chi^2$	1155.18	243.77	210.24	282.80	
Number of observations	8364	1741	1988	2994	
<i>Equation (1)</i>					
Constant	-1.988*** (14.28)	-1.729*** (6.18)	-2.702*** (11.02)	-2.680*** (16.09)	
SIZE	0.114*** (16.47)	0.134*** (8.66)	0.205*** (14.04)	0.111*** (13.24)	
FO	0.115*** (3.45)	0.111* (1.19)	0.355*** (5.54)	0.280*** (4.30)	
EXPORT	0.357*** (13.08)	0.296*** (6.49)	-0.023 (0.54)	0.055* (1.70)	
NEW	0.270*** (4.66)	0.195* (1.88)	0.200** (2.15)	-0.038 (0.58)	
Country dummies	Yes	Yes	Yes	Yes	
Industry dummies	Yes	Yes	Yes	Yes	
Wald $\chi^2$	1808.06	629.63	679.33	1540.91	
Number of observations	17 330	4878	6213	17 755	

Note: Absolute value of robust z-statistics in parentheses and \*\*\*, \*\* and \* indicate significance at the 1, 5 and 10 per cent levels, respectively.

suggests that the EU innovation policy succeeds to improve circulation of knowledge through cooperation within the European Research Area. And it is particularly encouraging to see that firms in the new EU member countries also benefited from access to at least some of these programmes even before the actual expansion of the EU, regardless

of the size, ownership or market of the firm. Again, support for innovation from the local authorities is the only variable that does not appear to be statistically significant in any of these estimates, which is reassuring for the interpretation of the model.<sup>10</sup>

The main outcome from results for the dependent variables COOPnat and COOPint, which are not reported because of constraints of space as noted above, is that the coefficient of FO was statistically significant for both of them in the context of the 'Baltics' and the 'Balkans', only significant for COOPint in the sub-sample of 'Central Europe' and not statistically significant at conventional levels in the context of the most advanced 'Western Europe'. From this, it follows that the results for all of the cooperation variables tend to vary along the level of economic development of countries where the firms are located.

It should be stressed, finally, that the results do not suffer from a serious problem of multicollinearity. Any correlation coefficient between a pair of the explanatory variables (and in any of the total or the regional samples used in the estimates) does not exceed 0.31, which confirms that these variables capture the distinct characteristics of firms.

## Conclusions

After controlling for a number of other relevant factors, the results show that foreign affiliates have a significantly higher propensity to venture into cooperation, especially with (non-affiliated) partners abroad, which lends strong support to the argument that foreign ownership lubricates flows of knowledge across national borders. As it is close to impossible to prevent knowledge spillovers between partners involved in innovation cooperation, the results also provided much-needed direct evidence on knowledge spillovers facilitated by foreign ownership.

Furthermore, we provided evidence for significant differences in the effect of foreign ownership between the advanced and the less developed countries. Although there seems to be no difference in this respect along the ownership lines in the advanced EU members, foreign ownership turned out to be important for innovation cooperation in the new EU member countries. And there seems to be a tendency for this effect to increase with the decreasing economic level of the country.

From the methodological perspective, the paper shows how cross-country comparative research can be conducted by using data directly at the firm level. Analysis of the pan-European data set gave us a unique opportunity to compare the results of the very same model in countries at widely different levels of economic development. And we have shown that this approach can yield important insights into the differences in terms of how activities of multinational firms affect advanced and less developed countries. As new micro-data sets with data harmonized across many countries become increasingly available for research purposes from Eurostat and elsewhere, it is a major opportunity for future research to provide more comparative evidence of this kind.

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## Notes

1. Some of the variables containing sensitive financial information were so-called micro-aggregated by averaging data for three similar firms. As the only micro-aggregated variable used in this paper refers to the size of firms, most of the analysis is based on data directly at the firm level.
2. Also Greece, Hungary and Iceland are included in the Eurostat’s data set, but firms from these countries were not included in the analysis because of missing data.
3. As the minimum value of turnover is zero (firms without sales in the given year), unity has been added to each observation before computing the natural logarithm.
4. It was not possible to use more detailed industrial classification owing to limitations of the data set. The definition of the industry dummies used in the analysis is available from the author upon request.
5. Because only a single factor with an eigenvalue higher than 1 has been detected (other eigenvalues were 0.53 and less), we have retained one principal factor as follows: suppliers (0.38), customers (0.47), competitors (0.52), universities (0.58), public research institutes (0.53), conferences (0.67) and exhibitions (0.61), factor loadings in parentheses. Regression scoring has been used to generate the INFO variable.
6. Although the scale advantages differ by country, foreign-owned firms are on average larger in all countries in the sample.
7. NEW appears in equation (1) but not in equation (2), and this variable is therefore used to identify the exclusion restriction, which shall be further explained below.
8. As firms from Belgium and the Czech Republic are included in the data set, we have estimated the model separately for each country, but the coefficient of FO did not turn out to be a statistically significant explanatory factor of COOPnat.
9. Note that Veugelers and Cassiman (2004) did not use this variable.
10. It should be noted that we have also estimated the model separately for the various types of partners for cooperation (such as suppliers, customers, universities and so on); however, not much difference in the effect of FO has been found along these lines, so that these results are not reported.

## References

- Arora, A., Fosfuri, A. and Gambardella, A. (2001) *Markets for Technology: The Economics of Innovation and Corporate Strategy*. Cambridge, MA: MIT Press.
- Arora, A. and Gambardella, A. (1994) Evaluating technological information and utilizing it. *Journal of Economic Behaviour and Organization* 24: 91–114.
- Asheim, B. and Gertler, M. (2004) Regional Systems of Innovation. In: J. Fagerberg, D.C. Mowery and R. Nelson (eds.) *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, pp. 291–317.
- Becker, W. and Dietz, J. (2004) R&D cooperation and innovation activities of firms – evidence for the German manufacturing industry. *Research Policy* 33: 209–223.

- Blomström, M. and Kokko, A. (1998) Multinational corporations and spillovers. *Journal of Economic Surveys* 12: 247–278.
- Cantwell, J. (1995) The globalisation of technology: What remains of the product cycle model? *Cambridge Journal of Economics* 19: 155–174.
- Cassiman, B. and Veugelers, R. (2002) R&D cooperation and spillovers: Some evidence from Belgium. *American Economic Review* 92: 1169–1184.
- Caves, R. (1996) *Multinational Enterprise and Economic Analysis*, 2nd edn., Cambridge: Cambridge University Press.
- Chesnais, F. (1992) National Systems of Innovation, Foreign Direct Investment and the Operations of Multinational Enterprises. In: B.A. Lundvall (ed.) *National Systems of Innovation – Towards a Theory of Innovation and Interactive Learning*. London: Pinter Publishers.
- Cohen, W.M. and Levinthal, D.A. (1990) Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* 35: 128–152.
- Colombo, M. (1995) Firm size and cooperation: The determinants of cooperative agreements in information technology industries. *International Journal of the Economics of Business* 2: 3–29.
- De Bondt, R. (1996) Spillovers and innovative activities. *International Journal of Industrial Organization* 15: 1–28.
- Dosi, G. (1988) Sources, procedures, and microeconomic effects of innovation. *Journal of Economic Literature* 26: 1120–1171.
- Dunning, J.H. (1988) The eclectic paradigm of international production: A restatement and some possible extensions. *Journal of International Business Studies* 19: 1–31.
- Edquist, C. (1997) *Systems of Innovation: Technologies, Institutions and Organisations*. London: Pinter Publisher.
- Eurostat. (2007) *The CIS 3 Anonymised Microdata Sets*. Luxembourg: Eurostat.
- Gulati, R. (1998) Alliances and networks. *Strategic Management Journal* 19: 293–317.
- Heckman, J.J. (1976) The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. *Annals of Economic and Social Measurement* 5: 475–492.
- Kokko, A., Tansini, R. and Zejan, M.C. (1996) Local technological capability and productivity spillovers from FDI in the Uruguayan manufacturing sector. *Journal of Development Studies* 32: 602–611.
- Knell, M. and Srholec, M. (2004) *Innovation Cooperation and Foreign Ownership: Evidence from Innovative Firms in the Czech Republic*, Proceedings from the 30th European International Business Academy (EIBA) Annual Conference, Ljubljana.
- Lall, S. (1980) Vertical inter-firm linkages in LDCs: An empirical study. *Oxford Bulletin of Economics and Statistics* 42: 203–226.
- Lundvall, B.Å. (1988) Innovation as an Interactive Process: From User-Producer Interaction to the National System of Innovation. In: G. Dosi, C. Freeman, R. Nelson, G. Silverberg and L. Soete (eds.) *Technical Change and Economic Theory*. London: Pinter, pp. 349–369.
- Lundvall, B.Å. (1992) *National System of Innovation. Towards a Theory of Innovation and Interactive Learning*. London: Pinter.
- Maskell, P. and Malmberg, A. (1999) Localised learning and industrial competitiveness. *Cambridge Journal of Economics* 23: 167–186.
- Miotti, L. and Sachwald, F. (2003) Co-operative R&D: Why and with whom? An integrated framework of analysis. *Research Policy* 32: 1481–1499.
- Narula, R. (2003) *Globalization and Technology*. Cambridge, UK: Polity.
- Negassi, S. (2004) R&D co-operation and innovation a microeconomic study on French firms. *Research Policy* 33: 365–384.
- Nelson, R.R. (1993) *National Innovation Systems: A Comparative Study*. Oxford: Oxford University Press.
- Nooteboom, B. (1999) Innovation and inter-firm linkages: New implications for policy. *Research Policy* 28: 793–805.
- OECD. (1997) *Oslo Manual*. OECD: Paris.
- Pavitt, K. and Patel, P. (1999) Global Corporations and National Systems of Innovation: Who Dominates Whom? In: D. Archibugi, J. Howells and J. Michie (eds.) *Innovation Policy in a Global Economy*. Cambridge: Cambridge University Press, pp. 94–119.
- Richardson, G.B. (1972) The organisation of industry. *Economic Journal* 82: 883–896.

- Romer, P.M. (1990) Endogenous technological change. *Journal of Political Economy* 98: 71–102.
- Rugman, A.M. and D’Cruz, R. (2003) *Multinationals as Flagship Firms*. Oxford: Oxford University Press.
- Sachwald, F. (1998) Cooperative agreements and the theory of the firm: Focusing on barriers to change. *Journal of Economic Behaviour and Organization* 35: 203–225.
- Tether, B. (2002) Who co-operates for innovation, and why. An empirical analysis. *Research Policy* 31: 947–967.
- UNCTAD. (2001) *World Investment Report 2001 – Promoting Linkages*. New York and Geneva: United Nations Conference on Trade and Development.
- Verspagen, B. (2004) Innovation and Economic Growth. In: J. Fagerberg, D.C. Mowery and R. Nelson (eds.) *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, pp. 487–513.
- Veugelers, R. (1997) Internal R&D expenditures and external technology sourcing. *Research Policy* 26: 303–315.
- Veugelers, R. and Cassiman, B. (1999) Make and buy in innovation strategies: Evidence from Belgian manufacturing firms. *Research Policy* 28: 63–80.
- Veugelers, R. and Cassiman, B. (2004) Foreign subsidiaries as a channel of international technology diffusion: Some direct firm level evidence from Belgium. *European Economic Review* 48: 455–476.
- von Hippel, E. (1976) The dominant role of users in the scientific instrument innovation process. *Research Policy* 5: 212–239.