Effects of Foreign Ownership on Innovation Activities: Empirical Evidence for 12 European Countries

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Abstract:

In the present study we investigate the relationship between foreign ownership and innovation activities using the firm-level data of the third Community Innovation Survey (CIS) covering 12 European countries. Probit estimates based on 28,000 firms observations show that foreign-owned firms are more innovative than domestic firms, particularly in the New EU Member States. However, results from the Blinder-Oaxaca decomposition of the differences in the percentage of innovating firms between foreign-owned and domestic firms reveals that the differences are mainly due to the different firm characteristics rather than the differences in coefficients. In particular, the dominance of foreign-owned firms in the largest firm size group is the main factor contributing to the gap in the percentage of innovators between foreign-owned firms and domestic firms. Furthermore, using the fractional logit model, we find that in the New EU Member states, foreign ownership has a positive and significant impact on the share of market novelties as well as on the share of new products in turnover. In this case, the results from the Blinder Oaxaca decomposition analysis indicate that the ownership difference in the share of innovative sales is not due to the differences in the observed firms' characteristics.

Keywords: foreign ownership, multinational firms, product and process innovations

JEL Classification: F23, C24, C25, L2, O3.

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1. Introduction[1]

In the present paper we investigate the effect of foreign ownership on innovation performance for selected Western and Eastern European countries. It is well-known that the importance of foreign affiliates in industrial R&D varies considerably across OECD countries. For instance, in Hungary, Ireland, Czech Republic, and Belgium the share of foreign affiliates in the total industrial R&D expenditures is 50 per cent or more. In contrast, in Germany, Spain, and Portugal the share of foreign affiliates in the total industrial R&D is 27 per cent or less (see Graph 2 in appendix). Despite the important role of foreign-owned firms in performing business R&D and innovation activities in some OECD countries, we usually observe that foreign-owned firms possess lower R&D intensity than domestically owned firms (see OECD, 2003; OECD, 1998). This reflects the fact that multinational firms still tend to undertake most of their R&D activity within their home country rather than in a host country. In particular, R&D activities abroad primarily comprise design, development activities, and market related activities (OECD, 2003). More recently, by using firm level data for the UK, Griffith, Redding, and Simpson (2004) find that the establishments that are part of British-owned multinationals account for a larger share of R&D activity than foreign-owned multinationals.

However, the relationship between innovation output and foreign ownership is not clear-cut. Since foreign ownership is often associated with direct technology transfer from multinational companies (MNCs) to local affiliates, one can expect a positive relationship between foreign ownership and innovation output. Previous studies also confirm that foreign-owned firms are more likely to introduce new products and new production processes (Sadowski and Sadowski-Rasters, 2006 based on CIS 2 for the Netherlands; Frenz and Ietto-Gillies, 2007, based on CIS 3 for the UK). Similarly, using Italian CIS data, Balcet and Evangelista (2005) find that foreign affiliates have a relatively high propensity to innovate. However, much of the effect is explained by the fact that foreign affiliates are overrepresented in science-based industries, and by their firm size. Since foreign-owned firms differ from domestic firms regarding many characteristics, it is difficult to compare the innovation performance between the two groups. In particular, foreign affiliates tend to be larger, employ a larger fraction of skilled workers, and have higher labour productivity and export intensity (Griffith, Redding, and Simpson, 2004). There is also a concentration of foreign affiliates in R&D intensive, science-based, and scale-intensive industries (e.g. wholesale trade). Hence, a large part of the differences in innovation intensity between foreign affiliates and domestic firms may be due to a compositional effect, i.e. to the high concentration of foreign affiliates in specific industries and to the presence of a size factor.

In the present paper, we investigate the effects of foreign ownership on innovation performance using the CIS 3 (community innovation survey). We distinguish between two types of innovation output; namely the share of turnover with market novelties and the share of turnover with new products. The former measure is commonly referred to as imitative innovations, whereas the latter as radical or true innovations (Brouwer and Kleinknecht, 1996; Kleinknecht et al., 2002). We also look at the propensity to innovate, such as the probability to introduce new production processes and products. Furthermore, we also undertake a cross-country comparison of the effects of foreign ownership (i.e. Eastern and Western European countries). In order to investigate the sources of the possible ownership gap in innovativeness, we apply the Blinder-Oaxaca decomposition. To our knowledge there are relatively few empirical studies that analyse the role of foreign ownership for innovation output activities for the New EU Member states. The principle source of information used in the present study is the Community Innovation Survey 3 (CIS-data) in micro-aggregated form covering data for 12 European countries (i.e. Belgium, Spain, Germany, Greece, Norway, Portugal, Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Slovakia). Note that all the variables used in the empirical analysis except for innovation expenditures as a percentage of turnover are original values and are not aggregated using the micro-aggregation procedure. The CIS is a popular data source for studies of the economics of innovation, since the harmonised questionnaire allows for comparisons across firms, industries, and countries. However, due to confidentiality reasons cross-country studies on the differences in innovation performance using CIS data are still rare (notable exceptions include Griffith et al., 2006; Janz et al., 2004).

The structure of the present paper is as follows. Section 2 introduces the empirical model and hypotheses. Section 3 presents the data that were used, followed by a discussion of the empirical results in section 4. Some concluding remarks are provided in section 5.

2. Empirical model

In order to analyse the determinants of the probability to innovate, we use the following binary probit model (the individual index *i* is suppressed for convenience):

$$y^* = x'\beta + \varepsilon ,$$

where the latent variable y^* is observed as a binary variable y, which is defined as:

$$y = \begin{cases} 1 & if \quad y^* > 0 \\ 0 & if \quad y^* \le 0 \end{cases}.$$

The binary dependent variable y takes the value of 1 for firms that introduce technological innovations from 1998-2000, and 0 otherwise. In particular, we use five different types of technological innovations: (i) introduction of new products, (ii) introduction of new products developed in-house, (iii) introduction of new market products (new to the firm), (iv) introduction of new production processes, and (v) introduction of new production processes developed in-house. x is a vector of covariates and ß is the corresponding coefficient vector. Random factors, as well as unobservable factors influencing the innovation decision, are captured by the error term. The set of explanatory variables include a set of dummy variables for sector affiliation, firm size, and other firm characteristics (dummy variables indicating an increase in turnover due to merger & acquisitions, newly founded firms, turnover decrease due to "firm closure" measuring in turn whether the firm has sold or closed parts of the enterprise, and information of the firms most relevant geographical market (i.e. local, national, or international markets). The main parameter of interest is the ownership difference in the probability of the introduction of new products or new production processes. The parameters can be estimated by maximum likelihood.

In order to identify the major factors that are responsible for the differences in the propensity to innovate between foreign owned firms and domestic firms we use the Oaxaca-Blinder decomposition translated to the case of the binary probit model (Fairlie, 1999, 2005). This technique decomposes the foreign ownership difference in the percentage of innovating firms, $Y_d - Y_f$, into the coefficients (or residual) effect and the characteristic effect:

$$Y_d - Y_f = \left[\overline{P}(\beta_p, X_d) - \overline{P}(\beta_p, X_f)\right] + \left[\overline{P}(\beta_d, X_d) - \overline{P}(\beta_f, X_d)\right],$$

= characteristics effect + coefficients effect,

where $\overline{P}$ represents the average predicted probability of technological innovations. X_d and X_f refer to the firms' characteristics of the sample of foreign-owned and domestic firms, respectively. β_d, β_f and β_p refer to the parameters of the probit estimations for the sample of foreign-owned and domestic firms and the pooled model, respectively. The characteristics' effect measure the difference in predicted innovation probabilities when the firm characteristics of both foreign and domestic firms are used and the parameter vector is held constant. The coefficient effect is the difference in predicted innovation probabilities that results when the characteristics of domestic firms are held constant but the coefficient vector of both foreign and domestic firms are used.

Furthermore, we do not only investigate the impact of foreign ownership on the innovation decision but also the impact of foreign ownership on innovation performance. In particular, we estimate a share equation explaining the share of turnover with new products and market novelties, Y:

$$Y = \alpha + \beta_1 INQ + \beta_2 d_{for} + \sum_{n}^{3} \beta_{hist,n} d_{hist,n} + \sum_{h}^{2} \beta_{mark,h} d_{mark,h} + \sum_{l}^{7} \beta_{strat,l} d_{strat,l} + \sum_{k}^{24} \beta_{sources,k} d_{sources,k} + \sum_{g}^{3} \beta_{size,g} d_{size,g} + \sum_{m}^{11} \beta_{co,m} d_{co,m} + \sum_{p}^{7} \beta_{\text{sec},p} d_{\text{sec},p} + \varepsilon.$$

INQ is innovation intensity defined as the ratio of innovation expenditure to total turnover, d_{for} is a dummy variable for those firms that are a part of a multinational firm with its headquarters outside the home country, $d_{hist,n}$ comprises dummy variables for newly founded firms, mergers & acquisitions and firms' disclosure from 1998-2000, $d_{size,g}$ are dummy variables for firm size, $d_{strat,l}$ are dummy variables measuring the innovation strategy, $d_{mark,h}$ denotes the geographical market, $d_{sources,k}$ are dummy variables on the use of different innovation sources that are of high importance, medium and low importance, $d_{co,m}$ and $d_{\text{sec},p}$ denote country and sector dummy variables, respectively, and ε is the error term. The turnover with new market products is a proportion whose values are bound between zero and 1 (or zero and one hundred per cent) by definition. Indeed our measure of innovation success contains some clusters of zero and one values. In order to account for the censoring of the indicators of innovation success at zero and one, the empirical literature on knowledge production functions uses the (two-limit) Tobit model to estimate the determinants of the share of innovative sales. However, the Tobit model is not useful in our case because censoring occurs when the share of innovative sales is zero or equals 1 and not because the dependent variable is unobservable, i.e. is a truncated or censored subset of a latent continuous variable. Therefore, following Papke and Woolridge (1996), we apply the so-called fractional logit model:

$$E(Y_i|X_i) = G(X_i\beta) = \frac{\exp(X_i\beta)}{1+\exp(X_i\beta)},$$

where i denotes the firm, Y_i take values in the interval [0,1], i.e. $0 \le Y_i \le 1$. G is a function satisfying the predicted variables, $Y_i|$, will lie in the interval [0,1] and X_i is a vector of explanatory variables. The empirical model can be estimated by the quasi-maximum likelihood estimator, with heteroscedasticity robust asymptotic variance.

As above-mentioned, we use two left hand variables. The first is the share of new or significantly improved products in turnover. This indicator is more general than the dummy variable indicating the introduction of new products. Note that product innovations also include imitation activities, i.e. new products that are already introduced by other enterprise. Therefore, product innovations can be regarded as an indicator of the diffusion of innovation. The second measure of innovation success is the share of market novelties in turnover. In this case, new or significantly improved products are not only new to the firm but also to the market. Furthermore, in order to account for parameter heterogeneity we provide separate estimates for two groups of countries (i.e. Eastern and Western European Countries).

We expect that foreign ownership only plays a moderate role in explaining innovation success across countries. The literature on the economics of innovation has identified a number of other fundamental characteristics and determinants of innovation success, such as R&D investment, technological opportunities, appropriability conditions, demand conditions, firm size, age, firms' history, and market concentration (Cohen, 1995; Cohen, and Levin 1989). The linear model of innovation predicts a simple relationship between R&D expenditures and innovation output. R&D activities lead to inventions that eventually lead to product and process innovations (Cohen and Klepper, 1996). We use innovation expenditures as a percentage of turnover as a measure of innovation input. Innovation expenditures comprise expenditures on internal R&D, acquisition of external R&D services, acquisition of externally developed machinery and equipment, the acquisition of other externally developed technologies and knowledge and expenditures on worker training that are directly linked to innovation, market introduction of innovations, design and other preparations for production/deliveries. It is noteworthy that this variable is the only variable in our study that is aggregated using the micro-aggregation technique.

The innovation strategy is also an important factor explaining innovation performance. It is possible that firms innovate by exploiting the available external knowledge sources without spending a single dollar on innovation input such as R&D. Therefore, it is important to distinguish between the "make", "buy" or "make-and-buy" option, on the one hand, and between "formal" and "informal" R&D on the other hand (Veugelers and Cassiman, 1999). Furthermore, the impact of the use of purchased embodied technology is likely to be higher in companies in Western European countries than in the New EU member states. In contrast, the impact of conducting internal R&D is higher in the sample of Western European countries than in New EU member states. We use dummy variables whether or not the firms are engaged in different innovation activities.

Firm size is also an important firm characteristic. Empirical studies for the US suggests that the relationship between firm size and innovative activity is rather non-linear and U-shaped, meaning that small firms and very large firms can be expected to have a higher R&D/innovation intensity, but also that medium-sized firms would possess lower innovation intensity (Acs and Audretsch, 1987, 1988). Based on the Science Policy Research Unit (SPRU) innovations database in the United Kingdom, Pavitt et al. (1987) find that both very small firms and very large firms accounted for a disproportionately large share of innovations. In this study the firm size is measured using the distribution of turnover for each country. A firm with turnover above the 75^{th} percentile of the distribution will be classed as large, while a firm with a turnover below the 25^{th} percentile will be classed as small. Firms with a turnover between the 25^{th} percentile and median and between the median and 75^{th} percentile are deemed medium sized firms.

The theoretical and empirical literature has long recognised the importance external sources of information for innovation (von Hippel, 1988). Industrial researchers access knowledge external to the firm through many knowledge channels. Moreover, internal and external sources (e.g. suppliers, customers), international and national fairs and exhibitions are important sources of innovation. Descriptive evidence for EU countries based on CIS 3 data indicates that EU enterprises rely heavily on their own knowledge base (EC 2004). Among the external sources of knowledge, customers and suppliers are the most frequently used sources. Von Hippel (1988) emphasises the importance of customers and end-users as sources of innovation. The author demonstrates that innovation is often driven by customers and end users of products and services. Firms often benefit from customer-driven innovation either through direct observation of the customers' use of the firm's products, or through the customers' active modification of products (von Hippel, 1988). Innovations developed by end users sometimes become the basis for important new commercial products and services. It has also been argued that such innovations are concentrated in the "lead user" segment of the user community. Morrison, Roberts, and von Hippel (2000) show that lead users with sufficient technological expertise often generate product adaptations or solutions with immediate commercial potential for the seller. Customer-oriented companies offering increased customer contact are therefore more likely to identify opportunities to develop new products or markets.

3. Data and descriptive statistics

The data source used in this study comprises the CIS 3 micro aggregated data. The survey was conducted in 2001 and covers 1998-2000 for most of the variables. CIS 3 contains information on both the input and output dimensions of innovation activities. Firms are firstly asked whether or not they introduce new products, market novelties and new production processes. In a second step, firms are also asked to assess the proportion of their turnover that derives from a) products new to the firm but not new to the market b) products new to the firm and new to the market. If an enterprise receives a large proportion of its revenue from new products, we assume that this enterprise is more innovative than a firm receiving a smaller proportion of its revenue from new products. The relevant questions used to construct the variables include questions about the importance of the types of innovations that occur, their national sources, and innovation expenditures divided by total sources. Note that innovation expenditures and total turnover are the only variables in the empirical specification that are aggregated using the "micro-aggregation" procedure.

Table 1: Percentage of innovators by ownership

	Western European countries				Eastern European countries			
	domestic firms	foreign owned	difference	# of obs	domestic firms	foreign owned	difference	# of obs
new products	0.33	0.43	0.10	18600	0.21	0.34	0.13	10009
new products developed in-house	0.29	0.41	0.12	18329	0.19	0.32	0.13	10008
new market products	0.16	0.25	0.09	18358	0.11	0.20	0.09	10009
new production processes	0.28	0.36	0.08	18592	0.16	0.24	0.09	10009
new production processes dev in-house	0.23	0.32	0.09	18045	0.13	0.22	0.08	10009

Notes: The percentages are calculated using sample weights.

Table 2: Share of innovative sales by ownership (means)

	Western European countries				Eastern European countries			
	domestic firms	foreign owned	difference	# of obs	domestic firms	foreign owned	difference	# of obs
new products	0.261	0.222	-0.039	6,402	0.116	0.142	0.026	4,997
new market products	0.104	0.095	-0.008	6,138	0.052	0.066	0.014	4,463

Notes: Averages are calculated using sample weights.

Our sample includes the manufacturing and service sectors. For the probit estimations, we have information from approximately 28,000 firm observations. For our second empirical model we restrict the sample to firms that introduced product innovations. The reason for this is that for non-innovative firms we do not have much information on the different explanatory variables (e.g. innovation sources, innovation intensity. Restricting the sample to firms with product innovations reduces the sample to approx. 11,700 firms. As mentioned above, foreign-owned firms are more technologically advanced than domestic firms. Descriptive statistics based on micro-aggregated CIS3 data indicate that the percentage of innovating firms is higher among foreign-owned firms than domestically owned firms (see Table 1). This also holds true for the share of innovative sales (see Table 2).

4. Estimation results

Tables 3 and 4 display the marginal effects and corresponding z-values of the probit model of the propensity to innovate for Western and Eastern European countries, respectively. Specifically, we provide probit estimates for five different types of innovation activities (i.e. introduction of new products, introduction of new products developed in-house, introduction of market novelties, introduction of new production processes, and the introduction of new production processes developed in-house). For the sample including Western European firms we find that the propensity to introduce new products developed in-house is higher for foreign-owned firms than for domestically owned firms.

Table 3:Probit estimates of the impact of foreign ownership on the introduction of new products and new production processes for the sample of Western European Countries (marginal effects)

	new products		new products developed in-house		new market products		new production processes		new production processes dev in-house	
	dF/dx	z	dF/dx	z	dF/dx	z	dF/dx	z	dF/dx	z
foreign-owned firm (yes/no)	0.007	0.64	0.014	1.68	0.019	1.68	-0.011	-1.03	0.006	0.59
newly founded firm (yes/no)	0.028	1.37	0.040	2.47	0.035	1.78	0.042	2.20	0.056	2.91
exporting (yes/no)	0.082	9.51	0.046	6.80	0.085	10.09	0.043	5.11	0.046	5.45
turnover increase due to M&A (yes/no)	0.098	5.58	0.068	4.99	0.100	5.83	0.082	4.86	0.091	5.31
turnover reduction due to disclosure (yes/no)	-0.077	-2.85	-0.057	-2.78	-0.061	-2.30	-0.080	-3.15	-0.053	-2.10
Firms most significant market (ref local):										
national market (yes/no)	0.107	11.94	0.066	9.14	0.121	13.61	0.053	6.15	0.050	5.73
international market (yes/no)	0.147	12.18	0.099	9.95	0.162	13.54	0.103	8.88	0.104	8.80
firm size dummy variables:										
firm size class turnover (25th to 50th)	0.064	5.77	0.040	4.44	0.054	4.95	0.070	6.56	0.056	5.14
firm size class turnover (51st to 75th)	0.140	12.24	0.092	9.68	0.127	11.25	0.142	12.86	0.133	11.82
firm size class turnover (76th to 100th)	0.281	23.19	0.178	17.19	0.274	22.62	0.286	24.34	0.279	23.05
industry dummy variables:										
Mining & energy	-0.120	-5.90	-0.081	-5.25	-0.124	-6.28	-0.057	-2.95	-0.057	-2.97
Intermediate manufacturing	0.038	3.42	0.025	2.87	0.022	2.00	0.055	5.14	0.042	3.80
Investment manufacturing	0.109	9.55	0.076	8.37	0.092	8.27	0.059	5.36	0.052	4.67
Distributive trade	-0.100	-6.45	-0.055	-4.62	-0.137	-9.36	-0.098	-6.72	-0.094	-6.54
Transport & financial intermediation	-0.035	-2.56	-0.035	-3.30	-0.064	-4.95	-0.027	-2.09	-0.017	-1.33
Business services	0.253	16.21	0.216	15.92	0.232	14.85	0.100	6.71	0.099	6.57
country dummy variables (ref. cat. Belgium)										
Germany	0.014	0.87	0.003	0.26	0.046	2.85	0.014	0.87	0.054	3.47
Spain	-0.123	-8.38	-0.034	-3.04	-0.100	-6.98	-0.031	-2.15	-0.005	-0.36
Greece	-0.221	-13.55	-0.076	-5.95	-0.180	-11.22	-0.151	-9.04		
Norway	-0.088	-5.76	-0.042	-3.67	-0.057	-3.79	-0.061	-4.05	-0.027	-1.83
Portugal	-0.150	-8.66	0.023	1.59	-0.120	-7.13	-0.017	-0.92	0.018	0.98
# of obs	18601		18330		18360		18594		16808	

Notes: The marginal effects represent the effect of a one unit change for continuous explanatory variables and a discrete change for the dummy variables.

Table 4:Probit estimates of the impact of foreign ownership on the introduction of new products and new production processes for the sample of Eastern European Countries (marginal effects)

	new products		new products developed in-house		new market products		new production processes		new production processes dev in-house	
	dF/dx	z	dF/dx	z	dF/dx	z	dF/dx	z	dF/dx	z
foreign-owned firm (yes/no)	0.045	3.14	0.047	3.37	0.045	4.19	0.034	2.72	0.039	3.34
newly founded firm (yes/no)	0.001	0.04	-0.005	-0.22	-0.003	-0.20	0.015	0.73	0.027	1.38
exporting (yes/no)	0.072	5.70	0.068	5.58	0.052	5.47	0.045	4.05	0.043	4.06
turnover increase due to M&A (yes/no)	0.074	3.38	0.067	3.20	0.049	2.95	0.068	3.53	0.051	2.84
turnover reduction due to disclosure (yes/no)	-0.042	-1.66	-0.018	-0.72	0.000	0.01	0.020	-0.86	0.013	-0.59
Firms most significant market (ref local):										
national market (yes/no)	0.048	3.58	0.050	3.78	0.029	2.81	0.012	0.97	0.015	1.29
international market (yes/no)	0.009	0.62	0.008	0.57	0.007	-0.69	-0.009	-0.70	0.008	-0.68
firm size dummy variables:										
firm size class turnover (25th to 50th)	0.082	5.51	0.073	5.02	0.044	3.73	0.075	5.34	0.070	5.24
firm size class turnover (51st to 75th)	0.169	11.03	0.163	10.85	0.086	6.91	0.167	11.43	0.148	10.57
firm size class turnover (76th to 100th)	0.316	19.49	0.303	18.90	0.191	13.96	0.316	20.16	0.286	18.77
industry dummy variables:										
Mining & energy	0.159	-6.80	-0.147	-6.69	0.099	-5.74	0.016	0.71	0.000	0.01
Intermediate manufacturing	0.009	0.60	0.000	0.02	-0.018	-1.74	0.042	3.23	0.031	2.55
Investment manufacturing	0.059	4.06	0.048	3.48	0.053	4.67	0.046	3.43	0.026	2.08
Distributive trade	0.115	-8.02	-0.148	-11.24	0.049	-4.53	0.101	-7.89	0.093	-7.84
Transport & financial intermediation	0.139	-9.59	-0.132	-9.73	0.083	-7.68	0.065	-4.88	0.059	-4.74
Business services	0.102	5.19	0.090	4.77	0.086	5.45	0.098	5.24	0.079	4.49
country dummy variables (ref. cat. Hungary)										
Czech Republic	0.145	7.09	0.149	7.54	0.109	6.37	0.094	5.05	0.106	5.85
Estonia	0.095	4.50	0.092	4.48	0.083	4.67	0.109	5.52	0.114	5.91
Lithuania	0.074	3.36	0.076	3.56	0.111	5.79	0.093	4.55	0.095	4.74
Latvia	0.002	0.07	0.020	0.82	0.057	2.62	0.035	1.49	0.058	2.53
Slovakia	0.019	0.84	0.026	1.17	0.056	2.88	0.069	-3.53	0.050	-2.62
# of obs	10018		10018		10018		10018		10017	

Similarly, we find that the probability to introduce market novelties is significantly higher for foreign-owned firms than for domestic firms. However, the effects are only significant at the 10 per cent level. The magnitude of the foreign-ownership effect is also quite low. For instance, foreign-owned firms have a 1.4 percentage higher propensity to introduce market novelties than domestically owned firms. In contrast, for Eastern European countries we find that the probability to introduce product or process innovations is significantly higher for foreign owned firms than for domestic companies. This holds for all different types of technological innovations (see Table 4). The foreign ownership effect is the largest for the introduction of new products and market novelties while it is somewhat smaller for the introduction of new production processes. Turning to the other explanatory variables we find that firm size and exporting are positively related to the probability to innovate. Furthermore, firms that consider international markets as their most important market also have a much higher probability to innovate. As expected, the marginal effects indicate that the propensity to innovate is highest in business services followed by investment manufacturing.

The probit estimates presented above show that even after controlling for firm characteristics there remains a sizeable difference in the probability to introduce technological innovations between foreign-owned and domestic firms. In order to identify the major factors responsible for the ownership differences in the probability to innovate we apply the Oaxaca-Blinder-type decomposition for binary probit models as developed by Fairlie (1999, 2005).[2] This allows us to decompose the differences in the propensity to innovate into the characteristics effect and into the coefficients effects.

Table 5: Fairlie decomposition of the foreign ownership effect on the propensity to innovate

	percentage of innovators				Results of the decomposition analysis				
	domestic firms	foreign-owned	differ-ence	un-explained	ex-plained	firm size effect	sector effects	country effects	other effects
								Western European countries	
new products	0.301	0.461	-0.160	-0.018	-0.142	-0.087	-0.002	-0.002	-0.054
					(89)	(61)	(1)	(1)	(38)
new market products	0.174	0.285	-0.111	-0.016	-0.095	-0.061	-0.001	-0.001	-0.033
					(86)	(64)	(1)	(1)	(35)
								Eastern European countries	
new products	0.259	0.419	-0.160	-0.046	-0.114	-0.097	0.005	-0.009	-0.013
					(71)	(85)	(-4)	(8)	(11)
new products developed in-house	0.235	0.387	-0.152	-0.047	-0.105	-0.096	0.010	-0.008	-0.011
					(69)	(91)	(-9)	(7)	(11)
new market products	0.140	0.256	-0.116	-0.053	-0.063	-0.063	0.005	0.003	-0.008
					(54)	(100)	(-7)	(-5)	(12)
new production processes	0.200	0.330	-0.130	-0.037	-0.093	-0.100	0.007	0.008	-0.009
					(71)	(107)	(-8)	(-9)	(10)
new production processes dev in-house	0.174	0.301	-0.127	-0.045	-0.082	-0.090	0.008	0.007	-0.007
					(64)	(110)	(-10)	(-9)	(9)

Notes: percentages are in parenthesis.

The latter measure, the extent to which differences in the propensity to innovate between foreign and domestically owned forms are accounted for, observed the firm characteristics. The remaining unexplained part provides evidence as to how, and to what extent, the characteristics differentially affect the propensity of technological innovations. Table 5 shows the effects of the decomposition

analysis of the differences in the percentage of innovators between foreign owned and domestically owned firms for the sample including Western and Eastern European firms for five different types of innovation activities. The decomposition analysis for Western European firms shows that the characteristics effects explain between 86 and 88 per cent of the difference in innovativeness between foreign owned and domestic firms. This means that if foreign owned firms share the same characteristics as domestic firms the observed difference in the innovation rate would be reduced significantly. For Eastern European firms, the characteristics effect explains between 54 and 71 per cent of the difference in innovativeness between foreign and domestically owned firms. In other words, if domestically owned firms shared the same characteristics as foreign owned firms the observed difference in the percentage of firms with new products would be increased from 15 to 4 per cent. As can be seen in table 5, the firm size has the largest effect and accounts for 85 and 110 per cent of the explained gap. The remaining factors, namely sector affiliation and country effects, only play marginal roles.

Tables 6 and 7 provide the marginal effects of the fractional logit models for the share of new products in turnover as well as the share of new market products in turnover based on the total sample. We also provide separate estimates for the Western European and Eastern European countries. We find that in the New Member States foreign-owned firms are significantly more innovative than domestic firms with marginal effects for the share of new products and market novelties of 0.024 and 0.011, respectively. However, for Western European countries foreign ownership is positive but not significantly different from zero. Other factors such as innovation input, innovation strategies, use of different innovation sources, firm size, sector affiliation and resent firms history (i.e. newly founded firms, mergers, and acquisitions) seem to be more important than foreign ownership in explaining innovation performance. For instance, firms that consider clients as a highly important source of innovation have on average a 6 percentage points higher share of new product sales. It is also interesting to note that the effects of clients are higher than that of any other external innovation source. The importance of clients as an innovation source is consistent with van Hippel (1998). Innovation success in terms of new products and market novelties is also significantly higher for firms that use fairs & exhibitions intensively as a source of innovation. Furthermore, we find that both indicators of innovation output are significantly negatively related to firm size. The highest innovation output is observed for the 25th of the smallest firms in terms of turnover. For instance, in the case of the Western European countries, the share of new products in turnover in the largest firm size class is 7 percentage points lower than in the smallest firm size class.

Table 6: Fractional logit model Estimates for the share of turnover with new products

	total sample		Western European		Eastern European	
	dF/dx[a]	z	dF/dx[a]	z	dF/dx[a]	z
foreign ownership	0.019	2.89	0.008	0.87	0.024	2.73
innovation intensity	0.187	9.09	0.217	8.00	0.133	4.43
newly founded firm	0.045	3.19	0.047	2.38	0.048	2.66
turnover growth due to mergers & acquisitions	0.026	2.65	0.020	1.45	0.027	2.23
sales reduction due to disclosure	-0.014	-0.87	-0.010	-0.36	-0.016	-1.15
Firms most significant market: national market (ref. local)	-0.004	-0.58	-0.004	-0.47	0.007	0.90
Firms most significant market: international market	0.026	3.60	0.027	2.50	0.030	3.58
firm size:(Wald-test p-value:) (ref. 0th 25 th)	(0.000)		(0.001)		(0.001)	
firm size class turnover (25 th to 50 th)	-0.003	-0.37	-0.004	-0.37	-0.002	-0.25
firm size class turnover (50 th to 75 th)	-0.027	-3.90	-0.038	-3.62	-0.018	-2.20
firm size class turnover (75 th to 100 th)	-0.050	-6.81	-0.073	-6.62	-0.028	-3.27
innovation strategies: (Wald-test p-value:):	(0.000)		(0.000)		(0.001)	
intramural R&D	0.016	2.78	0.010	1.17	0.010	1.48
extramural R&D	0.005	0.89	0.007	0.86	0.005	0.69
acquisition of machinery and equipment	0.027	5.05	0.015	2.07	0.025	3.54
acquisition of other external knowledge	0.008	1.52	0.010	1.28	0.003	0.49
Training	0.012	2.26	0.016	2.15	0.006	0.90
market introduction of innovation	0.012	2.09	0.007	0.93	0.012	1.75
design and other preparation	0.006	1.05	0.009	1.15	0.000	0.04
Innovation sources ref not relevant, :(Wald-test p-value:):	(0.000)		(0.001)		(0.000)	
fairs, exhibitions, low importance	0.022	2.34	0.007	0.59	0.030	2.20
fairs, exhibitions, medium importance	0.019	2.22	0.003	0.24	0.029	2.45
fairs, exhibitions, high importance	0.044	4.04	0.024	1.76	0.051	3.35
conferences, meetings, journals, low importance	0.001	0.12	-0.004	-0.34	0.001	0.05
conferences, meetings, journals, medium importance	0.011	1.34	0.005	0.45	0.008	0.78
conferences, meetings, journals, high importance	0.000	0.00	-0.003	-0.23	-0.003	-0.23
government research institutes, low importance	-0.010	-1.38	0.001	0.13	-0.008	-0.94
government research institutes, medium importance	-0.020	-2.58	-0.008	-0.67	-0.019	-1.84
government research institutes, high importance	-0.033	-3.08	-0.031	-2.01	-0.022	-1.56
universities, low importance	-0.017	-2.45	-0.017	-1.72	-0.013	-1.53
universities, medium importance	-0.004	-0.47	0.002	0.21	-0.010	-1.09
universities, high importance	0.016	1.41	0.015	0.93	0.012	0.84
competitors, low importance	-0.010	-1.48	-0.010	-1.01	-0.013	-1.42
competitors, medium importance	-0.003	-0.48	-0.001	-0.11	-0.017	-1.99
competitors, high importance	0.000	-0.02	0.007	0.56	-0.023	-2.53
clients, low importance	0.042	3.91	0.005	0.37	0.086	4.10
clients, medium importance	0.042	4.70	0.017	1.55	0.064	4.13
clients, high importance	0.061	6.37	0.030	2.63	0.093	5.13
suppliers, low importance	0.017	2.08	-0.005	-0.47	0.035	2.72
suppliers, medium importance	0.022	3.02	-0.004	-0.40	0.041	3.79
suppliers, high importance	0.027	3.20	0.005	0.49	0.036	2.89
internal sources, low importance	0.071	4.85	-0.026	-1.68	0.093	4.22
internal sources, medium importance	0.068	6.03	-0.008	-0.59	0.073	4.66
internal sources, high importance	0.090	8.07	0.013	1.02	0.110	6.15
sector effects (ref. consumer manufacturing) (Wald-test)	(0.000)		(0.002)		(0.000)	
mining & energy	-0.068	-5.01	-0.075	-3.30	-0.044	-3.08
intermediate manufacturing	-0.026	-4.02	-0.038	-3.86	-0.007	-0.92
investment manufacturing	0.019	2.71	0.033	3.16	0.004	0.49
distributive trade	-0.021	-2.36	-0.022	-1.47	-0.008	-0.90
transport & financial intermediation	-0.005	-0.47	-0.010	-0.66	0.001	0.08
business services	0.039	4.00	0.049	3.47	0.031	2.43
country effects (ref. country: BE or CZ) (Wald t.)	(0.000)		(0.001)		(0.000)	
Czech Republic	-0.015	-1.33				
Germany	0.043	3.54	0.057	4.08		
Estonia	0.140	8.31			0.074	6.33
Spain	0.142	10.62	0.148	10.82		
Greece	0.131	6.50	0.144	6.72		
Hungary	0.036	1.69			0.004	0.29
Norway	0.038	3.16	0.041	2.96		
Portugal	0.097	5.72	0.108	5.80		
Lithuania	0.168	8.33			0.109	6.64
Latvia	0.085	4.27			0.039	2.71
Slovakia	0.031	1.81			-0.001	-0.12
# of obs.	11407		6403		5004	
R^2	0.195		0.110		0.294	
R^2 due to country effects/ R^2 due to sector effects	0.101/0.036		0.025/0.038		0.151/0.023	

Notes: [a]denotes the marginal effects. z-values are based on heteroscedasticity consistent standard errors.

Table 7: Estimates of the fractional logit model for the turnover share of market novelties

	total sample		Western European		Eastern European	
	marg eff.	z	marg eff.	z	marg eff.	z
foreign ownership	0.012	2.78	0.009	1.55	0.011	2.02
innovation intensity	0.090	8.35	0.105	7.35	0.070	4.27
Newly founded firm	0.029	2.79	0.057	3.39	0.006	0.55
turnover growth due to mergers & acquisitions	0.021	2.97	0.014	1.49	0.025	2.76
sales reduction due to disclosure	-0.005	-0.56	-0.014	-0.90	0.000	-0.04
Firms most significant market (ref. local) :(Wald-t.p.)	(0.000)		(0.050)		(0.020)	
national market	0.000	0.02	0.000	0.06	0.002	0.34
international market	0.013	2.74	0.014	1.93	0.011	2.15
firm size:(Wald-test p-value:) (ref. 0th 25 th)	(0.000)		(0.001)		(0.010)	
firm size class turnover (25 th to 50 th)	0.001	0.12	-0.001	-0.19	0.003	0.45
firm size class turnover (50 th to 75 th)	-0.009	-2.04	-0.012	-1.75	-0.007	-1.44
firm size class turnover (75 th to 100 th)	-0.023	-4.83	-0.034	-4.66	-0.012	-2.23
innovation strategies: (Wald-test p-value:):	(0.000)		(0.000)		(0.001)	
intramural R&D	0.015	3.97	0.020	3.54	0.005	1.22
extramural R&D	0.002	0.55	0.003	0.67	0.001	0.25
acquisition of machinery and equipment	0.007	1.97	0.004	0.83	0.005	1.16
acquisition of other external knowledge	0.004	1.28	0.002	0.43	0.004	1.02
Training	0.007	1.79	0.008	1.63	0.004	0.81
market introduction of innovation	0.015	3.93	0.014	2.57	0.014	2.92
design and other preparation	0.005	1.41	0.011	2.11	-0.002	-0.57
innovation sources :(Wald-test p-value:):	(0.000)		(0.001)		(0.000)	
fairs, exhibitions, low importance	0.012	1.85	0.001	0.09	0.023	2.22
fairs, exhibitions, medium importance	0.013	2.11	0.006	0.72	0.019	2.13
fairs, exhibitions, high importance	0.017	2.30	0.012	1.30	0.019	1.83
conferences, meetings, journals, low importance	-0.003	-0.63	-0.002	-0.23	-0.008	-1.48
conferences, meetings, journals, medium importance	0.000	-0.01	0.003	0.43	-0.007	-1.30
conferences, meetings, journals, high importance	0.002	0.23	0.003	0.35	-0.004	-0.52
government research institutes, low importance	-0.001	-0.24	0.001	0.19	0.001	0.17
government research institutes, medium importance	-0.004	-0.74	0.002	0.21	-0.004	-0.64
government research institutes, high importance	-0.006	-0.83	-0.013	-1.37	0.006	0.55
universities, low importance	-0.008	-1.74	-0.006	-1.00	-0.007	-1.36
universities, medium importance	-0.004	-0.76	0.004	0.52	-0.009	-1.72
universities, high importance	0.004	0.58	0.010	0.93	-0.006	-0.73
competitors, low importance	-0.008	-1.77	-0.011	-1.85	-0.002	-0.40
competitors, medium importance	-0.012	-2.93	-0.020	-3.59	-0.004	-0.82
competitors, high importance	-0.015	-3.20	-0.020	-3.06	-0.012	-2.12
clients, low importance	0.012	1.69	-0.007	-0.93	0.032	2.33
clients, medium importance	0.011	1.84	0.005	0.73	0.013	1.42
clients, high importance	0.023	3.54	0.012	1.68	0.028	2.48
suppliers, low importance	0.010	1.80	-0.004	-0.60	0.024	2.47
suppliers, medium importance	0.009	1.84	-0.002	-0.35	0.019	2.49
suppliers, high importance	0.018	2.96	0.004	0.59	0.028	2.82
internal sources, low importance	0.020	1.96	-0.026	-2.95	0.028	1.93
internal sources, medium importance	0.025	3.13	-0.013	-1.52	0.030	2.73
internal sources, high importance	0.036	4.54	-0.002	-0.29	0.047	3.55
industry dummy variables (ref. consumer manuf.) (p-value)						
Mining & energy	-0.033	-4.01	-0.035	-2.27	-0.022	-2.98
Intermediate manufacturing	-0.010	-2.26	-0.011	-1.72	-0.005	-1.10
Investment manufacturing	0.011	2.26	0.015	2.15	0.007	1.33
Distributive trade	-0.004	-0.64	-0.007	-0.70	0.001	0.18
Transport & financial intermediation	-0.004	-0.60	0.001	0.11	-0.007	-1.04
business services	0.022	3.24	0.028	2.78	0.018	2.01
country dummy variables (ref. country: BE and CZ)						
Czech Republic	-0.008	-1.01				
Germany	-0.004	-0.52	-0.002	-0.28		
Estonia	0.140	7.34			0.078	6.27
Spain	0.038	4.43	0.043	4.48		
Greece	0.070	4.35	0.078	4.31		
Hungary	0.000	0.02			-0.007	-0.97
Norway	-0.002	-0.21	-0.001	-0.13		
Portugal	0.090	5.89	0.104	6.06		
Lithuania	0.126	6.54			0.079	5.81
Latvia	0.098	4.67			0.060	3.95
Slovakia	0.090	4.73			0.046	4.05
# of obs.	10617		6146		4471	
R^2	0.133		0.087		0.211	
R^2 due to country effects/R^2 due to sector effects	0.065/0.020		0.016/0.022		0.131/0.015	

Furthermore, we find that the share of new products with market novelties is significantly higher in firms that act successfully on international markets. It also noteworthy that young firms have a significantly higher share of new products and new market products in total turnover. This also holds true for the share of new market products. Regarding industry affiliation, Wald-Tests indicate that industry effects jointly significant at the 1 per cent level. In particular, we find that firms in business services and investment manufacturing have the highest share of new market products as well as products that are new to the firm.

It is interesting to look at the sources of the gap in the share of innovating firms between foreign owned and domestic firms. To quantify this effect, we use a variant of the Oaxaca and Blinder decomposition as developed by Oaxaca and Ransom's (1994) that decomposes the gap into the characteristics component (i.e. contributions from group differences in the variables) and into the "unexplained" component resulting from differences in the coefficients. Table 8 shows that the difference in the share of innovative sales between foreign and domestic firms of approx. 2.4 percentage points is mainly due to differences in the unexplained factors and to a smaller extent to differences in the characteristics. For the share of market novelties we find similar results.

Table 8: Results of the Blinder –Oaxaca decomposition

	domestic firms	foreign-owned	difference	unexplained	explained
percentage of firms with new products	0.166	0.190	-0.024	-0.018	-0.006 27
percentage of firms with new market products	0.082	0.095	-0.013	-0.011	-0.002 16

5. Summary and outlook

In the present study we investigate the relationship between foreign ownership and innovation activities using the micro-aggregated data of the third community innovation survey including 12 European countries. Firstly, we provided evidence for the effects of foreign ownership on the propensity to innovate distinguishing between five different types (i.e. introduction of new products, introduction of market novelties, and the introduction of new production processes). We controlled for a large number of firm characteristics, focusing sector affiliation, firm size, and exporting. For the New Member States we find that the probability to innovate is significantly higher for foreign-owned firms than for domestic firms regardless of the type of innovation activities. For the group of Western European countries we find that foreign ownership is also positive but only marginally at the 10% level. For the New Member States the decomposition of the differences in the percentage of

innovating firms between foreign owned and domestic firms reveals that the differences are mainly due the different firm characteristics rather than to differences in unexplained coefficients. In particular, the dominance of foreign-owned firms in the largest firm size group is the main factor contributing to the ownership gap in the percentage of innovators.

Secondly, we investigated the link between foreign ownership and the turnover with innovative products. In particular, the share of new products in turnover as well as the share of market novelties have been related by factors such as the amount and type of innovation input activities, use of different innovation sources and firm characteristics (e.g. firm size, newly founded firms, foreign ownership recent mergers and acquisitions) and country effects. The empirical model used in this study is a fractional logit model that accounts for the fact that the dependent variable is bound by definition between 0 and 1. For the New Member States foreign-owned firms are significantly more innovative than domestic firms. Using a variant of the Blinder Oaxaca decomposition analysis developed by Oaxaca and Ransom (1994) we find that the difference in the share of innovative sales between foreign-owned and domestic firms is mainly due to differences in the estimated coefficients and not to differences in observed the firms' characteristics. Furthermore, we find that innovation output depends significantly on firm size, innovation strategy, innovation sources, and sector affiliation. We find that firm innovation success, measured by innovative sales rises significantly with the innovation effort. However, innovation output not only depends on investment in innovation effort but also on the type of innovation activities. Internal R&D activities, acquisition of new machinery, training related innovation expenditures and activities with respect to the market introduction of innovation are crucial factors for the firm's innovative success.

Overall we can conclude that for the New EU Member States, foreign-owned firms are more innovative in terms of the share of new products or market novelties but not with respect to the probability to innovate. For the group of Western European countries we find that foreign-ownership is not an important determinant of innovation output. A possible reason for the difference between the firms in Eastern and Western European countries is that the average age of the foreign-owned firms is lower in the New Member States than in Western European countries. However, this result should be treated with some caution due to the fact that the number of Western European countries included in our study is quite limited. More research in this area is needed before arriving at any definitive conclusions.

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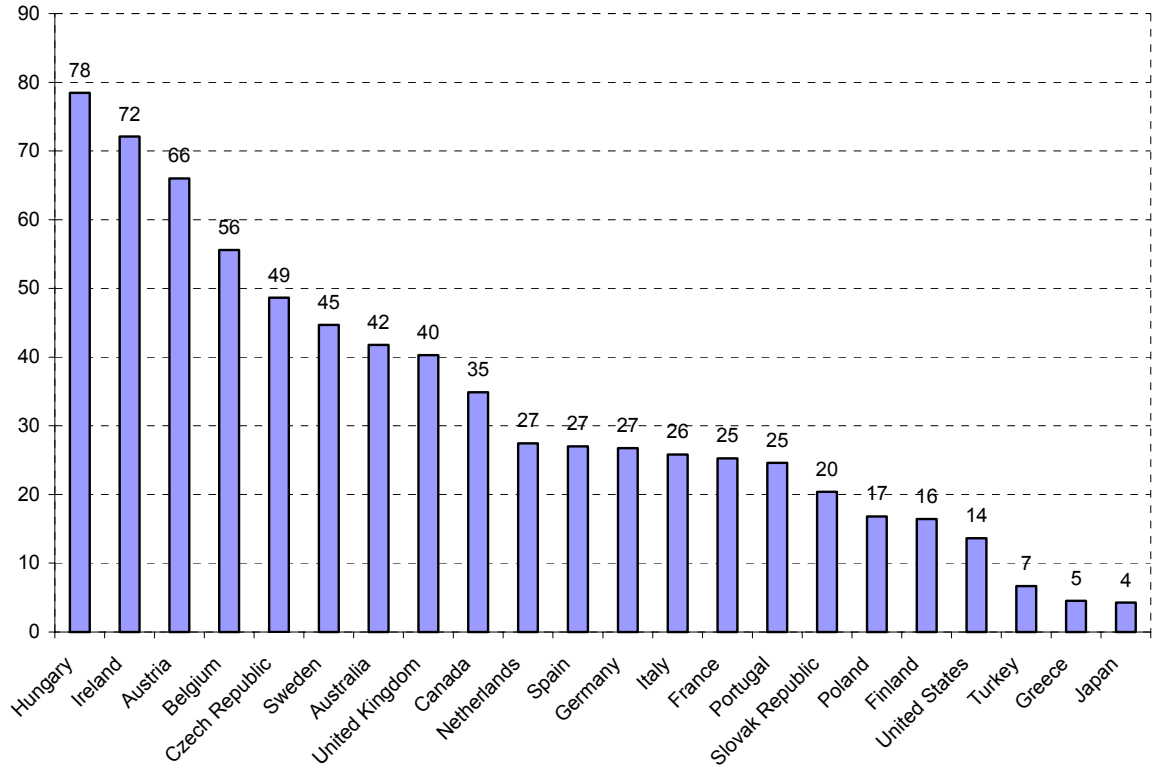
Appendix

Graph 1: R&D expenditure of foreign affiliates as a percentage of R&D expenditures of enterprises (2004 or the latest available year)



Notes: The number for Austria is estimated. Source: OECD MSTI, own calculations.

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[2] We use the Stata programme implemented by Jann (2006).