Market concentration and innovation in transnational corporations

Evidence from foreign affiliates in Central and Eastern Europe

Abstract

The main research question of this contribution is concerned with whether local market concentration influences R&D and innovation activities of foreign affiliates of trans-national companies. We focus on transition economies and use discriminant function analysis to investigate differences in the innovation activity of foreign affiliates operating in concentrated markets, compared to firms operating in non-concentrated markets. The database consists of the results of a questionnaire administered to a representative sample of foreign affiliates in a selection of five transition economies. We find that foreign affiliates in more concentrated markets, when compared to foreign affiliates in less concentrated markets, export more to their own foreign investor network, do more basic and applied research, use more of the existing technology already incorporated in the products of their own foreign investor network, do less process innovation, and acquire less knowledge from abroad. The main implications of these results are that host country market concentration stimulates intra-network knowledge diffusion (with a risk of transfer pricing), while more intense competition stimulates knowledge creation (at least as far as process innovation is concerned) and knowledge absorption from outside the affiliates' own network.

Keywords: market structure, transnational corporations, innovation, foreign direct investment
JEL: L16, F23, O30

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1 Introduction: theory and related empirical works

At the most general level for our analysis, we refer to the theory concerned with the relationship between innovation and market structure. This question is far from resolved: a positive relationship, where firms tend to innovate more when they enjoy some form of monopoly-profits, and a negative one, where firms are forced to innovate by fierce competition to stay afloat, both co-exist in the the empirical and theoretical literature (see e.g. Krap/Stephan, 2008).

The prevalent theory in international literature, from Schumpeter (1942) to Dasgupta and Stiglitz (1980) – for a more detailed literature review on this topic see Subodh (2002) - argues that monopoly profits provide incentives for companies to engage in research and development (R&D). Endogenous growth theory - see Rosenberg (1981) and Porter (1990), among others - considers innovation as the most important driver of productivity growth. It also seems to argue that, since R&D is expensive, only companies with large profits can afford such technological development. Therefore, monopolies or large oligopolies, earning higher than normal profits, are likely to invest more in R&D than firms operating in a more competitive environment. Evidence from developed economies supports this argument, up to a point. Most R&D intensive sectors are international oligopolies, such as pharmaceuticals and biotechnology, technology hardware and equipment, automobiles and parts, oil and gas producers, chemicals (according to the 2007 statistics from the European Commission - not only in EU, but globally). Most concentrated industries benefit from high economies of scale or a high level of technology (Tohmo et al., 2006). Among recent studies supporting the argument that higher market concentration leads to the higher R&D intensity we can mention Gayle (2001), Smith et al. (2002), Weiss (2005), Bhattacharya and Innes (2007).

On the other hand, Viscusi et al. (2005) present a theory supporting the argument that the incentive to invent is greater in a competitive industry than in a monopoly industry, both for "minor" inventions (one that leaves the market price unaffected) and for "major" inventions (one that leads to price cuts). The authors also mention Tirole's replacement effect, which holds that a monopolist firm is less stimulated to innovate because by doing so it "replaces itself", while a competitive firm is more stimulated to innovate because by doing so "it becomes a monopoly". Medvedev and Zemplinerova (2005), in a study on the Czech economy, found that market concentration reduces innovation. In a more comprehensive empirical study, Carlin et al. (2004) conclude for the 24 transition economies analysed that innovativeness of firms tended to increase with competition: a minimum number of seriously competing firms is sufficient to generate competitive conduct. Raider (1998) replaced the traditional concentration ratio with a network model of market competition and found that markets facing competitive environments show greater R&D intensity and faster rates of innovation than markets facing less competition. Howitt (2007), also referring to other recent empirical work, observes a positive correlation between product market competition and productivity growth and innovativeness within a firm or industry.

Our research effort differs in that it addresses innovation undertaken by foreign direct investment affiliates only, in the context of their local market competition. Here, the body of the international business literature on the behaviour of transnational corporations (TNC) in different market structure settings is rather scarce. Most contributions are concerned with the behaviour of TNC and the resulting effect on the market structure of the host economy industry (see e.g. Graham, 1989; Cowling/Sudgen, 1987; Peoples/Sudgen, 2000). These studies do not assess whether TNC's subsidiaries adjust their (strategic) behaviour with respect to their technological activities (R&D and innovation) to the degree of competition they face locally. The stream of literature that is concerned with the issue of R&D and innovation-activities of local affiliates (see e.g. Papanasstasiou/Pearce, 1999) does not consider market concentration at the sectoral level (with a focus on the transition economies of Central East Europe, see e.g. Damijan et al., 2003 and Manea/Pierce, 2004). There hence appears to exist a striking gap in the literature on market structures as one determinant of transnational corporations' R&D and innovation, despite the fact that this has clear implications for economic policy in general and competition policy as well as policies to attract foreign direct investment in particular. Our paper aims to fill this gap.

As a first approximation of an application of the innovation-market structure relationship to TNC, we can first assume that TNC subsidiaries are less in need of monopoly-profits granted by concentrated market structures in their host economy to cover the costs of R&D and innovation. This is because they are able to transfer funds between different locations (see e.g. Papanastassiou/Pearce, 2005), monopoly-profits may well originate in other locations. This may reduce the relevance of the classical Schumpeter-hypothesis in the case of TNC. Second, foreign direct investment subsidiaries are attached to a particular investment motive of the foreign investor, hence R&D and innovative behaviour of an affiliate may well depend to a lesser degree on the affiliate's local market structure. This is particularly the case for subsidiaries that belong to multinational corporations (MNC): those typically form part of an international network with multiple locations, where each location adds to increasing efficiency for the whole network of the MNC (see e.g. Birkinshaw/Hood, 1998). Finally, the innovation-market structure relationship for TNC will also depend on the degree of local market orientation vs export orientation. In general, the distinction between domestic enterprises and foreign affiliates with respect to the market structure-innovation link hinges on whether foreign direct investment subsidiaries are governed as local profit centres: then, their behaviour will be influenced by the extent of concentration vs competition that they are confronted with on their local markets. This means that in our conceptual approach, we do not refute the possibility, for example, that at the international level, one of the two relationships between innovation and market structure to hold true, while at the local level, the other perspective could prevail. It is, in fact, the internalization factor specific to multinational enterprises in Dunning's eclectic paradigm[1] that may explain why the results of R&D undertaken in a different competitive context could be internalized by a multinational enterprise in another competitive context.

[1] For an up-to-date version of the paradigm, see Cantwell, J. and R. Narula (editors, 2003)

2 Conceptual framework: research question and testable hypotheses

Our main research question is whether the level of local market concentration influences (and if it does, in which way) the R&D and innovation activity undertaken by foreign affilliates. We focus on the manufacturing sector, and consider five transition economies from Central and Eastern Europe (CEE): Romania, Poland, Croatia, Slovenia and East Germany. We assume that the concentration-innovation nexus is particularly robust in manufacturing FDI, the selection of CEE countries should provide some insights into a still heterogeneous group of post-socialist economies.

We answer our overarching research question by empirically testing a set of five hypotheses:

H1 Foreign affiliates in more concentrated markets do more foreign trade within their foreign investor's network than foreign affiliates in less concentrated markets.

H2 Foreign affiliates in more concentrated markets do more R&D than foreign affiliates in less concentrated markets.

H3 Foreign affiliates in more concentrated markets do more basic and applied research than foreign affiliates in less concentrated markets.

H4 Foreign affiliates in more concentrated markets transfer more technology from abroad than foreign affiliates in less concentrated markets.

H5 Foreign affiliates in more concentrated markets do more product and process innovation than foreign affiliates in less concentrated markets (the classical Schumpeterian hypothesis).

Before testing these hypothesis, it is worth mentioning that the R&D and innovation activity in transition economies started from a low base (while there were some R&D intensive sectors developed in the transition economies before 1990, there were very few public investments in those sectors after 1990, which led to a fast degradation and turned most of these sectors obsolete). Therefore, if we find conclusive evidence to support or reject our hypothesis, the relevance of our conclusions should remain with the transition economies.

3 Methodology: data and empirical analysis

Our data is based on the results of a questionnaire applied in five transition economies: Romania, Poland, Croatia, Slovenia and East Germany. The questionnaire was administered in the first half of 2007 and was designed to be a broadly representative sample of foreign affiliates in each of these five economies in terms of the type of activity within manufacturing and in terms of size (turnover and number of employees). To establish the total population of foreign direct investment subsidiaries, we used mainly the AMADEUS database, propped up with additional information where the AMADEUS database proved to omit a significant number of subsidiaries. Over all five transition economies, the field work was able to collect some 736 valid replies (Romania 220, Poland 110, Croatia 144, Slovenia 40, East Germany 222).

Our method of analysis of the data generated is based on discriminant function analysis, which is used to classify cases into the values of a categorical dependent, usually a dichotomy. Discriminant analysis helps investigating difference between groups, and it fits our research purpose to see differences in the innovation behaviour of firms operating in concentrated markets compared to firms operating in non-concentrated markets. The stepwise procedure which we implement here, selects the most correlated independent first, removes the variance in the dependent, then selects the second independent which most correlates with the remaining variance in the dependent, and so on, until selection of an additional independent does not increase the R-squared (in the case of discriminant analysis, this corresponds to a canonical R-squared) by a significant amount.

While the method is not new, it remains popular and it is more robust than regression analysis for analysing groups' characteristics when the classification of groups is known in advance (otherwise, cluster analysis would have been more appropriate). The stepwise discriminant analysis was used by Ray and Rahman (2006) in a recent study published by *Transnational Corporations* with a comparable methodological challenge: here, the categorical dependent variable was type of capital (foreign affiliates or local companies). The same analysis was also used in a number of other recent studies on innovation, including Gellynck et al. (2007) for the food industry, Sharma and Rai (2003) for computer engineering, and Bozic (2007) in a single country study.

In our analysis, the dependent dichotomised variable is high market concentration, and we denote:

Con_hi = 0 for non-concentrated markets, *Con_hi* = 1 for concentrated markets

We used the Herfindahl index as our measure of market concentration. We selected the sectors with a Herfindahl index higher than 10% in each of the five transition economies analysed. The 10% threshold is not arbitrary: it is taken from the European Commission's anti-trust policy, where it stands for the minimum level of concentration in a sector which blows the whistle for potential anti-competitive behaviour. The resulting sectors are similar across Europe, as they are in general international oligopolies: tobacco, coke refining, metallurgy, radioTV communication, and means of road transportation. Hence, we split our data base in two groups: a larger one containing 625 firms from all sectors except for these five sectors; and a smaller one containing 111 firms from these five sectors. The independent variables tested are described in the Table 1 below.

Table 1 Three types of independent variables

Type of variables: structure of sales and supplies	
Name	Definition
exp_finv	Foreign affiliates' exports to its foreign investor network, as a share in total sale.
exp_ofor	Foreign affiliates' exports to other foreign buyers, as a share in total sales.
sal_linv	Foreign affiliates' sales to other domestic subsidiaries of its foreign investor, as a share in total sales.
sal_dom	Foreign affiliates' sales to other domestic buyers, as a share in total sales.
imp_finv	Foreign affiliates' imports from its foreign investor network, as a share in total supplies.
imp_ofor	Foreign affiliates' imports from other foreign suppliers, as a share in total supplies.
sup_linv	Foreign affiliates' supplies to other domestic subsidiaries of its foreign investor, as a share in total supplies.
sup_dom	Foreign affiliates' supplies from other domestic suppliers, as a share in total supplies.
Type of variables: business functions	
production	Production and operational management
marketing	Market research and management
research	Basic and applied research
product	Product development (product innovations)
process	Process engineering (process innovations)
anagement	Strategic management and planning
investment	Investment projects and finance
Type of variables: R&D	
rdexp	Expenditures on R&D and innovation, as a share in total sales
know_acqa	Importance of acquisition and purchase of external knowledge from abroad as a source for R&D and innovation in the foreign affiliate.
know_acqd	Importance of acquisition and purchase of external knowledge from domestic suppliers as a source for R&D and innovation in the foreign affiliate.
tech_exist	Importance of existing technology of your multinational corporation embodied in products already produced, as a source of technological knowledge for R&D and innovation in the foreign affiliate.

All eight variables for the type "structure of sales and supplies" were recoded as dichotomised variables (1 for less than 50%, 2 for more than 50%). The business function variables were also dichotomised (1 for currently undertaken by the foreign affiliate, 2 for currently undertaken by foreign investor network). The R&D variables were dichotomised so as to denote 1 for below average and 2 for above average for rdexp, the three variables that contain information about the "importance" attached to a particular R&D issue were all dichotomised as is usually done into 1 for not important and little important and 2 for important, very important, and extremely important.

The following Table 2 provides some descriptive information of the data used over all countries. It is meant to give a first impression of how the independent variables differ for our two groups of subsidiaries either operating in a concentrated or a competitive market structure.

Table 2 Group statistics independent variables according to market concentration groups

	Con_hi = 0		Con_hi = 1	
	Mean	Std.dev.	Mean	Std.dev.
Type of variables: structure of sales and supplies				
exp_finv	1.3065	.4618	1.5472	.5025
exp_ofor	1.2032	.4030	1.1132	.3199
sal_linv	1.0290	.1682	1.0189	.1374
sal_dom	1.4097	.4926	1.2830	.4548
imp_finv	1.2129	.4100	1.3396	.4781
imp_ofor	1.2419	.4289	1.2264	.4225
sup_linv	1.0452	.2080	1.0189	.1374
sup_dom	1.4742	.5001	1.2642	.4451
Type of variables: business functions				
production	1.1032	.3047	1.0755	.2667
marketing	1.3903	.4886	1.5472	.5025
research	1.4419	.4974	1.5283	.5040
products	1.4387	.4970	1.3962	.4938
process	1.3742	.4847	1.2075	.4094
management	1.4097	.4926	1.4528	.5025
investment	1.4645	.4995	1.3962	.4938
Type of variables: R&D				
rdexp	1.2581	.4383	1.2642	.4451
know_acqa	1.6032	.4900	1.4340	.5004
know_acqd	1.4645	.4995	1.2830	.4548
tech_exist	1.6290	.4838	1.7925	.4094

Note: Even though, strictly speaking, a mean of an either-or dichotomised variable is not defined, the mean does provide valuable information about whether a variable tends more to the concentrated or the competitive group.

A comparison of means of variables between the less concentrated and more concentrated market groups shows significant differences for a number of variables (such as in particular exp_finv or tech_exist) but also no differences for other variables (such as e.g. rdexp). Standard deviations are remarkably contained with little variation both among variables and between groups.

Whilst this already hints to where the largest differences emerge, the significance of differences between means need to be validated in a model. In a first step, significance levels for Wilk's lambdas are tested for each of the variables: when p-values of .05 are used as criterion, significant differences emerge for exp_finv and imp_finv for the structure of sales and supplies-type of variables; for marketing and process in the business function-group; and know_acqa, know_acqd, and tech_exist amongst the R&D-type of variables (see Table 3).

Table 3 Test of equality of group means

	Wilks' lambda	F	Sig.
Type of variables: structure of sales and supplies			
exp_finv	**.968**	**11.982**	**.001**
exp_ofor	.993	2.385	.123
sal_linv	1.000	.174	.677
sal_dom	.992	3.058	.081
imp_finv	**.989**	**4.110**	**.043**
imp_ofor	1.000	.060	.807
sup_linv	.998	.787	.376
sup_dom	**.978**	**8.229**	**.004**
Type of variables: business functions			
production	.999	.389	.533
marketing	**.987**	**4.625**	**.032**
research	.996	1.359	.244
products	.999	.331	.565
process	**.985**	**5.581**	**.019**
management	.999	.345	.557
investment	.998	.849	.358
Type of variables: R&D			
rdexp	1.000	.009	.926
know_acqa	**.985**	**5.367**	**.021**
know_acqd	**.983**	**6.126**	**.014**
tech_exist	**.985**	**5.384**	**.021**

In a further attempt, stepwise discriminant function analysis is applied to all variables together: this allows us to test some form of dependence between the differences of the independent variables. The development of F-values in each step suggests a stop-rule at 5 steps, so that the analysis results in significant differences of variables between the two group of concentrated vs competitive market structures for foreign affiliates' exports to its foreign investor network (exp_finv), process innovations (process), basic and applied research (research), the importance of existing technology of the multinational corporation as a source of technological knowledge in the foreign affiliate (tech_exist), and the importance of acquisition and purchase of external knowledge from abroad (know_acqa) (see Table 4).

Table 4 Stepwise statistics - variables entered/removed

Step	Entered	Wilks' lambda	Exact F	Sig.
1	exp_finv	.968	11.982	.001
2	process	.950	9.472	.000
3	research	.933	8.645	.000
4	tech_exist	.922	7.622	.000
5	know_acqa	.904	7.561	.000

Note: At each step, the variable that minimizes the overall Wilks' lambda is entered.

a. Maximum number of steps is 38.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

Wilks' lambda is used to test the significance of the discriminant function as a whole, resulting in a Chi-square value of 36.085. The model is significant at .01, which validates the function. The canonical correlation (a pseudo R squared) is .309.

Table 5 Log determinants for a rank of 5

Concentrated vs competitive groups		Log determinant
Con_hi = 0	non-concentrated	-7.878
Con_hi = 1	concentrated	-8.352
Pooled within-groups		-7.906

Table 6 Test results

Box's M		14.540
F	Approx.	.935
	df1	15
	df2	33155.817
	Sig.	.524

The log determinants are in fact relatively equal (see Table 5, a necessary criterion, since discriminant analysis assumes homogeneity of covariance matrices between groups). Moreover, the Box M test does not have significance which supports the homogeneity assumption (or strictly speaking cannot reject the null hypothesis, see Table 6). We can conclude that the model generated in our stepwise discriminant analysis is hence robust.

Table 7 Canonical discriminant and classification function coefficients

	Canonical discriminant function coefficients		Classification Function Coefficients (Fisher's linear discriminant functions)	
	standardized	un-standardized	Con_hi = 0	Con_hi = 1
exp_finv	.442	.946	5.274	6.143
research	.585	1.175	1.832	2.911
process	-.758	-1.598	3.514	2.045
know_acqa	-.466	-.947	5.120	4.250
tech_exist	.474	1.000	4.894	5.813
(Constant)		-.978	-15.964	-17.162

Based on the canonical discriminant function coefficients (see Table 7), we can distinguish between the relative weights of independent variables explaining the differences in behaviour of foreign direct investment affiliates between concentrated and less concentrated markets: the largest effect can be found for the process innovation variable (-1.598), followed by basic and applied research (1.175), the importance of existing technology of the multinational corporation as a source of technological knowledge in the foreign affiliate (1.000), the importance of acquisition and purchase of external knowledge from abroad (-.947), and foreign affiliates' exports to its foreign investor network (.946). Using the un-standardized function coefficients, we can hence write the resulting discriminant function of our model as follows:

Con_hi (more concentrated/less concentrated) = -0.978 + 0.946 exp_finv + 1.175 research – 1.598 process - 0.947 know_acqa + 1.000 tech_exist

Similarly, we can write two discriminant functions, one for each subgroup (less concentrated and more concentrated) based on the Fisher's coefficients.

As a further test of robustness, we calculate the squared Mahalanobis distance to centroid (Mahalanobis D squares) based on canonical functions for the original data. They turn out to be quite low (see Table 8), which means that the number of outlier cases is low.

Table 8 Case wise statistics

	Actual Group	Highest Group				
Case		Predicted Group	P(D>d | G=g)	df	P(G=g | D=d)	Mahalanobis D squares
1	0	0	.523	1	.733	.409
2	0	0	.523	1	.733	.409
3	0	0	.523	1	.733	.409
4	0	0	.829	1	.650	.047
7	1	1	.850	1	.562	.036
8	0	0	.759	1	.535	.094
9	0	0	.523	1	.733	.409
10	0	0	.386	1	.772	.751
11	0	0	.523	1	.733	.409
13	0	0	.758	1	.535	.095

68.9% of cases are correctly classified; the classification accuracy is sufficient (even for uneven groups).

4. Interpretation of results and policy implications

The results generated by our stepwise discriminant analysis of significant differences in variables of foreign subsidiary behaviour between subsidiaries active in concentrated vs less concentrated market structures can be interpreted as follows:

> **Foreign affiliates in more concentrated markets do export more to their parent company network than foreign affiliates in less concentrated markets.**

This means that H1 is partially confirmed (it is valid for exports, but we found no significant evidence for imports).

> **Foreign affiliates in more concentrated markets do more basic and applied research than foreign affiliates in less concentrated markets. However, they do not spend significantly more money on R&D.**

This means that H3 is confirmed, but we found no significant evidence for H2.

> **Foreign affiliates in more concentrated markets do less process innovation than foreign affiliates in less concentrated markets. There is no significant difference regarding product innovation.**

This means that H5 is rejected, but we find some support for its opposite effect (i.e. refuting the classical Schumpeter hypothesis for foreign investment subsidiaries in transition economies). This result corresponds to our initial expectation that TNCs are less in need of monopoly-profits granted by

concentrated market structures in their host economy to cover the costs of R&D and innovation: monopoly-profits may well originate in other locations.

> **Foreign affiliates in more concentrated markets acquire less knowledge from abroad than foreign affiliates in less concentrated markets.**

This means that H4 is rejected, but its opposite is confirmed.

> **Foreign affiliates in more concentrated markets use more of the existing technology already incorporated in the products of their foreign investor network.**

This confirms that H2 is rejected, but it qualifies the conclusion regarding H1, H4 and H5: foreign affiliates in more concentrated markets do import more technology from their own parent company network, but this technology is already incorporated in the final product (it does not contribute to the creation of new products).

These interesting results raise a number of important policy implications:

- Foreign affiliates in more concentrated markets seem more integrated in their foreign investor network: they export more within the network; they make less process innovation, as they probably replicate the processes used within their global network; and they use more of the existing technology already incorporated in the products of their foreign investor network, as they are not under competitive pressure to upgrade. Therefore, **the foreign affiliates in more concentrated markets act like implementing agents** (using Gupta and Govindarajan's terminology) **and the risk of using transfer pricing is bigger for foreign affiliates operating in more concentrated markets.**
- The fact that foreign affiliates in more concentrated markets do more basic and applied research, which does not appear to influence their propensity to generate product or process innovations, could mean that the research they finance is more local market-related, hence not easily replicable elsewhere, and research is not product or process related. When combined to the above mentioned conclusion of higher network involvement, one could submit that foreign affiliates in more concentrated markets are not stimulating innovation; instead, **concentration is positively correlated with intra-network knowledge diffusion.**
- On the other hand, foreign affiliates in less concentrated markets do more process innovation and acquire more technology from outside their foreign investor network. One could submit that **competition stimulates transnational corporations' subsidiaries to engage into activities of innovation and knowledge creation (at least process innovation); it also stimulates knowledge diffusion (absorption) from outside the own network.**

? The lack of significant result on product innovation might be linked to the limited level of product sophistication in transition economies: as a general rule, transition economies are still less active in generating product innovations.[2]

This all suggests that if policy makers in transition economies want to reap the benefits of technology transfer via inward foreign direct investment (i.e. increasing R&D, innovativeness, and knowledge creation with the help of foreign investors), then any policy that relies on subsidizing foreign investments (in various ways, and in general by granting/providing some degree of market power) may be misguided, as our results shows that foreign affiliates in less concentrated markets are technologically more active. This finally sheds some additional light on the role of effective competition policy in securing optimal incentives for domestic as well as foreign enterprises in transition economies.

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