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MARKET CONCENTRATION AND INNOVATION. EVIDENCE FROM FOREIGN AFFILIATES IN CENTRAL AND EASTERN EUROPE

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Market concentration and innovation. Evidence from foreign affiliates in Central and Eastern Europe

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Abstract

The main research question is whether the local market concentration, in a selected number of transition economies, influences the R&D and innovation activity of foreign affiliates operating on those markets. We 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 each of the 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 policy implication of these results is that concentration stimulates intra-network knowledge diffusion (with a risk of transfer pricing), while competition stimulates knowledge creation (at least as far as process innovation is concerned) and knowledge absorption from outside the affiliates' own network.

1. Introduction and conceptual framework

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 the incentives for companies to engage in R&D. The endogenous growth theory - see Rosenberg (1981) and Porter (1990), among others - considers innovation as most important productivity growth factor. It also seems to argue that, since R&D is expensive, only companies with large profits can afford it; and monopolists obtain monopolist profits, i.e. higher than normal profits. Therefore, monopolies or large oligopolies 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 the theory supporting the argument that the incentive to invent is greater in a competitive industry than in a monopoly industry, both for a “minor” invention (one that leaves the market price unaffected) and for a “major” invention (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 Zemplerova (2005), in a study on the Czech economy, found that market concentration reduces innovation. 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

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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 affiliates only, in the context of the local market competition. This means that we do not refute the possibility, for example, that at the international level, one of the two main perspectives 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 paradigm¹ 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. The issue of R&D of local affiliates has been explored in the relevant literature, maybe less for Eastern Europe; still, we can quote here Damijan et al (2003) and Manea and Pierce (2004). However, these studies did not have the market concentration variable at sector level.

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 affiliates. By market we understand manufacturing sector. We focus on five transition economies from Central and Eastern Europe: Romania, Poland, Croatia, Slovenia and East Germany.

Our hypotheses are:

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.

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.

2. Methodology and results

Our data is based on the results of a questionnaire applied² in five transition economies: Romania, Poland, Croatia, Slovenia and East Germany. The questionnaire was administered in the first half of 2007, to a representative sample of foreign affiliates in each of these five economies. We used the AMADEUS databas, and the sample selection satisfied the following criteria: foreign capital, type of activity (manufacturing firms only), turnover and number of employees (we looked for a balanced distribution). There were 736 valid replies.

Our method 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

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

² The questionnaire was applied as a part of the FP6 „U-Know” project.

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, remove the variance in the dependent, then select 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 DA, canonical R-squared) by a significant amount.

While the method is not new, it remains popular and it is more robust than regression in analysing groups' characteristics, when the classification of groups is known in advance (otherwise, the 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*, where the categorical dependent variable was type of capital (foreign affiliates or local companies). Discriminant analysis was also used in a number of 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.

The dependent dichotomic variable is high market concentration:

Con_hi 0 for non-concentrated markets, 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. These sectors are similar across Europe, as they are in general international oligopolies: tobacco, coke refining, metallurgy, radioTV communication, and means of road transportation. 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. 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 below.

Table 1. Independent variables

Type of variables: structure of sales and supplies	
Name	Definition
<i>Exp_finv</i>	Foreign affiliates' exports to its foreign investor network, as a share in total sale.
<i>Exp_ofor</i>	Foreign affiliates' exports to other foreign buyers, as a share in total sales.
<i>Sal_linv</i>	Foreign affiliates' sales to other domestic subsidiaries of its foreign investor, as a share in total sales.
<i>Sal_dom</i>	Foreign affiliates' sales to other domestic buyers, as a share in total sales.
<i>Imp_finv</i>	Foreign affiliates' imports from its foreign investor network, as a share in total supplies.
<i>Imp_ofor</i>	Foreign affiliates' imports from other foreign suppliers, as a share in total supplies.
<i>Sup_linv</i>	Foreign affiliates' supplies to other domestic subsidiaries of its foreign investor, as a share in total supplies.
<i>Sup_dom</i>	Foreign affiliates' supplies from other domestic suppliers, as a share in total supplies.
Type of variables: business functions	
<i>Production</i>	Production and operational management
<i>Marketing</i>	Market research and management
<i>Research</i>	Basic and applied research
<i>Product</i>	Product development (product innovations)
<i>Process</i>	Process engineering (process innovations)
<i>Management</i>	Strategic management and planning
<i>Investment</i>	Investment projects and finance
Type of variables: R&D	
<i>Rdexp</i>	Expenditures on R&D and innovation, as a share in total sales
<i>Know_acqa</i>	Importance of acquisition and purchase of external knowledge from abroad as a source for R&D and innovation in the foreign affiliate.
<i>Know_acqd</i>	Importance of acquisition and purchase of external knowledge from domestic suppliers as a source for R&D and innovation in the foreign affiliate.
<i>Tech_exist</i>	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.

These structure of sales and supplies variables were recoded as dichotomic (1=less than 50%, 2=more than 50%). The business functions variables were also recoded as dichotomic (1=currently undertaken by the foreign affiliate, 2=currently undertaken by foreign investor network). The R&D variables were recoded as dichotomic as well (1=below average, 2=above average for rdexp; 1=not important and little important, 2=important, very important and extremely important for the other three R&D variables).

Table 2. Group statistics

	Con_hi ,00		Con_hi 1,00	
	Mean	Std.dev.	Mean	Std.dev.
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
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
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

When means are compared between the less concentrated and more concentrated market groups, one can remark significant differences for a number of variables (such as exp_finv or tech_exist) but also no differences for other variables (such as rdexp). Standard deviations are remarkably contained, with little variation both among variables and between groups. However, the differences between means need to be validated in a model.

Table 3. Test of equality of group means

	Wilks' Lambda	F	Sig.
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
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
rdexp	1,000	,009	,926
know_acqa	,985	5,367	,021
know_acqd	,983	6,126	,014
tech_exist	,985	5,384	,021

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.

- Maximum number of steps is 38.
- Minimum partial F to enter is 3.84.
- Maximum partial F to remove is 2.71.

The largest the F, the better for significance; hence, the five selected variables have quite high F scores.

Wilks lambda is used to test the significance of the discriminant function as a whole. The result is significant at 1%, which validates the function. The canonical correlation (a pseudo R squared) is 0,309.

Table 5. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
	,904	36,085	5	,000

Table 6. Log Determinants

CON_HI	Rank	Log Determinant
,00	5	-7,878
1,00	5	-8,352
Pooled within-groups	5	-7,906

Table 7. Test Results

Box's M		14,540
F	Approx.	,935
	df1	15
	df2	33155,817
	Sig.	,524

Note: Tests null hypothesis of equal population covariance matrices.

The log determinants should be relatively equal (since discriminant analysis assumes homogeneity of covariance matrices between groups). They are indeed close in our test. Moreover, the Box M test does not have significance, which means that the homogeneity assumption is met. We can conclude that the analysis is robust.

Table 8. Standardized Canonical Discriminant Function Coefficients

	Function
	1
exp_finv	,442
research	,585
process	-,758
know_acqa	-,466
tech_exist	,474

Table 9. Canonical Discriminant Function Coefficients (unstandardized)

	Function
	1
exp_finv	,946
research	1,175
process	-1,598
know_acqa	-,947
tech_exist	1,000
(Constant)	-,978

Table 10. Classification Function Coefficients (Fisher's linear discriminant functions)

	Con_hi	
	,00	1,00
exp_finv	5,274	6,143
research	1,832	2,911
process	3,514	2,045
know_acqa	5,120	4,250
tech_exist	4,894	5,813
(Constant)	-15,964	-17,162

Based on the canonical discriminant function coefficient we can write the discriminant function as follows:

$$Con_hi \text{ (more concentrated/less concentrated)} = -0.978 + 0.946 \text{ exp_finv} + 1.175 \text{ research} - 1.598 \text{ process} - 0.947 \text{ know_acqa} + 1.000 \text{ tech_exist}.$$

Similarly, we can write two discriminant functions, one for each subgroup (less concentrated and more concentrated) based on the Fisher's coefficients (see table 10).

The Mahalanobis D squares (based on canonical functions for the original data) are quite low, which means that the number of outlier cases is low.

Table 11. Casewise Statistics

	Actual Group	Highest Group				
		Predicted Group	$P(D>d G=g)$		$P(G=g D=d)$	Squared Mahalanobis Distance to Centroid
Case Number			p	df		
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).

3. Interpretation of results and policy implications

The results summarized in tables 9 and 10 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 it is rejected 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 more money on R&D.**

This means that H3 is confirmed, but H2 is rejected.

- **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 its opposite is partially confirmed.

- **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 have a number of useful 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'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 influence product or process innovation, could mean that the research they finance is more local market-related, and its results are not replicable elsewhere, and are 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, the 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 innovation and knowledge creation (at least process innovation); it also stimulates knowledge diffusion (absorbtion) from outside the own network.**
- The lack of a significant result on product innovation might be linked to the limited level of product sophistication in transition economies.
- **If policy makers in transition economies want to stimulate innovation by subsidizing (in various ways) foreign investments, they should focus on foreign affiliates in less concentrated markets.**

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