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The Innovation Patterns of Firms in Low and High Technology Manufacturing Sectors in the New Member States

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Contents

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Abstract

For many years, analysis on innovations focused on high technology industries which were treated as synonymous with high competitiveness and growth. New research on low and medium technology industries has revealed that their growth is also based on innovations, though their sources differ from high technology industries. As the ‘catching up’ economies of the EU New Member States (NMS) are based on low and medium technology industries, the differences in innovativeness between high and low technology sector firms as well as within each of the sectors can play an important role in the future development of these countries. This paper aims to show the differences in innovation patterns among manufacturing firms operating in low and high technology sectors in the Czech Republic, Hungary and Poland. It is based on a survey of firms which took into account innovation inputs, cooperation among firms in R&D activities, the benefits of cooperation with business partners, innovation outputs and international competitiveness. The sample consisted of 358 firms operating in both low and medium technology industries (food and beverages and automotive) and high technology industries (pharmaceuticals and electronics). After employing cluster analysis, five types of innovation patterns were detected, characterised and compared in firms operating in the low and medium technology (LMT) sectors, and four in the high technology (HT) sector. Differences and similarities in innovation patterns between firms operating in each of the two sectors are discussed. The paper shows that external knowledge plays a crucial role in innovation activities in NMS’ firms. The ability to explore cooperation with business partners and the use of external knowledge are more important for the international competitiveness of the NMS’ products than in-house innovation resources.

Introduction

One of the main issues of economic growth and competitiveness in the New Member States (NMS) is their innovativeness. The discussion on this issue covers the role of high technology (HT) as compared with low and medium technology (LMT) industries in growth. For many years, HT industries were recognised as synonymous with high competitiveness and growth. This approach led to a near obsession with HT, an approach which has been shared by policy makers in the NMS. However, new research on LMT industries reveals that their growth is also based on innovations, although their sources differ from those of the HT industries, and these innovations are an important component of economic growth.

On the one hand, the economies of the NMS are based on LMT industries to a much greater degree than the old market economies. On the other hand, these countries are rapidly catching up with the latter countries. Since, according to research, innovations stimulate economic growth and the catching up of the NMS, the question arises regarding differences in innovation activities between HT and LMT sector firms in this group of countries and the sources of their innovation.

In respect to innovations and economic performance, firms in both sectors are heterogeneous. This raises the issue of differences in innovation patterns (or innovation modes[1]) among firms, i.e. differences in innovation sources and innovation effects. Since these countries were isolated from the world economy for many years, and subsequently rapidly developed economic networks among firms during the transition period, the question emerges of whether or not enterprises also benefit from cooperation with business partners. In other words, we would like to know if they gained the ability to absorb domestic and international knowledge spillovers.

This paper aims to answer the questions above. Its purpose is twofold. Firstly, it aims to examine differences in the innovation activities of firms active in the HT and LMT industries in three NMS: the Czech Republic, Hungary and Poland, including their sources and effects. Secondly, it aims to detect and characterize innovation patterns of HT as compared to LMT sector firms in the three countries, and their relationship with economic performance.

The paper is divided into two parts. In Chapter 1, the background for the study is presented. First, we discuss a typology of the industries based on R&D intensity and its relevance to the

[1] These two terms are used in this paper interchangeably.

theory of innovation. Next, we summarize the results of research on differences in innovativeness between LMT and HT sector firms in the developed market economies. This literature review is helpful in confronting the findings of our study on the differences in innovation sources, effects and innovation patterns in the NMS. Chapter 2 of the paper presents the results of our research on innovation activities run by firms in the HT and LMT sectors in the NMS. To our knowledge, no analyses on differences in the innovation activities of the firms in these two sectors have been undertaken for the NMS so far. The second part of the paper begins with a brief presentation of data source used in the study and an enterprise sample. In the next section, we discuss differences in innovation activities between LMT and HT sectors in the three NMS, and their sources. Next, the methodology employed to find out the innovation patterns in the NMS is presented. The last section of Chapter 2 presents and discusses innovation patterns of LMT and HT sector firms in the NMS. We focus on similarities and differences among innovation patterns in firms in the two sectors and their relationship with economic performance. Finally, we present our conclusions.

The paper adds new elements to the discussion on the relationship between innovation patterns of firms in both the LMT and HT sectors and their international competitiveness. It also strengthens the argument in favour of further incorporating LMT industries into innovation policy (particularly in the NMS), rather than focusing on the HT sector as a driving force for economic growth.

1. Background

1.1. Typology of industries based on R&D intensity and its relevance to reality

Modern development economics, industrial economics and new trade theory recognize the central role of innovation and technology in determining economic growth. The issue of international competitiveness arises in this context. Theoretical models, qualitative analysis and sectoral studies have shown that knowledge and subsequently innovation can lead to a divergence in growth across firms, sectors and countries. That is why these two have become an area of interest of government policy. A very simple indicator of technology or science intensity (so called R&D intensity measured as R&D spending to sales revenues or value added) was introduced[2] as a criterion of typology of industries and has been in use since then. The typology[3] of industries by R&D intensity, which was treated as synonymous with the technology intensity, was changed many times in terms of the notion of selected industrial groups (research intensive, science-based, technology intensive), their number (three and then four) and their contents. These typologies became very popular in the context of ongoing debates on the competitiveness of countries.[4] Science-intensity became synonymous with technology intensity and with the activities needed to successfully compete on the market. More importantly, "high technology rapidly came to be viewed as the right solution to the issue [of competitiveness] and statistics were developed to document this case" (Godin, 2004, p. 1218). Therefore from a policy perspective, it would seem desirable to identify and promote sectors displaying high innovativeness and competitiveness. The focus of government policies on high-tech industries resulted in neglecting the issue of innovativeness of R&D non-intensive or low technology, mature industries. The more so given that it was argued that HT industries develop high value added products, create high-wage jobs and new products, use resources more productively, increase productivity and competition as well as gain market share. They were also recognized as the fastest growing industries with an increasing share in world trade and an increasing trade balance, while the trade balance of the LT sector became negative (OECD 1963, pp. 29, 32, 33; Hatzichronoglou 1994, p. 4). Such statements on the characteristics of HT industries have made HT industries a fashionable subject of discussion for economists as well as policy makers. Lists of the defining characteristics of HT industries were long and ever-increasing (Glasson et al. 2006, table 1, p. 505). Various criteria[5] (mainly inputs) were used to identify them.

The obsession with high-tech resulted in the negligence of the role that innovation plays in the growth and competitive performance of low and medium technology industries. LMT industries were regarded as based on a low level of technology/knowledge. Innovation was seen as having a limited impact on their competitive performance and potential for future development. Labelled as low-tech, these industries were equated with low knowledge, and traditional or mature production. This was despite the fact that their share in total

[2] In the 1930s in the USA.
[3] In the 1990s, both intramural and indirect R&D (based on input-output coefficients) indicators were also used (OECD 1995) and later forgotten.
[4] Especially in the context of the discussion on competition rivalry between the US and Western Europe.
[5] Criteria included share of qualified workers in total employment; share of technical workers or scientific and technical personnel engaged in R&D; share of scientists and engineers engaged primarily in R&D in the total number of full-time employees (Glasson et al. 2006, table 2, p. 506); and R&D spending per employee.

manufacturing production, employment and value added in developed countries was very high (though slowly diminishing in the long run) (Hirsh-Kreisen, 2004).

However, firstly, the hypothesis of the low innovativeness of low technology industries was not always corroborated. Much high-tech production was found in the low-tech sector and vice-versa.

Secondly, the more knowledge-intensive character of modern economies does not imply that low technology industries cannot be innovative in their technological and product upgrading. No industry operates in isolation and the purchase of inputs (such as capital equipment and intermediate goods) acts as a carrier of technology and knowledge across industrial sectors. Therefore the interactive process between users and producers (i.e. linkages and spillovers across sectors) affects their performance. High-tech industries are not an isolated, self-dependent part of the economy. In the process of diffusing new technologies (and the knowledge created by high-tech industries), productivity growth takes place first in the sectors that generate them and then in the sectors that adopt them. It is worth noting that the rates of return on R&D in high-tech industries are also a direct function of the rate of diffusion of the knowledge they create (Robertson et al, 2003). So the amount of R&D investment depends on the size of the market that absorbs their effects and on the ability of consumers and users (including firms in the LMT sector), to adopt their results. It explains (see the review of econometrical studies presented by Clark and Weyont, 2006) the substantial extra industry spillover effects of R&D in terms of rates of return, which may be as important, or even more so, than the R&D industry's own effect.

Thirdly, although the innovations created in high-tech industries are diffused to other sectors, which are their main customers (Robertson and Patel, 2007), not all external knowledge may be easily used and transformed. To integrate new technology into existing processes or to develop new products using such technology, not only are in-house R&D activities needed but also the ability to adopt existing forms of knowledge. The adoption of the new processes needs specific, 'practical' application knowledge which is distinct from theoretical knowledge (Hirsch-Kreisen, PILOT). In other words, external knowledge may affect firms, not only through scientific knowledge but, first and foremost, through human capital, which is equipped with a certain type of knowledge.

Fourthly, understanding innovation as a process of learning and knowledge creation brings about the observation that different types of knowledge can be relevant to different industries (Robertson and Smith, 2009). Various methods of acquiring and using knowledge, and different forms and sources of innovations form the basis of the development of specific innovation patterns.

Fifthly, the perception of the high-tech sector as a crucial driver of economic growth and competitiveness neglects to consider an important fact raised by Carrol et al (2003, p. 429). They argue that the impact of innovations on a national economy depends on two factors: the proportion of the economy that is affected and the productivity gains in activity in which innovation is introduced. If this is so, then a very low share of high-tech industries in the economy implies there is a limited impact on growth and productivity gains. In other words, high technology industries are not as important as the discussion on the HT sector assumes (Hirsch-Kreisen, PILOT, p.8), while LMT sectors have a greater significance than the limited discussion would suggest.

1.2. What we know about the differences in innovativeness of the LMT and HT industries

Although the literature on innovation in the LMT industries is not abundant, the following features of these industries may be extracted:

(1) The most important sources of innovation in LMT industries are not R&D (Heidenreich 2009). However there is a high intra-sector heterogeneity in respect to R&D intensity (Kirner et al. 2009). On the other hand, the external knowledge that the firms in the LMT sector use requires the absorptive capacity to transform and combine it with existing in-house knowledge stock.

(2) It is the external source of innovation, especially the embodied knowledge in the form of semi-products, machinery and raw materials that plays the most important role in innovation activities in LMT industries (Alcaide-Marzal and Tortajada-Esparza, 2007). The acquisition of machinery and equipment is the major source of their innovations (Robertson and Patel, 2007; von Tulzelmann and Acha, 2005; Laestatadius, 2005, Heidenreich, 2008). The use of consultants is much more important than in HT industries (Flor and Oltra, 2004; Heidenreich, 2009; Pavitt, 1984; Santamaria, 2009; Hirsch-Kreisen 2004). This implies that backward linkages are more common in LMT industries. The supplier-dominated nature of these industries (Pavitt 1984, p. 354) also implies an incremental rather than radical nature of innovation. Search strategies for external knowledge by firms in LMT industries differ considerably from those of HT firms (Grimpe and Sofka, 2009). In HT industries, university knowledge is crucial and plays an important role in generating knowledge stocks inside firms. Thus the search strategy of HT industries depends upon knowledge acquisition from universities. This is not the case for firms in LMT industries.

(3) The low income elasticity of LMT industries' products implies a greater role of process than product innovation. According to Santamaria (2009, p. 514), the "greatest differences between LMT and HT firms are observed in the context of process innovations" and this opinion is commonly accepted (Heidenreich, 2009; Hansen and Goran, 1997). It also implies weaker performance in respect to product innovation (Kirner et al., 2009).

(4) Although process innovation and inputs from suppliers are important, the demand (consumer) focus, meaning market-induced product innovations to open up new sales opportunities, also play a role. Since, to large extent, the innovations of LMT sector firms originate from changes in demand, on the one hand they focus on the greatest possible exploration of properties of inputs used in production. On the other hand, due to the fact that LMT markets are not dynamic, product innovation focuses on the product changes named as aesthetic innovations that do not fit the concept of technological innovation (Alcaide-Marzal and Tortajada-Esparza, 2007). Market differentiation of products and segmentation is crucial for the expansion of firms in these industries (Menrad, 2004; Hansen and Goran, 1997). It impacts the ability to compete with other firms in these industries and across countries. Market oriented innovations in the form of market knowledge, design and marketing (Sterlaccchini, 1999) are a precondition for better growth prospects and increased market shares. The emphasis of LMT sector firms on the quality of the production process enables them to differ from competitors in product quality and reasonable costs. It is worth mentioning that only a part of the production of the LMT sector occurs in low wage countries while innovation activities remain in the OECD countries and strengthen LMT firms' competitiveness (Goran and Hansen, 1997). This suggests that the role of innovation also varies in different quality segments of LMT industries.

(5) The crucial role of process innovation in innovation activities of LMT sector firms suggests the important role played by organizational innovation (Heidenreich) 2009; Brusoni and Sgalari, 2006; Hirsch-Kreisen, Hahn and Jacobson, 2008). Management plays a key role in these changes (Brusoni and Sgalari, 2006).

(6) LMT sector firms exhibit strong multidisciplinary cooperation in different forms of innovation, accompanied by low R&D spending. This implies that to recombine the available (external) knowledge and technology and integrate the new one they need to possess 'absorptive capacities', that is the ability to use, transform and advance knowledge. This makes them move within a wide spectrum of innovations activities, from incremental to architectural innovations. Many of them are prominent in less advanced science and technology (the example of patents in the less advanced biology of food industry, see von Tunzelmann and Acha, 2005; also the example of the tire industry, see Brusoni and Sgalari,

2006). It suggests that quality of labour force, especially managers, technical and marketing staff is of great importance for LMT sector firms. However, since a critical role is played by tacit knowledge, including learning by doing, it is difficult to measure and confirm the above hypothesis.

On the other hand, there is some divergence in opinion on certain characteristics of LMT as compared to HT industries, particularly as concerns the role of training activities. They are recognised as crucial (Santamaria et al., 2009; Schmierl and Kohler, 2005) or not more important than in the case of HT industries (Heidenreich, 2009).

Last but not least, LMT sector firms possess practical knowledge that results from experiences in cooperation (Radauer and Streicher, 2007). As their competitiveness reflects their ability to use embodied and disembodied knowledge, "technological competition leads rather directly to inter-industry diffusion of technologies and therefore to the inter-industry use of the knowledge which is 'embodied' in these technologies" (Smith, 2002, p. 20.). Differences in ability to use knowledge across firms and countries affect differences in their competitiveness.

As the literature on LMT sector firms is rather modest, there are not many typologies of these companies in use. Let us mention the one introduced by Hirsch-Kreisen (2004) who identified three types of LMT sector firms: (1) standard manufacturers proceeding with innovation in small steps when further developing their product; (2) companies directly promoting market-induced product innovations as demand has been the major factor affecting industry dynamics and innovation; (3) process specialists whose production technology follows one of the best HT manufacturers and who introduce incremental innovations.

On other hand, analyses of high technology firms reveals that although R&D is an important measure of their innovativeness, there are differences among them in terms of R&D intensity.

2. Innovation patterns of firms in the NMS

2.1. Data source and enterprise sample

The data used in this paper was collected through a firm survey performed by an international research team led by Richard Woodward (of CASE-Center for Social and Economic Research) and within the European research project entitled "Changes in Industrial Competitiveness as a Factor of Integration: Identifying the Challenges of the Enlarged Single European Market".[6] The survey was aimed at investigating the networking of firms in the three accession countries (the Czech Republic, Hungary and Poland) and Spain, and its effect on competitiveness[7]. Fortunately we have found a substantial number of questions included in the survey questionnaire as relevant to the analysis of innovation processes. Altogether 41 innovation indicators were selected (see them listed in Table 5 in the Appendix). We grouped them into four sets by the dimensions of innovation activities: (1) innovation inputs, (2) innovation linkages, (3) effects of cooperation with business partners reflecting that diffusion of external knowledge is taking place, and (4) innovation outputs. As many academics argue that in the catching up economies "diffusion can be the most important part of innovation" (Hall 2005, p. 460), we decided to include not only the linkages but also their effects. We also chose four performance indicators: these are self-assessments of the competitiveness of a company's products and technology separately on the domestic and on the international markets.

All respondents surveyed were managers responsible for day to day business processes. The interviews were conducted in 2004 in Hungary and Poland and in early 2005 in the Czech Republic. The data collected refers to 2003 and in some cases to the five year period 1998-2003.

Data was collected for 490 companies. After carefully examining the answers received to questions relevant for researching the innovation patterns, we had to delete 132 firms from the data base, due to missing individual data. As a result the sample shrunk by ¼ to 358 firms. The composition of the sample is presented in Table 1.

[6] It was funded from the 5th Framework Programme of the European Community (Ref. HPSE-CT-2002-00148). The project was led by Anna Wziątek-Kubiak. CASE-Center for Social and Economic Research, Warsaw led the research consortium.
[7] For the results of this specific analysis see Woodward and Wójcik (2007).

Table 1. Enterprise sample composition

	No of firms	%		No of firms	%
Industry			**Country**		
1. Food and beverages	160	45	1. Czech Republic	70	20
2. Automotive	65	18	2. Hungary	111	31
LMT sector (1+2)	225	63	3. Poland	177	49
3. Electronic	109	30	**Ownership**		
4. Pharmaceutical	24	7	1. Domestic	244	68.2
HT sector (3+4)	133	37	2. Foreign	108	30.2

Four industries were studied in the survey: (1) Food and beverages (NACE Rev.1 – da15); (2) Pharmaceuticals (NACE Rev.1 – dg244); (3) Electronics (NACE Rev. 1 – dl30); and (4) Automotive Industry (NACE Rev.1 – dm34). Food and beverages firms were the most numerous (45% of the sample), while pharmaceutical firms appeared the least (only 7%). Enterprises were grouped into two sectors: the food and beverages producers and the automotive companies were placed into the low and medium technology (LMT) sector, while the electronic and pharmaceutical firms were placed into the high technology (HT) sector. LMT sector firms accounted for 63% of the sample, while the remaining 37% belonged to the HT sector.

Polish firms dominated the sample: they accounted for close to half of the enterprise population surveyed. The majority (ca 70%) of firms was domestically owned. All size classes of firms were investigated, but medium-sized firms dominated the sample.

2.2. Differences in innovation activities between LMT and HT sectors

In order to figure out the differences in innovation activities and their intensity between firms belonging to the two sectors (HT and LMT in the three NMS), we compared the data for the entire two subsets of enterprises (see it in Table 2 below). A comparison of the averages for firms within the two groupings gives a brief glance into the problem of specificities of low and high technology sectors from an innovation point of view and in the catching up economies. For the sake of analysis and its presentation, some of the variables exhibited in Table 2 are averages for groups of original indicators; such aggregation was made whenever it was justified by the substance of the indicators. In addition to the innovation variables, there are two performance indicators exhibited (see them in the last two rows of Table 2); we have decided to take into account international competitiveness and leave aside the domestic one.

Table 2. LMT and HT sectors in the NMS: Innovation activities compared

Sector Innovation variables	LMT industries	HT industries	HT/LMT
R&D Intensity			
• Expenditures for R&D in 2003 (R&D/sales revenues, %)	0.31	0.80	2.6
• Increase in expenditures for R&D 2003/1998 (index)	1.28	1.44	1.12
I. Innovation inputs			
1. HR: Employment share of R&D and IT staff (average, %)	1.6	5.9	3.7
2. Innovation activities in-house (average, % of firms)	44.4	61.8	1.4
II. Innovation Linkages			
1. Cooperation with universities and research units (% of firms):			
• Domestic ones	42.7	55.6	1.3
• Foreign ones	10.7	30.8	2.9
• Independent researchers	12.9	39.8	3.1
2. Backward linkages (average, % of firms)	42.9	39.9	0.93

3. Innovation activities subcontracted (% of firms):			
• Product development and improvement	24.9	27.1	1.1
• Process development and improvement	27.1	19.5	0.7
III. Effects of cooperation with business partners			
1. Benefits of cooperation with business partners influencing product innovation (% of firms)	50.6	56.0	1.1
2. Benefits of cooperation with business partners influencing process innovation (% of firms)	46.7	48.6	1.04
IV. Innovation Outputs			
1. Share of new products and new technology in firm's sales revenues (% of firms)			
• Share of sales revenues from sales of new products in 2003	29.0	38.7	1.33
• Sales revenue share of production from manufacturing technology less than 2 years old in 2003	43.7	53.5	1.22
2. New products introduced in the last two years (% of firms) and**:**			
• Being new for domestic market	42.7	48.9	1.15
• Being new for international market	15.1	32.2	2.13
International competitiveness of firms			
1. Company's products are strongly competitive (% of firms)	24.9	39.1	1.57
2. Company's technology is strongly competitive (% of firms)	21.8	37.6	1.72

The data collected for the sample of enterprises indicates that by the time of EU accession, HT sector firms in the Czech Republic, Hungary and Poland had an R&D intensity that was 2.6 times larger than LMT sector enterprises. The prevalence of HT industries in this respect is in line with what is characteristic for developed market economies. It is also worth noting that the distance between the two groups of firms in the accession countries grew over time. This may suggest that the process of diffusion of innovation from HT to LMT sector firms in the NMS took place. As Robertson and Patel (2007, p. 711) show, the larger the number of LMT sector firms that adopt innovation, the quicker the rate of amortization of development cost and dynamics of R&D growth in HT industries.

However, in 2003, sample firms of HT industries had on average a low level of R&D intensity: R&D spending to sales revenues equaled only 0.8% and in fact did not meet the standard of either the 1994 OECD classification of industries by R&D intensity (which established a minimum level at 5% for the HT industry) or any other classification. Since their R&D intensity was much lower than in the HT sector firms in developed market economies, we suspect that their products belonged to the low quality segment of HT industries as compared to developed Western states.

With respect to innovation inputs, it should be noted that the stock of highly qualified labor (measured by the share of R&D and IT staff in total employment) in HT was much higher (3.7 times) than in LMT sector firms. This shows that the former are much better endowed with innovation resources than the latter, although they are still much worse than most developed European economies' firms in this respect.

As far as innovation activities are concerned, we have found that a greater number of HT sector firms run in-house innovation activities (product and process) than LMT sector firms (62% and 44% respectively). This finding is consistent with the differences which exist in incumbent EU member states. However, the detected gap between the two sectors in the NMS was smaller than expected. The difference is much higher though when we check for the continuality of the R&D internal efforts, measured by the establishment of R&D or design unit in-house. 61% of HT sector firms run in-house innovation activity continuously, while in the case of the LMT sector only 31% do (see data in Tables 8 and 9 in the Appendix).

As it is recognized that in the catching up countries the diffusion of external knowledge plays an important role, we also take into account the differences in using various types of partners in R&D cooperation that is suppliers of machinery and raw materials, subcontractors and research organizations. The more so given that cooperation is also increasingly viewed in the literature as an important technology acquisition alternative.

Cooperation with research organizations helps a firm to broaden its knowledge through acquiring a new one. 56 % of HT sector firms cooperated with domestic research units, and, surprisingly, this was not that much more common than for LMT sector firms (only 30% more; see table 2 above). The major difference between the two sectors was detected in the case of cooperation with foreign research units and with independent researchers, which was used by 3 times more firms in HT industries, than in the LMT sector. However even for HT industry firms, it was not very common (31% and 40% of firms only, see Table 2).

LMT industries are significant purchasers of embodied technology from other sectors. According to Robertson and Patel (2007, Table 1, p. 713), the flow of embodied R&D to food industries in Poland, Hungary and the Czech Republic as compared to their internal R&D was three times greater than in the case of most of the developed market economies' food industry. This suggests the relatively high diffusion of innovations from other industries to the food industry in the analyzed countries as well as its important role in the innovation process. As in the case of the incumbent EU countries, our sample firms' cooperation in R&D with suppliers of machinery and equipment as well as raw materials was more commonly explored in LMT sector firms than in their HT counterparts. However the distance between the two sectors was not large and smaller than expected.

There was not much difference between the LMT and HT sectors in using the external innovation inputs through subcontracting product development activities, however these kind of linkages were quite seldom used (only by ¼ of the sample firms). Also, the subcontracting of process development innovation activities was seldom adopted by both subsets of firms; however it was more widespread in LMT industries (by 30%). This last observation supports the hypothesis regarding the greater focus of LMT sector firms on process innovation which was proven in the case of the incumbent EU economies (see section 1.2 above).

Only a slight difference between firms belonging to the two technological sectors has been detected with respect to the effective use of cooperation with external partners: slightly more HT sector firms (10%) benefited from cooperation with business partners in product innovation; in the case of process innovation, the difference was even smaller. This confirms that the diffusion of external knowledge between collaborating firms does take place.

Various studies argue that some degree of absorptive capacity is required for effective collaboration learning. Our research shows that the higher the R&D intensity and stock of qualified labor, the higher the cooperation with foreign research organizations. An abundance of qualified labor allows for good communication with providers of technology and good cooperation with foreign organizations. On the other hand, a low R&D intensity and a modest stock of qualified labor in LMT sector firms goes hand in hand with high cooperation in R&D with suppliers and R&D outsourcing (i.e. backward linkages). These forms of cooperation do not need a high absorptive capacity, which is crucial for cooperation with research organizations, particularly foreign ones. In other words, the differences in abundance in innovation resources accompany differences in forms and partners of cooperation in R&D. The experiences of developed market economies confirm this rule.

We noticed a difference between firms belonging to the two sectors with regards to innovation outputs, and we found it higher in the case of products than in the case of technology. On average, the share of new (2 year old) products in the total sales revenues of a firm accounted for 38.7% in the HT sector, which was 33% more than in the LMT sector.

As compared with products, new technology was more often introduced in each of the two sectors: in 2003, the average share of production from manufacturing technology that was less than 2 years old accounted for 53.5% for an HT sector company and 44% for an LMT sector company; the difference was 22%.

Also the other two innovation output measures indicate the prevalence of firms in the HT sector. From 2001 to 2003, more than two times more HT sector firms introduced new products on the international market. In the case of introducing new products for the domestic market, the difference between firms belonging to the two sectors was rather small (only 15%; see Table 2 above). Moreover it is important to notice that in both sectors, in the same two year period, over half of the firms did not introduce new products for the domestic market, and a majority (85% in the LMT sector, and 68% in the HT sector) did not introduce new products for the international market.

Finally, we shall draw conclusions on the economic performance of firms classified in the two sectors. More firms in the HT sector regard themselves as strongly competitive in both product and technology and in both domestic and international markets than companies from the LMT sector (see Table 2 and Tables 9 and 10 in the Appendix). Another interesting, though seemingly obvious, observation is that in the case of both markets (domestic and international), more companies in each of the two sectors consider themselves more competitive in terms of their product than in terms of their technology. Also, more companies in each of the two sectors believe they are strongly competitive on the domestic rather than international market.

The nominal values show that the vast majority of firms in both sectors do not assess their products as strongly competitive internationally (75% in the case of the LMT sector and 61% in the case of HT). This stance is similar and slightly worse in the case of the international competitiveness of technology used by enterprises: yet more firms consider their competiveness as either moderate or weak vis-à-vis international competitors (78% and 62%).

2.3. Methodology employed to explore innovation patterns

In order to figure out the innovation patterns of firms, a cluster analysis was adopted. Given the relatively large number of innovation indicators (41), we decided to use principal component analysis (PCA) to measure the sources of innovation in firms. PCA allows us to reduce a large number of indicators to a small number of composite variables (called 'factors') that synthesize the information contained in the original variables. Factors are standardised variables containing the information common to the original variables. In this way, we were able to consider as much available information as possible. PCA is based on the idea that indicators which refer to the same issue are likely to be strongly correlated and factors that are obtained are uncorrelated. PCA helps prevent including irrelevant variables and reduces the risk that any single indicator dominates the outcome of the cluster analysis.

We assumed that if the correlation between factors and original variables is lower than 0.48, the analysis is inappropriate.

In the next step, non-hierarchical cluster analysis was performed in order to group firms into a number of clusters by innovation variables as homogenous as possible (small within cluster variance) and at the same time as different as possible from each other (large between clusters variance).

In the Appendix, there are two tables which show the results of factor analysis for LMT sector firms (Table 6) and HT sector firms (Table 7). They include the loadings of the variables on selected factors after the so called rotation. The loadings of the various indicators on the retained factors are correlation coefficients between the indicators (the rows of the two tables) and factors (columns) and provide the basis for interpreting the different factors. These loadings are adjusted through rotation to maximize the difference between them. We use varimax Kaizer's normalized rotation that assumes that the underlying factors are uncorrelated.

The first step of factor analysis led to statistically satisfactory results. 12 factors jointly explaining, in the case of the LMT sector firms, 55.4%, and in the case of HT sector firms, 59.6% of the total variance, were selected. Based on the distance from the centroids, we compared the variance within clusters and between clusters. In the second step we conducted a non-hierarchical cluster analysis based on the twelve composite variables extracted in the factor analysis of the first step. Introducing hierarchical agglomeration methods for a subset of objects and comparing results for the range of $K_{min} \leq K \leq K_{max}$ (where K is between 2 and 7), we chose the optimal number of clusters. Using hierarchical analysis and Ward's minimal variance method, we chose 5 clusters that group the firms into 5 categories in terms of innovation indicators. Since one cluster within the HT sector consisted of one firm only, we decided to skip it and restrict analysis to four clusters in this sector. Centroids of clusters obtained in the hierarchical method were used as the initial centroids for the K-means algorithm.

2.4. Innovation patterns in LMT and HT sectors in the NMS

After detecting the clusters, we analyzed their features. The first step was to study the values of their innovation indicators that were chosen in the course of the cluster analysis. The data for the two sectors (LMT and HT) are presented in Tables 8 and 9 in the Appendix.

The second step was to compare the value of each factor (i.e., composite variables) between the clusters of a given sector. We used the following scores: from ‘lowest’, through ‘low’, ‘moderate’, ‘high’ to ‘highest’.

Table 3. LMT Sector in the NMS: Firms' innovation pattern characteristics

Clusters / Innovation factors	1 Based on linkages & BC	2 Low profile	3 Short term competiti-veness strategy	4 Hunters for product innovation	5 High profile
R&D intensity	very low	moderate	moderate	high	highest
Human resources	low	low	lowest	high	low
In-house innovation activities	low	moderate	low	highest	high
Backward linkages	moderate	lowest	low	highest	high
Cooperation with research organizations	highest	low	moderate	moderate	high
Subcontracting	high	lowest	low	highest	moderate
Beneficial cooperation: product innovation	highest	lowest	low	low	high
Beneficial cooperation: process innovation	highest	lowest	low	high	high
Innovation Output: - in product (P) - in process (T)	P- lowest T-moderate	P – low T - low	P- highest T- high	P- high T- moderate	P-moderate T- highest
Competitiveness: - product (P) - technology (T)	P- highest T- high	P- low T- low	P- low T- low	P- moderate T- moderate	P- high T- low
Cluster composition: - No of firms (N); (%) - industry dominating, (%)	N=44; (20%) Food – 82%	N=54; (24%) Food –72%	N=56; (25%) Food – 66%	N=28; (12%) Food – 68%	N=43; (19%) Food – 67%

The third and last step was to analyze all the scores for each cluster in a given sector and invent a name for each one based on its distinguishing features.

Innovation patterns are presented in Table 3 (above) for the LMT sector and Table 4 (below) for the HT sector.

Table 4. HT sector in the NMS: Firms' innovation pattern characteristics

Clusters **Innovation factors**	**1** **Benefiting from cooperation**	**2** **High profile**	**3** **Hunters for product innovation**	**4** **In-house innovation backed by R&D cooperation**
R&D intensity	very low	high	highest	highest
Human resources	moderate	moderate	moderate	highest
In-house innovation activities	low	highest	high	high
Backward linkages	low	highest	Low	high
Cooperation with research organizations	low	highest	moderate	high
Subcontracting	moderate	high	high	low
Beneficial cooperation: product innovation	high	highest	Low	moderate
Beneficial cooperation: process innovation	high	highest	Low	moderate
Innovation Output: - in product (P) - in process (T)	P – high T - highest	P- moderate T- moderate	P- moderate T- moderate	P- highest T- high
Competitiveness: - product (P) - technology (T)	P- moderate T- moderate	P- highest T- highest	P- low T- low	P- high T- high
Cluster composition - No of firms (N) and (%) - industry dominating, %	N=51; (38%) Electronic-88%	N=30; (23%) Electronic-80%	N=37; (28%) Electronic-70%	N=14; (10.5%) Electronic-93%

We detected seven innovation patterns in the NMS during the EU accession preparatory period. Two of them were common to both sectors while five we recognized as unique, although we found some commonalities between certain ones.

The two innovation patterns common for both sectors are 'high profile' and 'hunters for product innovation in the market'. When analyzing each of the two, we will also discuss minor differences that occur in the patterns between the two sectors.

High profile (HP)

The High profile innovation pattern differs considerably from other patterns in both the LMT and HT industries. This includes the greater innovation resources that firms use, the in-house innovation activities they perform, the cooperation in R&D with suppliers and research organizations and the benefits of cooperation with business partners.

However there are also important differences between LMT and HT sector firms employing the HP innovation pattern. LMT sector firms engage much less innovation resources and perform much less in-house innovation R&D activities continuously than HT sector firms. Many more HT sector firms engage in R&D cooperation, not only with research organizations, especially foreign ones, but also with suppliers. However, most firms in both sectors benefit from cooperation with business partners and in this respect, the difference between them is quite small.

Surprisingly, the better innovation performance of LMT sector firms when compared to their HT counterparts does not translate into their higher international competitiveness. More HT sector firms are strongly competitive and much less are weakly competitive than their LMT sector counterparts. It suggests that as a tool to keep or increase market share, HT sector firms focus on upgrading their products or diminishing their prices rather than on changing product range. Therefore we may conclude that the similar innovation pattern of HT and LMT sector firms are accompanied by differences in competition strategies. The greater innovation resources and involvement in innovation activities on the part of HT sector firms results in their higher economic performance, as compared to firms in the LMT sector.

Hunters

There are many similarities in innovation patterns between HP and Hunters. The most distinguishing feature of the latter one is the widespread use of subcontracting of R&D. This is accompanied by abundant endowments in innovation resources, high R&D intensity, in-house innovation activities and cooperation with research organizations. However these advantages are accompanied by a lower share of benefits of cooperation with business partners in both product and process innovation in the HT sector and in product innovations in the LMT sector. This suggests that the diffusion of external knowledge was not widespread, especially in the HT sector firms. It results in a lower share of firms with strong international competitiveness of product and production technology in the HT as compared to the LMT sector and confirms that diffusion of external knowledge plays a role in international competitiveness. Comparison of the HP cluster with the Hunters one in respect to the share of firms benefiting from cooperation with business partners as well as the share of firms with strong competitiveness also confirms the above hypothesis.

Benefiting from cooperation (innovation pattern in the HT sector), and
Based on linkages and beneficial cooperation (innovation patterns in the LMT sector)

These two patterns share similar features except for two: (1) the popularity of backward cooperation, including cooperation with R&D organizations and R&D outsourcing, which is more widespread in LMT sector firms, and (2) innovation output, which is much lower in the LMT innovation pattern. Although backward cooperation in R&D was more often employed in the LMT cluster than in the HT one, the diffusion of external knowledge was similar. It is worth mentioning that both clusters are also alike in terms of international competitiveness: their competitiveness is rather low when compared to other clusters in their sectors. A comparison of the two clusters provides a good example of the hypothesis on the crucial role of diffusion of external knowledge in the economic performance of NMS firms. The similarity in diffusion of external knowledge and in innovation activities in both clusters results in the similarity in their international competitiveness.

The following innovation patterns are specific either to the LMT or HT industries.

In-house innovation activities backed by R&D cooperation (innovation pattern in the HT sector)

This innovation mode shares some features with the HP one. However, contrary to what we observed in the HP pattern, here R&D subcontracting was seldom used. More importantly and surprisingly, although firms were well equipped with innovation resources, the number of companies benefiting from cooperation with business partners (in both product and process innovations) was moderate and this indicates that the diffusion of external knowledge was not widespread. This either contradicts the Cohen and Levinthal (1990) hypothesis that in-house R&D activities play an important role in the absorption of external knowledge that spills over to firms, or that getting the ability to benefit from cooperation with business partners takes more time than one would expect. Another possibility is that although in-house R&D was high, the stock of accumulated knowledge remained low. Lower than in HP cluster share of firms in case of which diffusion of external knowledge takes place, results in a bit lesser share of firms with strong international competitiveness, although this share remains high.

The comparison of all of the clusters analyzed above confirms the hypothesis that the international competitiveness of NMS' products depends more on the ability to explore cooperation with business partners and the use of external knowledge than on in-house innovation resources. Moreover, it suggests that external knowledge and the ability to use it play a crucial role in the innovation activities of firms in the NMS.

In the LMT sector, there are two innovation patterns which share similar features. These are **Low profile (LP)** and **Short term competitiveness strategy**. The first one differs from the second in two respects: the extent of cooperation with research organizations and the level of innovation output. In both respects, there are more companies performing 'short term strategy of competitiveness' than 'low profile' companies. In the former, firms using in-house research and cooperation with research organizations try to use cooperation to renew their product range as often as possible. Their innovation resources and activities suggest that their strategy of differentiation of product range is based on imitation. The products of quite a large portion of these firms are strongly competitive on the domestic market (see Table 10 in Appendix), however their competitiveness on the international market is low (see Table 3 above).

Conclusions

Our study on the differences in innovation sources, activities and outputs of firms in the HT and LMT sectors in the Czech Republic, Hungary and Poland as well as our investigation on innovation patterns employed by companies on the eve of these countries' EU accession has brought about the following conclusions. The internal innovation resources of firms (namely R&D intensity and share of R&D and IT staff in total employment) were much higher in firms in the HT sector. This finding explains another one, namely that in the HT sector, more companies developed in-house innovation activities and cooperated with outside research organizations. Only cooperation in R&D with suppliers was more commonly explored in the LMT sector firms. The above-mentioned differences in innovation activities and their sources between the two sectors in the EU NMS are in line with what is characteristic for old EU member states.

Although the differences in innovation inputs and cooperation with research organizations between the two sectors' firms were substantial, it was surprising to find that the differences in benefits of cooperation with business partners and in backward cooperation were very small. These two findings suggest that the much lower R&D intensity of firms in the LMT sector was not an important barrier for the inflow of innovation.

The comparison of the clusters of firms selected according to their innovation characteristics with their international competitiveness suggests that the international competitiveness of the NMS' products depends more on the ability to explore beneficial cooperation with business partners and to use external knowledge than on in-house innovation resources. It also confirms the crucial role played by the diffusion of external innovation resources and knowledge for innovativeness of LMT sector firms in the NMS. Yet other conclusions are that knowledge spillovers are the main source of innovation in the NMS, and that they play a more important role in the innovation activities of LMT than HT industry firms compensating for smaller endowment in innovation resources in the former of the two.

There were no great differences in firms' innovation patterns between the two technological sectors, however innovation resources and activities in most clusters detected in the LMT sector were lower than in their HT counterparts.

Unlike in the LMT sector, no Low profile innovation pattern was detected in the HT sector. In fact, in LMT industries there were not one but two clusters of low-innovating firms: besides Low profile there was also the Short term competitiveness strategy cluster. These two accounted for as much as half of the total LMT sector population. It is not surprising that in the LMT sectors, we did not detect an innovation pattern Based on in-house innovation backed by R&D cooperation which was found in the HT sector.

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Appendix

Table 5. Innovation indicators using four dimensions of innovation activity

Innovation Indicator	Measurement scale	Value range
I. Innovation Inputs		
1. Employment share of technicians and engineers in 2003 (%)	Metric	0, 100
2. Employment share of R&D and IT in 2003 (%)	Metric	0, 100
3. Annual expenditures for R&D in 2003 – share in sales revenues (%)	Metric	0, 100
4. Expenditures for R&D 2003/1998 (deflated)	Metric	≤ 0
5. Importance of managerial training	Ordinal	1, 3
6. Importance of employees training	Ordinal	1, 3
7. R&D or design unit in-house (yes/no)	Nominal	1, 0
8. Quality control laboratory in-house (yes/no)	Nominal	1, 0
9. Product development and improvements activities in-house (yes/no)	Nominal	1, 0
10. Process development and improvements activities in-house (yes/no)	Nominal	1, 0
11. Applied research in-house (yes/no)	Nominal	1, 0
12. Design in-house (yes/no)	Nominal	1, 0
13. Gathering commercial and technical information in-house (yes/no)	Nominal	1, 0

II. Innovation linkages

1. Applied research subcontracted (yes/no)	Nominal	1, 0
2. Product development and improvements activities subcontracted (yes/no)	Nominal	1, 0
3. Process development and improvements activities subcontracted (yes/no)	Nominal	1, 0
4. Design subcontracted (yes/no)	Nominal	1, 0
5. Gathering commercial and technical information subcontracted (yes/no)	Nominal	1, 0
6. R&D Department cooperates with domestic universities and research institutes (yes/no)	Nominal	1, 0
7. R&D Department cooperates with foreign universities and research institutes (yes/no)	Nominal	1, 0
8. R&D Department cooperates with independent researchers (yes/no)	Nominal	1, 0
9. R&D Department cooperates with raw material suppliers (yes/no)	Nominal	1, 0
10. R&D Department cooperates with machinery and equipment suppliers (yes/no)	Nominal	1, 0

III. Effects of cooperation with business partners

1. Beneficial cooperation with business partners in employee training; and other improvements in skills and knowledge of employees and management (yes/no)	Nominal	1, 0
2. Beneficial cooperation with business partners in product quality improvements (yes/no)	Nominal	1, 0
3. Beneficial cooperation with business partners in product specification and design (yes/no)	Nominal	1, 0
4. Beneficial cooperation with business partners in		

product development (yes/no)	Nominal	1, 0
5. Beneficial cooperation with business partners in improving the production process (yes/no)	Nominal	1, 0
6. Beneficial cooperation with business partners in improved access to modern technologies (yes/no)	Nominal	1, 0
7. Beneficial cooperation with business partners in modernization of production equipment (yes/no)	Nominal	1, 0
8. Beneficial cooperation with business partners in inventory management improvements (yes/no)	Nominal	1, 0
9. Beneficial cooperation with business partners in marketing improvement (yes/no)	Nominal	1, 0
10. Beneficial cooperation with business partners in better access to finance (yes/no)	Nominal	1, 0

IV. Innovation Outputs

1. ISO certificate received (yes/no)	Nominal	1, 0
2. New products introduced in a firm and sold in years 1998 and 2003[8](yes/no)	Nominal	1, 0
3. New products sold in 1998 and 2003[9] being new for the domestic market (yes/no)	Nominal	1, 0
4. New products sold in 1998 and 2003[10] being new for the		

[8] For 1998 products introduced not earlier than in 1996, and for 2003 – not earlier than in 2001.
[9] Defined as in footnote 1

international market (yes/no)	Nominal	1, 0
5. Share of sales revenues from sales of new products[11] in 2003 (%)	Metric	0, 100
6. Sales revenues from sales of new products 2003/1998 (index)	Metric	≤ 0
7. Sales revenue share of production from manufacturing technology less than 2 years old in 2003 (%)	Metric	0, 100
8. Sales revenues from manufacturing technology less than 2 years old 2003/1998 (index)	Metric	≤ 0
Performance indicators		
1. Competitiveness of company's products in the domestic market	Ordinal	1, 3
2. Competitiveness of company's products in comparison with the world leaders in the industry	Ordinal	1, 3
3. Competitiveness of company's production technology in the domestic market	Ordinal	1, 3
4. Competitiveness of company's production technology vis-à-vis world leaders in the industry	Ordinal	1, 3

[10] Defined as in footnote 1
[11] Defined as in footnote 1

Table 6. LMT sector firms in the NMS: Results of factor analysis

Variables	Factors											
	1	2	3	4	5	6	7	8	9	10	11	12
Beneficial Cooperation (BC) with business partners in product specification and design	0.429											
BC in better access to finance	0.702											
BC in improved access to modern technologies	0.760											
BC in improving the production process	0.712											
BC in modernization of production equipment	0.893											
R&D or design unit in-house		0.472										
Product development in-house		0.736										
Process development in-house		0.823										
Applied research in-house		0.424										
Design in-house		0.518										
Gathering commercial and technical info in-house		0.570										
R&D department cooperates with domestic institutes			0.672									
R&D department cooperates with			0.519									

Variables	Factors											
	1	2	3	4	5	6	7	8	9	10	11	12
foreign institutes												
R&D department cooperates with raw material suppliers			0.796									
R&D department cooperates with machinery and equipment suppliers			0.691									
R&D department cooperates with independent researchers			0.651									
Product development subcontracted				0.798								
Process development subcontracted				0.773								
Design subcontracted				0.603								
Managerial training very important					0.843							
Employees training very important					0.808							
Employment share of R&D and IT staff in 2003						0.773						
BC in inventory management and improvement							0.631					
BC in product quality improvements							0.674					
BC in marketing improvements							0.518					
Share of sales revenues from sales of new products in 2003								0.727				
Sales revenue share of production								0.695				

Variables	Factors											
	1	2	3	4	5	6	7	8	9	10	11	12
from manufacturing technology less than 2 years old in 2003												
ISO certificate received									0.695			
Quality control laboratory in-house									0.495			
New products sold and being new for international market										0.763		
R&D intensity in 2003											0.685	
R&D intensity 2003/1998 (index)											0.689	
New products introduced in a firm												0.736
New products sold and being new for domestic market												0.637

Table 7. HT sector firms in the NMS: Results of factor analysis

Variables	Factors										
	1	2	3	4	5	6	7	8	9	10	11	12
Beneficial Cooperation with business partners (BC) in improvement of skills of management and employees	0.519											
BC in inventory management and improvement	0.535											
BC in product quality improvements	0.601											
BC in product specification and design	0.622											
BC in product development	0.447											
BC in better access to finance	0.633											
BC in improved access to modern technologies	0.740											
BC in improving the production process	0.738											
BC in modernization of production equipment	0.827											
R&D or design unit in-house		0.584										
Product development in-house		0.887										
Process development in-house		0.853										
Applied research in-house		0.526										
Design in-house		0.544										
Gathering commercial and technical info in-house		0.471										

Variables	Factors											
	1	2	3	4	5	6	7	8	9	10	11	12
R&D department cooperates with domestic institutes			0.663									
R&D department cooperates with foreign institutes			0.610									
R&D department cooperates with raw material suppliers			0.722									
R&D department cooperates with machinery and equipment suppliers			0.725									
R&D department cooperates with independent researchers			0.656									
Employment share of technicians and engineers in 2003				0.836								
Employment share of R&D and IT staff in 2003				0.740								
Managerial training very important					0.790							
Employees training very important					0.856							
R&D intensity in 2003						0.773						
Share of sales revenues from sales of new products in 2003							0.693					
Sales revenue share of production from manufacturing technology less than 2 years old in 2003							0.570					

Variables	**Factors**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Product development subcontracted								0.772				
Process development subcontracted								0.704				
New products introduced in a firm									0.681			
ISO certificate received										0.747		
Applied research subcontracted												0.522
Gathering commercial and technical information subcontracted											0.516	

Table 8. LMT sector firms in the NMS: Clusters description by types of innovation factors

(% of cluster's firms answering 'yes', except for factors 6, 8 and 11 where other measures apply)

Cluster / Factors and variables	1 Based on linkages & BC	2 Low profile	3 Short term competitiveness strategy	4 Hunters for product innovation	5 High profile	All firms
I. In-house innovation inputs and activities						
Innovation activities in-house (factor 2)						
• R&D or design unit in-house	29.5	33.3	21.4	35.7	39.5	31.1
• Product development and improvement activities in-house	50.0	68.5	60.7	75.0	76.7	65.3
• Process development and improvement activities in-house	54.5	57.4	46.4	82.1	79.1	61.3
• Design in-house	34.1	42.6	32.1	53.6	34.9	38.2
• Gathering commercial and technical info in-house	43.2	35.2	28.6	53.6	46.5	39.4
HR upgrading (factor 5)						
• Management training very important	75.0	46.3	50.0	53.6	4.7	45.8
• Employees training very important	54.5	37.0	32.1	21.4	0.0	30.2
Human resources (factor 6)						
• Employment share of R&D and IT (%)	1.7	1.5	1.0	2.8	1.7	1.6
R&D Intensity (factor 11)						
• Expenditures for R&D in 2003 (R&D to sales revenues, %)	0.12	0.39	0.35	0.27	0.38	0.31
• Increase in expenditures for R&D 2003/1998 (index)	1.00	1.20	1.42	1.37	1.43	1.28

II. Innovation Linkages						
Backward linkages & cooperation with research units (factor 3): R&D Department cooperates with:						
• Domestic universities and research institutes	56.8	27.8	37.5	53.6	46.5	42.7
• Foreign universities and research institutes	20.5	11.1	5.4	0.0	14.0	10.7
• Independent researchers	18.2	7.4	17.9	7.1	11.6	12.9
• Raw material suppliers	54.5	33.3	42.9	67.9	46.5	46.7
• Machinery and equipment suppliers	36.4	24.1	37.5	67.9	44.2	39.1
Basic innovation activities subcontracted (factor 4)						
• Product development and improvement activities subcontracted	45.5	5.6	12.5	53.6	25.6	24.9
• Process development and improvement activities subcontracted	63.6	5.6	14.3	42.9	23.3	27.1
• Design subcontracted	36.4	13.0	12.5	64.3	20.9	25.3
III. Effects of cooperation with business partners						
Benefits of cooperation with business partners influencing mostly process innovation (factor 1), and namely, cooperation:						
• in product specifications and design	68.2	18.5	37.5	53.6	74.4	48.0
• in improved access to modern technologies	65.9	9.3	44.6	67.9	46.5	43.6
• in improving the production process	65.9	14.8	41.1	57.1	67.4	46.7
• in modernization of production equipment	75.0	1.9	58.9	67.9	60.5	49.8
• in better access to finance	50.0	7.4	39.3	46.4	32.6	33.3
Benefits of cooperation with business partners in other areas (factor 7) and namely, cooperation:						
• in inventory management improvements	56.8	37.0	23.2	28.6	53.5	39.6
• in product quality improvements	90.9	66.7	62.5	57.1	86.0	72.9
• in marketing improvements	65.9	27.8	28.6	53.6	53.5	43.6

IV. Innovation Outputs						
Share of new products and new technology in a firm's sales revenues (factor 8):						
• Share of sales revenues from sales of new products in 2003	22.2	11.6	44.0	24.9	40.8	29.0
• Sales revenue share of production from manufacturing technology less than 2 years old in 2003	30.7	23.2	56.2	32.3	73.8	43.7
ISO certificate received (factor 9)	43.2	46.3	67.9	28.6	65.1	52.4
New products sold and being new for international market (factor 10)	0.0	3.7	39.3	17.9	11.6	15.1
New products introduced in the last two years (factor 12) and						
• New in a firm	59.1	55.6	82.1	100.0	44.2	66.2
• Being new for domestic market	25.0	31.5	82.1	64.3	9.3	42.7

Table 9. HT sector firms in the NMS: Clusters description by types of innovation factors

(% of cluster's firms answering 'yes', except for variables in factors 4, 6 and 7, where other measures are applied)

Cluster Factors and viarables	1 (-)	2 Bene-fiting from coope-ration	3 High profile	4 Hunt-ers for pro-duct innov-ation	5 In-house inno-vation back-ed by R&D coope-ration	All firms
I. In-house innovation inputs and activities						
Innovation activities in-house (factor 2)						
• R&D or design unit in-house	0.0	41.2	80.0	67.6	78.6	60.9
• Product development and improvement activities in-house	0.0	68.6	86.7	86.5	71.4	77.4
• Process development and improvement activities in-house	0.0	58.8	86.7	83.8	71.4	72.9

• Design in-house	0.0	41.2	56.7	64.9	64.3	53.4
• Gathering commercial and technical info in-house	0.0	54.9	73.3	56.8	57.1	59.4
Human resources (factor 4)						
• Employment share of technicians and engineers	100.0	13.7	8.9	12.3	47.3	16.4
• Employment share of R&D and IT	50.0	2.3	4.0	4.3	23.6	5.9
HR upgrading (factor 5)						
• Management training very important	0.0	27.5	76.7	32.4	64.3	43.6
• Employees training very important	0.0	21.6	63.3	37.8	57.1	39.1
R&D Intensity (factor 6)						
• Expenditures for R&D in 2003 (R&D to sales revenues, %)	0.00	0.14	0.98	1.39	1.30	0.80
II. Innovation Linkages						
Basic innovation activities subcontracted (factor 8)						
• Product development and improvement activities subcontracted	0.0	25.5	26.7	35.1	14.3	27.1
• Process development and improvement activities subcontracted	0.0	19.6	23.3	21.6	7.1	19.5
Backward linkages & cooperation with research units (factor 3): **R&D Department cooperates with:**						
• Domestic universities and research institutes	100.0	19.6	100.0	59.5	78.6	55.6
• Foreign universities and research institutes	0.0	5.9	93.3	10.8	42.9	30.8
• Independent researchers	0.0	17.6	80.0	27.0	71.4	39.8
• Raw material suppliers	0.0	25.5	83.3	29.7	42.9	41.4
• Machinery and equipment suppliers	100.0	27.5	70.0	21.6	50.0	38.3
Gathering commercial and technical information subcontracted (factor 11)	0.0	3.9	46.7	18.9	21.4	19.5
Applied research subcontracted (factor 12)	0.0	3.9	46.7	43.2	35.7	27.8

III. Effects of cooperation with business partners						
Benefits of cooperation with business partners influencing both product and process innovation (factor 1), and namely, cooperation:						
• in employee training; and other improvements in skills and knowledge of employees and management	0.0	60.8	80.0	24.3	57.1	54.1
• in inventory management improvements	0.0	52.9	83.3	8.1	28.6	44.4
• in product quality improvements	0.0	88.2	90.0	35.1	71.4	71.4
• in product specifications and design	0.0	72.5	70.0	29.7	71.4	59.4
• in product development	100.0	62.7	70.0	32.4	85.7	58.6
• in improved access to modern technologies	0.0	41.2	76.7	18.9	42.9	42.9
• in improving the production process	0.0	66.7	76.7	24.3	21.4	51.9
• in modernization of production equipment	0.0	54.9	80.0	29.7	35.7	51.1
• in better access to finance	0.0	31.4	50.0	16.2	28.6	30.8
IV. Innovation Outputs						
Share of new products and new technology in a firm's sales revenues (factor 7):						
• Share of sales revenues from sales of new products in 2003	60.0	45.5	30.1	26.8	62.1	38.7
• Sales revenue share of production from manufacturing technology less than 2 years old in 2003	100.0	62.8	48.4	44.8	50.9	53.5
New products introduced in a firm less then two years ago (factor 9)	100.0	58.8	63.3	67.6	78.6	64.7
ISO certificate received (factor 10)	0.0	82.4	86.7	75.7	92.9	82.0

Table 10. LMT sector in the NMS: Product and technology competitiveness of firms by cluster (% of cluster's companies answering 'yes')

Assessment of comparative position	Clusters	1	2	3	4	5	All firms
Competitiveness of company's products on the domestic market	Company's products are: a) strongly competitive	36.4	29.6	42.9	53.6	60.5	43.1
	b) moderately competitive	59.1	57.4	51.8	46.4	37.2	51.1
	c) weakly competitive	4.5	13.0	5.4	0.0	2.3	5.8
Competitiveness of company's products on the world market	Company's products are: a) strongly competitive	36.4	18.5	12.5	32.1	32.6	24.9
	b) moderately competitive	50.0	57.4	73.2	42.9	55.8	57.8
	c) weakly competitive	13.6	24.1	14.3	25.0	11.6	17.3
Competitiveness of company's production technology on the domestic market	Company's technology is: a) strongly competitive	43.2	25.9	44.6	42.9	44.2	39.6
	b) moderately competitive	47.7	59.3	50.0	53.6	53.5	52.9
	c) weakly competitive	9.1	14.8	5.4	3.6	2.3	7.6
Competitiveness of company's production technology on the world market	Company's technology is: a) strongly competitive	34.1	18.5	16.1	25.0	18.6	21.8
	b) moderately competitive	40.9	51.9	67.9	42.9	58.1	53.8
	c) weakly competitive	25.0	29.6	16.1	32.1	23.3	24.4

Table 11. HT sector in the NMS: Product and technology competitiveness of firms by cluster (% of cluster's companies answering 'yes')

Assessment of comparative position	Clusters	1	2	3	4	5	All firms
Competitiveness of company's products on the domestic market	Company's products are: a) strongly competitive	0.0	52.9	76.7	62.2	78.6	63.2
	b) moderately competitive	100.0	45.1	23.3	37.8	21.4	36.1
	c) weakly competitive	0,0	2.0	0.0	0.0	0,0	0.8
Competitiveness of company's products on the world market	Company's products are: a) strongly competitive	100.0	37.3	50.0	29.7	42.9	39.1
	b) moderately competitive	0.0	51.0	43.3	62.2	50.0	51.9
	c) weakly competitive	0.0	11.8	6.7	8.1	7.1	9.0
Competitiveness of company's production technology on the domestic market	Company's technology is: a) strongly competitive	0.0	47.1	73.3	56.8	50.0	55.6
	b) moderately competitive	100.0	47.1	26.7	32.4	50.0	39.1
	c) weakly competitive	0.0	5.9	0,0	10.8	0.0	5.3
Competitiveness of company's production technology on the world market	Company's technology is: a) strongly competitive	100.0	31.4	60.0	24.3	42.9	37.6
	b) moderately competitive	0.0	47.1	30.0	51.4	50.0	44.4
	c) weakly competitive	0.0	21.6	10.0	24.3	7.1	18.0