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Innovation Systems and Knowledge-Intensive Enterpreneurship: a Country Case Study of Poland

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Abstract

This study surveys the current state of affairs in Poland with regard to the development of knowledge-intensive entrepreneurship (KIE), or new firm creation in industries considered to be science-based or to use research and development (R&D) intensively. We place KIE in Poland in the larger institutional context, outlining the key features of the country's National Innovation System, and then focus on KIE itself. Our findings are perhaps more optimistic than many previous studies of knowledge-based economy development in Poland. We observe significant progress due to Polish access to the European Union. The frequency with which universities are playing a significant role as partners for firms in the innovation process has increased significantly; moreover, we observe a significant degree of internationalization of innovation-related cooperation. Another optimistic development is that the level of activity of venture capitalists seems to be fairly high in Poland considering the relatively low degree of development of capital markets offering VC investors exit opportunities. Moreover, after almost two decades of decline in the share of R&D spending in GDP, there are signs that this is beginning to rise, and that businesses are beginning to spend more on R&D. While demand-side problems continue to be significant barriers for the development of KIE, due to the relatively low level of education and GDP per capita in the country, the trends here are optimistic, with high rates of economic growth and improvements in the level of education of younger generations. Significant improvement is still needed in the area of intellectual property protection.

1. Introduction[1]

The role of new firm creation in restructuring and revitalizing the post-Communist economies of East Central Europe (ECE) has been explored in a large literature on the subject (see, for example, Aidis, 2005; Aidis & Adachi, 2007; Aidis et al., 2008, 2010; Hoshi et al., 2003). It is a well-established fact that much of this entrepreneurial wave has occurred in sectors such as services and trade, neglected under central planning. Similarly, a fair amount of material has been published on the National Innovation System in Poland (e.g., Kubielas, 2006; Górzyński et al., 2006). However, little research has been done at the intersection of these two areas: Knowledge-Intensive Entrepreneurship (KIE) in the ECE countries (some exceptions include Radosevic et al., 2010; Woodward et al., 2010, 2011). This paper focuses on an area of entrepreneurship which appears to be both underdeveloped and under-researched in the ECE context, but which is of particular importance for the modernization of these economies: knowledge-intensive entrepreneurship (KIE), or new firm creation in industries which are considered to be science-based or to use research and development (R&D) intensively. In this paper we will focus on the experience of Poland, the largest economy among the new European Union member states, but also one whose economy is characterized by exceptionally low R&D intensity.

In this report we will attempt to place KIE in Poland in the larger institutional context, outlining the key features of the country's National Innovation System, and then focus on KIE itself. To achieve a comparative perspective on KIE in Poland within the context of the European Union, our discussion will also refer to data regarding Sweden, Denmark, the UK, and Germany among the old EU member countries (which we will refer to hereinafter as the EU-15 countries), and the Czech Republic and Latvia among the new ones. These countries include three in the close neighborhood of Poland (Latvia, Germany and the Czech Republic); two of these share Poland's post-Communist heritage, and Germany is included as a point of comparison with a mature market economy that is one of the world leaders in R&D performance. The UK and the two Scandinavian countries are also included as examples of Western European economies with quite different systems from that of Germany (Sweden is particularly noted for its status as number one in the world for the share of R&D spending in GDP). In our analysis, we employ the composite Index of Knowledge Intensive

[1] We would like to thank Slavo Radosevic, Mira Lenardić and Slavica Singer for their very helpful comments on earlier versions of this work. The usual disclaimers apply.

Entrepreneurial Opportunities (IKIEO) constructed by Radosevic and Yoruk (2011), which is created by summing the sub-indices of market opportunities (MO), technological opportunities (TO), and institutional opportunities (IO); this index is discussed in greater detail in sections 2.2 and 3.2.

The comparisons with Sweden, Denmark and the UK are based on the following reports, prepared within the AEGIS project:

- Bram Timmermans, "Innovation system and knowledge-intensive entrepreneurship: Denmark"
- Jon Mikel Zabala and Charles Edquist, "Innovation system and knowledge-intensive entrepreneurship: Sweden"
- Esin Yoruk, Mila Striukova and Slavo Radosevic, "Innovation system and knowledge-intensive entrepreneurship: United Kingdom"

2. Poland's National Innovation System

Entrepreneurship is not just about individuals; systems and networks play a crucial role in the development of entrepreneurial opportunities. "Successful entrepreneurs are consummate networkers who thrive in communities", Malerba (2010:8) writes, and lists the assets that firms are able to access through networks, including, very importantly, knowledge: "information and assessments on markets and technologies." In the context of KIE the systems we are particularly interested in are innovation systems, including the National Innovation System (NIS). By this we mean the system of institutions serving to further innovation and innovativeness in a given country (see, e.g., Lundvall, ed., 1992; Nelson, ed., 1993). This includes, for example, the education system, public institutions supporting or conducting research and development (R&D) activity or technology transfer, and of course the R&D departments of firms themselves. Of course, it is networks and cooperation that bring together the various components of a National Innovation System to make it a system. Lundvall (1992:2) calls attention to the role of linkages in the system, noting that "a system of innovation is constituted by elements and *relationships which interact* in the production, diffusion and use of new, and economically useful, knowledge" (emphasis added) and emphasizing that the NIS is a "social system" and a "dynamic system", which is "characterized both by *positive feed-back* and by reproduction" (emphasis added).

The first question that comes to mind in discussing Poland's National Innovation System (NIS) is whether the country can be said to have such a system at all. All the elements generally considered to constitute such a system are present in Poland. But are the links between those elements, crucial for bringing them together to constitute a system, also present? Certainly there is no lack of activity on the part of the public sector (i.e., central, regional and local governments, acting in recent years in conjunction with the European Commission) to create them. We will consider this question in the ensuing section.

In our discussion we will begin with a look at the actors relevant to a National Innovation System, considering the role of firms (in particular, their R&D spending and the skill level of employees), the science and technology (S&T) sector (including universities, research institutes, and Polish Academy of Science), relevant government bodies, and finally venture capital. We then evaluate the opportunities facing KIE in Poland, including market, technological, and institutional opportunities. We conclude our discussion of the NIS with a look at its performance, measured primarily in terms of R&D spending.

2.1. Actors

2.1.1. Firms

We will deal with the innovation performance of firms, the most important component of the NIS, in section 2.3. Here, given our focus on the linkages among actors in the National Innovation System, we will discuss their cooperation with firms and non-commercial institutions in the development of new products and services.

We see the percentage of firms in various size categories reporting having had contracts for such cooperation in Table 1. The data show that especially for medium-sized and large companies this increased quite substantially during the first half of the 2000s (peaking at almost a quarter of firms with over 49 employees), corresponding to the period in which Poland acceded to the European Union, but then seemed to decrease somewhat in the beginning of the second half of the decade. This decrease is most likely due to the overall decrease in innovativeness of Polish firms in the second half of the decade.

Table 1. Firms that had contracts for cooperation with other firms or institutions in innovation

	1998-2000	2003	2002-2004	2005	2004-2006	2006-2008
Firms with over 49 employees	12.7%	10.5%	24.6%	24.2%	23.6%	19.6%
Firms with over 9 employees	na	9.4%*	na	na	11.1%	6.6%

* Figure for 2001-2003
Source: Own calculation based on CSO data

More detailed data on the partners with which firms carry out such innovation-related cooperation are contained in the Community Innovation Survey data we received from the Polish Central Statistical Office (CSO). Tables A1-A4 in the Appendix show information on the number of firms in various size categories indicating cooperation with a given type of partner in various periods. Tables A1-A2 present these data for the early 2000s (2001-2003 for firms with over 9 employees and 2002-2004 for firms with over 49 employees). Examining these tables, we can see that, for the medium-sized and large firms, the type of partner indicated most frequently was suppliers (with almost half of firms indicating foreign suppliers among them). Customers were the second most frequent partner (again, over half of the firms indicated cooperation with foreign partners in this category). These were followed by companies in the same group (here, almost twice as many firms indicated foreign partners as indicated domestic ones), and then by institutions of higher education (almost exclusively Polish); consultants, competitors and other firms, and R&D institutes were indicated with similar degrees of frequency. There was very little cooperation with units of the Polish Academy of Sciences (Polish acronym PAN) and even less with foreign public sector institutions. If we include small firms (with 10-49 employees) as well, we again see suppliers as the most frequently indicated partner for innovation-related cooperation. Interestingly, in contrast to the narrower group of firms, the second most frequently named partners were firms in the same group (although foreign ones were named much less frequently, though still by a large minority), with customers in third rather than second place (again, foreign ones were named proportionally less often). Consultants, competitors and other firms, and R&D institutes were named with similar degrees of frequency. Institutions of higher education were a noticeably less important partner for smaller firms, but for them, too, foreign public sector institutions were almost negligible in importance.

Next, we look at the period 2006-2008 (Tables A3-A4 in the Appendix) – the most recent period for which CSO data are available. Looking at the narrower group of medium-sized and large enterprises, we again see suppliers as the most frequently indicated partner in innovation (again, a large minority of firms indicate foreign suppliers as partners). Similarly, customers are still in second place (and again the majority of indications are of foreign ones). Higher education institutions have moved from fourth to third place, swapping places with

companies in the same group (here the majority of indications are still of foreign partners). It is interesting to note that the relative importance of this group of partners grew as the frequency of both innovation and innovation-related cooperation declined. The relative frequency with which consulting companies, competitors and other firms, and R&D institutes are indicated remains unchanged, as is the case for PAN and foreign public sector institutions. If we turn our attention to the broader group of firms with 10 or more employees, once again we see suppliers in first place, although now customers are in second place, just as they are for the larger firms (a significant minority of firms indicated foreign partners among both suppliers and customers). Competitors and other firms have moved from fifth to third place, followed by consulting firms (again with a significant minority of firms indicating foreign partners in both cases). Firms in the same group have dropped greatly in significance, from second place to fifth (though now a majority of indications are for foreign partners), and they are followed by higher education institutions, then R&D institutes, and finally by very infrequent indications for PAN and foreign public sector partners.

For purposes of international comparison, table 2 presents data from the Fourth Community Innovation Survey, referring to the period 2002-2004. In terms of the overall frequency of cooperative arrangements among Polish firms, this seems to be very close to the European average. Interestingly, the same is also true for one of the most innovative European economies in this period, Germany (firms here seem to be loners, relying almost exclusively on in-house innovation and cooperating very little). Scandinavian firms are the leaders in terms of innovation-related cooperation, while Latvia is well below the European average.

With respect to the partners cooperated with, the dominance of suppliers, followed by customers, reflects the European norm. Higher education and government research institutions are much less frequently partners as a rule, though it is interesting to note that innovative firms tend to partner with them more frequently in post-communist and Nordic countries. In this sense Poland is exceptional within the group of post-communist countries, having very low rates of cooperation with those partners in this period.

Table 2. Innovation-related cooperation in European firms, 2002-2004

	Enterprises with innovation activity, % of all enterprises	Enterprises with co-operation with other enterprises or institutions, % of all enterprises	All types of co-operation with other enterprises or institutions	Co-operation partners:			
				Suppliers	Clients or customers	Universities or other higher education institutes	Government or public research institutes
			% of all innovative enterprises				
EU27	42	11	26	17	14	9	6
Czech Republic*	38	14	38	31	26	13	7
Denmark	52	22	43	28	28	14	7
Germany	65	10	16	7	8	8	4
Latvia	18	7	39	33	29	14	12
Poland	25	11	42	28	16	6	9
Sweden	50	22	43	32	28	17	6
United Kingdom	43	13	31	23	22	10	8

* Data for Czech Republic are for the period 2003-2005.
Source: Eurostat Press Office (2007), except enterprises with co-operation with other enterprises or institutions (% of all enterprises), own calculations based on Eurostat Press Office (2007).

A number of important observations about patterns of innovation-related cooperation in Poland can be made on the basis of these data.

The first is the clear dominance of other firms (particularly supply chain partners), rather than institutions in the S&T sector, as partners in the innovation process, in line with general European trends.

The second is that while the S&T sector may be of secondary importance, it is still a significant partner. In particular, universities are increasingly important in the innovation process, especially for medium-sized and large firms; interestingly, they eclipse the industrial R&D institutes that were specifically designed for technology transfer. Small firms interact with the S&T sector much less frequently than do medium-sized and large firms. As we have noted, the importance of the S&T sector as a partner grew as the frequency of innovation and innovation-related cooperation fell. Perhaps this is an indication that the firms that continue to value innovation highly are more strongly oriented toward science and technology related R&D and innovation.

Finally, we would like to draw attention to the high level of internationalization of the innovation process in Poland, even among small firms. Foreign partners of all types are mentioned by many firms of all sizes.

Such results seem to contrast with much that had been written earlier about cooperation between the science sector and industry in the post-socialist countries of Central and Eastern Europe in general and Poland in particular (see the next sub-section, on the S&T sector), indicating that such cooperation may have grown more frequent in the ensuing years. However, it is also true that the statistical picture may obscure other parts of the story, as the figures do not tell us anything about the nature of the cooperation (for example, whether the S&T sector partners are actually involved in the concept stage of new product development, or simply perform more routine tasks such as testing of materials and prototypes).

2.1.2. The S&T sector

We now turn our attention to the role of the S&T sector, including educational institutions, research institutes and the Polish Academy of Science, in Poland's NIS.

In the late 1990s a number of researchers wrote that cooperation between the science and technology (S&T) sector and industry in the post-socialist countries of Central and Eastern Europe in general and Poland in particular occurred very seldom and unproductively; universities, for example, were found to be poorly prepared for cooperation with business (in terms of, e.g., administrative flexibility and professionalism in drawing up contracts), although it was also noted that their Western counterparts often encountered similar problems (see, for example, Quevit, 1997; Radosevic, 1999; Kraslawski & Gajewski, 2000). More recent research continues to show the clear dominance of other firms (particularly customers and suppliers), rather than institutions in the S&T sector, as partners in the innovation process for knowledge-intensive firms in Poland (Radosevic et al., 2010).

Another very important component of the Polish S&T system is the country's more than 100 industrial research institutes, created under Communism to take the R&D function out of enterprises. The latter were grouped into industry-wide concerns functioning under branch ministries, with each industry assigned its own institute or group of institutes. Given the fact that the R&D institutes had all too often been engaged in the engineering of imitations of Western technologies, when the central planning system collapsed and the import of Western goods could take place freely, most of the institutes found themselves confronted with a drastic fall in demand for their services. Very often, therefore, they have attempted to cope with the new situation by finding new roles for themselves, with research often being funded exclusively by the state rather than by industrial customers, and relations with industry dominated by provision of services (e.g., the quality testing of materials and products using the institutes' lab equipment) or even engagement in manufacturing activity by the institutes themselves (Radosevic, 2004).

Thus, there appears to be a significant problem with the ability of these institutes to fulfill their technology transfer mission, since as (presumably) producers of applied research they remain much less significant partners for industry than institutions of higher learning, which are engaged (presumably) in more basic than applied research.

Table 3 contains some data on various measures of the performance of the S&T sectors for four. Three of the measures concern personnel, and one the quality of output of research institutes. As we can see, Poland is quite close to Latvia in terms of the availability of scientists and engineers, R&D personnel and people with PhD-level degrees, and quite far behind the Czech Republic and Germany. It seems that the long arm of history may be in evidence here, with the Czech Republic benefiting from strengths in engineering that it had developed prior to the Second World War (McDermott, 2002) and Poland continuing to feel the destruction of its intelligentsia (both Jewish and ethnic Polish) by the German and Soviet occupiers during the war (the Holocaust and the Katyn Forest massacre by the Soviet occupiers are well known; for the Tannenberg and Außerordentliche Befriedungsaktion – AB – operations of the Einsatzgruppen in Poland, see Gella, 1971, Rhodes 2002, Rossino 2003). Denmark and Sweden generally outperform the UK and Germany, except with respect to the quality of research institutes.

Table 3. International comparison for quality of S&T sector

	R&D personnel as % of total employment (2007)	People with PhD or equivalent* per 1,000 of the population aged 25-34) (2008)	Index for availability of scientists and engineers	Index for quality of scientific research institutes
Czech Republic	1.00	1.40	4.40	5.10
Denmark	1.67	na	5.10	5.50
Germany	1.33	2.60	4.80	5.90
Latvia	0.57	0.40	3.60	3.80
Poland	0.49	0.90	4.20	4.10
Sweden	1.69	na	5.80	5.90
UK	1.20	na	4.80	6.00

* - ISCED 6

Sources: Eurostat for R&D personnel and people with PhD or equivalent; otherwise World Economic Forum (2010)

In spite of the relative weakness revealed by the table, as we saw in section 2.1.1, universities are an important partner for Polish firms – especially medium-sized and large ones – in their innovation process, and their importance appears to be increasing.

2.1.3. Government bodies active in the area of KIE

Since the fall of the Communist regime, the Polish government has never given policy issues related to innovation and the transition to a Knowledge-Based Economy a high priority – its attention has always been focused rather on the problems of the shrinking "old economy," in particular extractive and heavy industries. The responsibility for innovation- and technology-related initiatives is scattered amongst various ministries and agencies, no institution with the responsibility for coordinating these initiatives has ever been designated, and no comprehensive and coherent strategy has ever been developed in this area. However, the Ministry of Economy managed to ensure the inclusion of innovation activity and Knowledge-Based Economy development as one of the central priorities in the National Development Plan 2004-2006, which laid out the priorities for activities to receive EU Structural Fund support. The program "Improving the Innovativeness of the Economy in Poland by 2006" (approved by the cabinet in 2000) was prepared as a supplement to the National Development Program and evidenced a broad approach which targeted not only the diffusion of technology and innovation, but information society development and sustainable development. Consequently, a significant share of Poland's Structural Fund assistance has been targeted at innovation-related activity. Continuing this trend, the support of entrepreneurship and innovation was the third of six priorities laid out in the National Development Plan for the years 2007-2013, approved by the cabinet in 2005. The Plan also sketched measures designed to increase the commercial activity of institutions of higher learning, as well as for the development of commercial institutions active in the area of technology transfer (e.g., academic enterprise incubators and R&D centers).

The Innovative Economy Programme, approved by the European Commission and the Polish cabinet in 2007, is one of six national programmes under the National Strategic Reference Framework, which are co-financed from EU resources. It is specifically designed to support Knowledge-Intensive Entrepreneurship with funding exceeding EUR 9.71 billion (EUR 8.25 billion of which come from the European Regional Development Fund and the rest from the State budget). The funds are channelled to entrepreneurs, business support institutions and S&T sector entities (see the Innovative Economy Programme web site).

What do data from the Polish Central Statistical Office (CSO) tell us about the financial assistance firms receive from the public sector for their innovation-related activity? Table A5 in the Appendix shows that small firms (that is, those employing between 10 and 49 persons) receive a good deal less public financial assistance for innovation-related activity than medium-sized and large firms (since 11.9% and 9.7% of the latter received such assistance in 2004-2006 and 2006-2008, respectively, while the corresponding figures for all firms employing over 9 persons are 3.2% and 1.4%); this is hardly surprising given that, as we

shall see in section 2.3, small firms have a much lower frequency of innovation than medium-sized and large ones. In both periods twice as many firms received such assistance from the European Union as from the Polish central government, and local authorities were only marginally a source of such assistance. It is worth noting that the EU Framework Programs represent only a small fraction of the EU assistance used for this purpose by firms, as the percentage of firms reporting this source was lower than that receiving assistance from local governments. The percentage of firms receiving such assistance declined from all sources from one period to the next (the period with higher percentages of firms receiving assistance corresponding to the years in which Poland joined the European Union).

As a result of these developments, funding from the EU Structural Funds for KIE support (coordinated and channeled by the Ministry of Regional Development) greatly exceeds the amounts of national funds being spent for these purposes. According to CSO data presented in Table A5 in the Appendix, 8.3% of firms with over 49 employees received funding for innovation activity from the EU and only 5.6% from local and central government in the years 2004-2006. In the years 2006-2008, again about twice as many firms received funding from the EU as from Polish authorities. In the case of smaller companies (with over 9 employees), the situation is similar.

One of the Polish government bodies most active in the area of KIE is the Polish Agency for Enterprise Development (Polish acronym: PARP), which is responsible for programs in the areas of small and medium-sized enterprise (SME) development, regional development, and support of innovation and technology transfer. It is also worth mentioning the Innovation Center FIRE, founded in 2002 by the Industrial Development Agency, on the initiative of the Ministry of Economy, designed to help start-ups with high technological content develop their business. The budget information presented concerning these organizations can be taken as an indication of the Polish government's low prioritization of issues related to innovation and KIE. Additionally, a policy was launched early in the 2000s to move the allocation of research grants financed from Polish government (as opposed to the European Commission) funds by the Ministry of Science and Higher Education from a system in which all grant allocation decisions were made by a committee of scientists to one in which policy-makers have more leverage over the process, allowing the state to implement a science policy of its own and ensuring that research funding would not be controlled by powerful interest groups within the scientific community. The latter were believed to turn what was ostensibly a project-based grant system into a system of subsidies for inefficient institutions. Under the new system, representatives of the scientific community were to evaluate grant proposals, but responsibility for decisions regarding funding priorities was to rest ultimately with the minister and his staff, allowing the ministry to develop a policy of prioritization of directions for research (Krzemiński, 2002). Almost ten years later, there is some joint coordination of

programs by the Ministry of Economy and the Ministry of Science, but most grants are still awarded by the peer review processes. An example of cooperation of Ministry of Science with Ministry of Economy is Measure 1.4 of the Innovative Economy Program (Support for Goal-Oriented Projects), which is co-coordinated by the Ministry of Science and by PARP on behalf of the Ministry of Economy (http://en.parp.gov.pl/files/214/3568.pdf).

PARP[2]

PARP is a governmental agency under the Ministry of Economy established in 2000 as a result of a merger of three governmental foundations that had been operating since the mid-1990s in the areas of SME support, regional development, and technology transfer. PARP's priority is to manage state and EU funds intended for supporting entrepreneurship and human resources, focusing on SME needs in particular. PARP is also one of the institutions responsible for the implementation of activities financed from the Structural Funds.

To realize its statutory goals of SME support and support for regional development and innovation, PARP uses the following instruments:

- grants to SMEs, SME support institutions, training institutions and labor market institutions (entrepreneurs may receive partial financing of activities for company development, export development, quality systems implementation, application of new technologies, etc.),
- advisory services,
- facilitation of SMEs' access to relevant information, studies and analyses,
- educational and promotional activities (each year the agency publishes a report on SMEs in Poland as well as a number of other publications and manuals, some of which can be read online; additionally, PARP organizes a yearly contest called "Polish Product of the Future," the aim of which is to promote innovations and assist in marketing innovative products).

Some KIE-related institutional initiatives of PARP are:

- the "Innovative Entrepreneurs Club," a forum for collaboration and exchange of information among entrepreneurs using innovative technologies and representatives of the S&T sector,
- the Bank of Technology and Products, which provides information about innovative products and technologies and matches business partners,
- Consultation Points act as "first point of contact" institutions for SMEs. There are currently 110 such points. SMEs may use free-of-charge consulting services covering

issues related to commercial activity and enterprise management. The main aims of the Points are to provide basic advice on how to set up and run a business and to provide information on all available support programs and assist entrepreneurs in the application process. The system of Consultation Points includes over 40 centers of the National Innovation Network (Krajowa Sieć Innowacji), which provide SMEs with consulting services related to the commercialization of new technologies (including technology transfer).

In 2011, PARP was budgeted approximately 1.4 billion euro in subsidies for these various SME support programs (Osiecki, 2010).

Innovation Center FIRE[3]

The FIRE Foundation was set up in 2002 by the Agency for Industrial Development in cooperation with the Ministry of Economy and Labor. Its major goal is to stimulate both market and financial development of start-up firms operating in the new technology sector and offering products with high commercial potential. The Foundation attempts to bring together representatives of the S&T sector, R&D-intensive enterprises lacking the funds and expertise needed to bring new technologies to the market, and creative employees from different types of enterprises willing to start their own technology-oriented business. For investors (business angels, seed capital and venture capital funds, etc.), FIRE is a partner helping them to find start-up companies that are innovative on a global scale, especially from sectors like biotechnology, nanotechnology, medical equipment, scientific equipment and software.

It is clear that the resources at the disposal of FIRE are not sufficient to realize its goals. In the years 2002-2005, FIRE had a budget of ca. 400,000 euro and employed 8 persons. In 2004-2005 one new firm was set up with the help of FIRE. For this reason, the Foundation has been forced to focus more on assistance for already existing firms than start-ups.

2.1.4. Venture capital

The underdevelopment of financial tools for financing the development of innovative ventures is often considered to be a serious factor hindering development of KIE in Poland (see, e.g., Górzyński and Woodward, eds., 2003). Like small business owners throughout the world, Polish entrepreneurs have traditionally complained about poor access to finance (see discussion in Woodward, 2001). However, as it has matured and grown more competitive, the Polish banking sector has shown more and more interest in the SME sector (see, for

[2] Except where indicated otherwise, the information in this section is taken from the PARP web site: http://www.parp.gov.pl

[3] The information about FIRE is taken from the FIRE web site (http://www.innowacje.org.pl) and an interview conducted by Patryk Koć.

example, NBP, 2005). Moreover, not all of the credit barriers in the sector are on the supply side. In their analysis of a 2001 survey of microentrepreneurs, Balcerowicz et al. (2002) found notional demand for credit to be very low; a quarter of the respondents rejected the idea of borrowing on principle, and only a little over 40% indicated a relatively high propensity to borrow from any source at all, including from friends and family, thus indicating a low frequency of propensity to borrow from a financial institution. That being said, nowhere in the world are banks particularly interested in the financing of risky new ventures, so various equity instruments (of which venture capital is the best known) are needed to fill this gap. However, venture capital is not a great strength of Continental Europe. How does Poland fare in this regard?

Roughly ten years ago, according to a PricewaterhouseCoopers (2002) study of venture capital investments in 21 European countries, Poland came out ahead of only two countries – Portugal and the Czech Republic – in terms of absolute volume; in per capita terms, Poland was in last place. Only about one seventh of the VC funds raised for Polish firms in 2003 came from domestic sources. This contrasts to the situation in the EU, where more than half of the money gathered by funds in 2003 came from domestic sources (especially banks and pension funds).

Table 4. Venture Capital compared to credit and publicly traded equity in Poland

	Domestic credit to private sector (% of GDP) (2007)	Stocks traded (% of GDP) (2007)	Venture capital (% of GDP) (2007)	Venture capital availability
Czech Republic	47.95	24.07	0.00	2.60
Denmark	203.39	78.11	0.10	3.30
Germany	105.49	101.42	0.05	2.80
Latvia	88.67	0.49	na	2.20
Poland	39.44	19.88	0.03	2.70
Sweden	123.94	213.72	0.22	4.00
UK	187.89	368.28	0.28	3.00

Sources: World Bank for domestic credit and stocks traded; Eurostat for venture capital as a percentage of GDP; World Economic Forum (2010) for venture capital availability

As we can see from Table 4, more recently (as of 2007), while having much lower levels of credit activity, Poland compared favorably with two of its post-communist neighbors and was even comparable to Germany in terms of VC activity. This is particularly remarkable given Poland's much thinner capital market compared to Germany's, which implies that Poland is getting perhaps more VC than "justified" on the basis of its exit opportunities. This indicates that Poland is generating more (and more attractive) investment opportunities for VC than one would expect on the basis of not only its equity market capitalization but also its R&D performance (see the discussions of the S&T sector in sections 2.1.2 and 2.3 below).

Summing up our discussion of the actors in the Polish NIS, we note that despite considerable limitations the country seems to be benefiting from venture capital investments that are perhaps disproportionately large compared to certain conventional measures of opportunities, and that the S&T sector (particularly universities) plays a surprisingly large, and growing, role in firms' innovation processes. If, therefore, as stated before, a National Innovation System consists not only in its constituent elements but in the linkages between them, it is clear that such a system does exist in Poland, even if it is in a comparatively early state of development. It is also clear that while the role of the public sector is in need of much improvement, EU membership (and the funding available to firms for innovation-related activity from the EU Structural Funds) is making a contribution in this regard.

2.2. Opportunities

Radosevic and Yoruk (2011) have constructed a composite Index of Knowledge Intensive Entrepreneurial Opportunities (IKIEO), which is created by summing the sub-indices of market opportunities (MO), technological opportunities (TO), and institutional opportunities (IO). The statistics on whose basis the various indices were calculated were as follows:

Technological opportunities

- Research and development: Gross Expenditures on R&D (GERD) and Business Expenditures on R&D (BERD) as a percentage of GDP;
- Skills: the share of R&D personnel in total employment, the share of people with tertiary education in the population, the quality of scientific research institutes, and the availability of scientists and engineers;
- Knowledge networks: the share of firms involved in innovation-related cooperation, the labor force mobility of S&T workers, and value chain breadth;

Market opportunities

- Demand: GDP per capita, GDP growth, share of trade in GDP, and buyer sophistication;
- Finance: domestic credit to the private sector as a percentage of GDP, stocks traded as a percentage of GDP, venture capital as a percentage of GDP, and venture capital availability;
- High-tech manufacturing and Knowledge-Intensive Services: the number of firms in these two industries as a percentage of all firms, the share of these

industries' exports in total exports, and employment in the two industries as a percentage of total employment;

Institutional opportunities

- Regulation: the number of procedures required to start a business, the number of days required to start a business, IPR protection, the degree to which government regulation is a burden, and the efficiency of the legal framework;
- Support: the state of cluster development, the percentage of firms declaring themselves to be part of a cluster, the percentage of firms declaring an interest in bidding on public projects, and the percentage of firms that declare an ability to sell an innovative product in a public procurement.

In Table 5, we look at the IKIEO as well as the three sub-indices for Poland, comparing them with several EU member countries, including the three with which we have compared Poland previously – the Czech Republic, German and Latvia – as well as the EU leader (Finland) and last-ranked country (Greece) in terms of the IKIEO index (for the overall index as well as the sub-indices, we provide both the calculated values and the rankings for all EU-27 countries with the exception of Malta).

Table 5. IKIEO international comparison for Poland

Country	TO	(Rank)	MO	(Rank)	IO	(Rank)	IKIEO	(Rank)
Czech Republic	37.39	13	30.18	13	46.96	18	114.53	15
Denmark	74.60	3	47.70	7	80.68	3	202.98	3
Germany	61.12	4	38.58	10	55.66	12	155.36	8
Latvia	11.26	24	19.36	22	49.02	16	79.63	21
Poland	22.23	21	20.22	21	35.73	22	78.18	23
Sweden	80.72	2	59.09	3	82.36	2	222.18	2
UK	52.22	9	62.71	2	65.06	6	179.99	5

Source: based on Radosevic and Yoruk (2011)

Poland's performance with regards to the indices is generally close to that of Latvia and close to the bottom of the EU-27, whereas the Czech Republic is generally around the middle, Germany usually in the top 10 (and particularly strong on technological opportunities), and Denmark and Sweden in the top 5. With respect to the three sub-indices, Poland's performance is quite consistent, and it is not possible to say that there is any area where it is doing noticeably better than in others. The UK ranks very high for institutional and market opportunities, but closer to the Czech Republic in terms of technological opportunities, making it in some respects a mirror image of Germany.

The TO index is based on GERD and BERD performance, the S&T sector indicators discussed in section 2.1.2, and some measures of knowledge networking. With respect to the S&T indicators, as we saw, Poland performs noticeably better than Latvia in most of them, but much worse than the Czech Republic in all of them.

The MO index is based on indicators of demand and its growth and of the relative importance of high-tech industries in the economy, as well as of financial market health (see the discussion of venture capital in section 2.1.4).

Finally, the IO index is based on indicators how the business environment is affected by regulation (see section 2.2 below) and measures of government support that may be relevant for KIE (such as policies stimulating the formation of clusters or public procurement policy).

In a study of a sample of 304 knowledge-intensive companies from six countries (including Croatia, the Czech Republic, Lithuania, Hungary, Poland, and Romania), Polish respondents named technological opportunity as the main motivation for founding their firms much less frequently than respondents from the other five countries; 15% did so, as opposed to well over 20% in the other countries. Polish firms considered the high cost of labor to be one of the most important barriers much more frequently than did respondents from other countries (Radosevic et al., 2010). Thus, Polish knowledge-intensive firms seem much less likely to be new technology based firms than knowledge-intensive firms in neighboring countries, and seem to have greater difficulty accessing trained personnel.

The CSO has identified the following factors hampering innovation activity in Poland:

- economic factors (a shortage of own and external finance for innovation activity);
- excessively high costs involved in introducing innovation;
- knowledge-related factors (a shortage of personnel with suitable qualifications and lack of information about technologies and markets);
- problems with finding suitable partners, and
- market factors such as excessive market monopolization and unpredictable demand.

Apart from the above factors, low innovation activity on the part of businesses may also be due to the absence of the need to undertake such activity, due to the low level of demand for new technology based innovation. In each Polish region, the most important factor hampering innovation in 2004-2006 was financial: Businesses do not undertake innovation activity because of inadequate financing (Wojnicka, 2011).

Obviously, the financing problem is quite a serious one, and measures are being taken to tackle it through EU funding, fiscal instruments and loan guarantees. However, policy measures and government assistance will never relieve companies of the responsibility to seek ways to reduce the costs of innovation by introducing new business models, including just-in-time measures and means designed to prevent wastage. Polish IT businesses are skillfully cutting innovation costs and at the same time overcoming barriers due to intellectual property protection. For example, they buy access to specialist programs over the Internet, instead of purchasing the programs themselves. Likewise, software producers offer free access to some functionalities of their programs on the Internet while requiring users to pay for temporary access to all the functionalities. Some small industrial enterprises operate in a similar way; they reduce the number of components in their products, without undermining their quality and functionality, so as to be able to compete with cheap imports from China (Wojnicka, 2011).

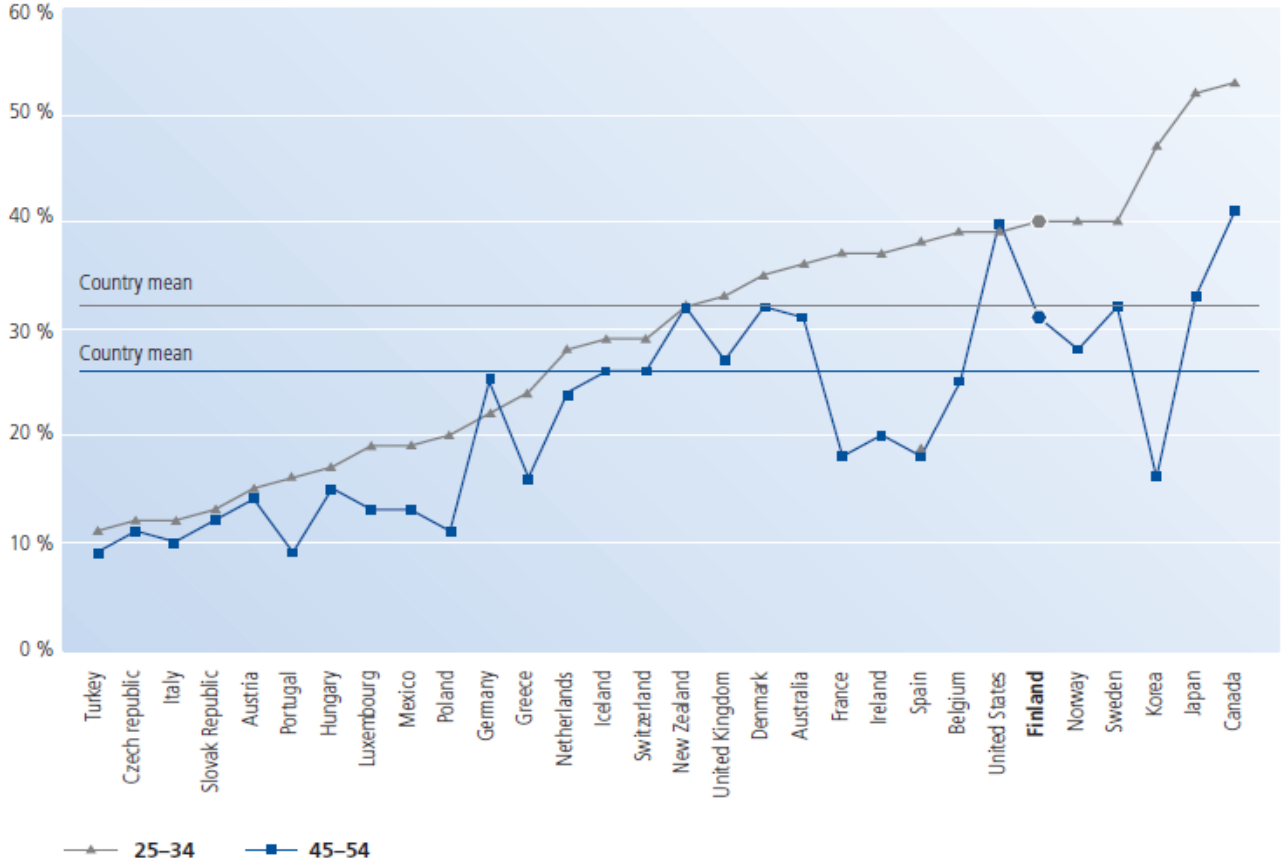
According to CSO research, market factors – in particular unpredictable demand and the domination of a single company on the market – are the second most important category of factors hampering innovation. Factors associated with access to knowledge are the third most important category. In this group of factors, the main problem reported by small and medium businesses is the difficulty in finding suitable partners and well-qualified personnel. The shortage of information about technologies and markets is also troublesome. Moreover, over 70% of all businesses in Poland (including over 30% of large companies) see no need for innovation activity at all. This means that their innovation awareness is low, reflecting the general public awareness in this sphere. By the same token, the general public's understanding of innovation determines the responsiveness of businesses and their introduction of new technologies. If there is no demand for innovation from the society, businesses will not pursue it (Wojnicka, 2011). Education plays a crucial role in developing demand for innovation by generating a population of consumers interested in using knowledge-intensive products, and is therefore important for market opportunities.

As we can see in Figure 1, Poland is in the bottom half of the OECD with respect to the percentage of persons aged 25-34 with higher education, and one of the four lowest-

ranking countries with respect to the higher education attainment of 45- to 54-year-olds. This tells us that Poland is likely to have a relatively low level of demand; however, the fact that the younger generation is better educated indicates that the situation should be improving. The figures in Table 6 tell us a similar story. Buyer sophistication and GDP per capita are relatively low; however, economic growth is very strong.

The role of problems with domestic demand and access to finance in the internationalization of Polish knowledge-intensive firms is underlined by Cieślik (2011). This study of the internationalization of three Polish new technology based startups founded in the 1990s and 2000s finds that the chief motives for these companies to explore international markets were business opportunities, insufficient demand in the domestic market, the desire to access finance capital, and the desire to build a prestigious international brand.

Figure 1. Population that has attained tertiary education. OECD countries (2003)



Source: Education at a Glance 2005 (OECD)

Cited in: Finnish National Board of Education (2005).

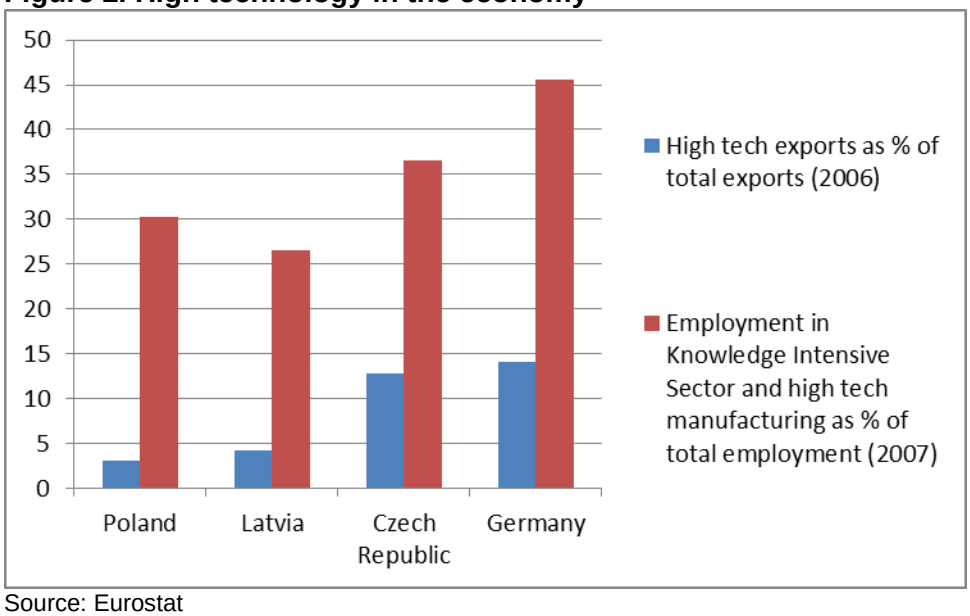
Table 6. Indicators of demand for innovation

	GDP per capita (current US$) (2007)	GDP growth (annual %) (2007)	Buyer sophistication (2009–10 weighted average)
Czech Republic	16,858.2	6.13	3.90
Denmark	56,770.1	1.65	4.30
Germany	40,309.7	2.46	4.40
Latvia	12,638.2	9.98	3.20
Poland	11,157.3	6.79	3.60
Sweden	49,553.1	2.56	5.00
UK	45,954.6	3.02	4.60

* Exports plus imports
Sources: World Bank for GDP per capita and GDP growth; World Economic Forum (2010) for buyer sophistication

Turning to the related question of the role of the high-tech sector in the economy, as we see in Figure 2, the pattern observed before of the similarity of Poland and Latvia at a low level and of Germany and the Czech Republic at a higher level is replicated here. Germany and the Czech Republic have similar shares of high-tech products in exports – about three times higher than in Poland. The distinction is less pronounced in terms of the share of employment in knowledge-intensive sectors in total employment.

Figure 2. High technology in the economy



Source: Eurostat

It is worth reminding the reader at this point that, as we have seen in section 2.1.4, the availability of venture capital in Poland may actually be high relative to the exit opportunities the country offers investors in terms of a developed equity market. Additionally, we saw that while the country's S&T sector faces problems (especially in terms of the number of trained personnel) in comparison with more advanced countries like Germany or even the Czech

Republic, its university system is playing an important and growing role in the product development process of Polish firms.

Having considered the demand and supply conditions in Poland for the production of innovation, we now turn to the question of institutional opportunities (or lack thereof) as revealed in the World Economic Forum's Global Competitiveness Report indicators on the country's business environment (Table 7).

Table 7. Business environment

	Number of procedures required to start a business (2009)	Time required to start a business (days) (2009)	IPR protection (2009–10 weighted average)	Burden of government regulation (2009–10 weighted average)	Efficiency of legal framework (2009–10 weighted average)
Czech Republic	8	15	3.9	2.7	3.3
Denmark	4	6	5.7	3.8	5.2
Germany	9	18	5.7	3.0	5.3
Latvia	5	16	3.6	3.1	2.8
Poland	6	32	3.7	2.7	3.1
Sweden	3	15	6.2	4.0	5.8
UK	6	13	5.5	3.1	4.9

Source: World Economic Forum (2010)

The table shows us that all three post-Communist countries compared here perform quite poorly on intellectual property protection and the efficiency of the legal framework compared to Germany. However, they are quite competitive compared to Germany in terms of the number of procedures required to start a business. In Poland's case this unfortunately does not translate into speed, as time required to start a business in Poland is much longer than in the other three countries. The regulatory burden is considered to be very similar in all four countries.

2.3. Performance of the Polish NIS

We will use a number of data sources here to provide a picture of the innovativeness of Polish firms, in particular small and medium-sized ones.

The CSO periodically carries out survey research on the innovativeness of Polish manufacturing firms. For the period 1994-1996, 37.6% of firms researched declared that they were engaged in innovation (Central Statistical Office, 1998), meaning that they designed or introduced a new or significantly improved product or process.[4] In 2003 39.3% of surveyed

[4] New, that is, for the given firm, but not necessarily for the country or the world.

manufacturing firms with at least 50 employees declared themselves to be engaged in such innovation (Central Statistical Office, 2005). As we see in table 8, this percentage had fallen by about 10 percentage points by the time of the 2006-2008 Community Innovation Survey.

If we consider the breakdown by business size, CSO research consistently shows the percentage of large firms which are innovative to be much higher than in the case of SMEs: it is well over half in the case of the former, but under 20% for small businesses (Central Statistical Office, 1998; Wojnicka, 2011). Looking at developments over time, we observe that for medium-sized manufacturers, the share of innovative firms fell from 40.0% in 2002-2004 to 37.4% in 2004-2006 and 32.7% in 2006-2008; for large businesses, it fell from 67% in 2002-2004 to 65.5% in 2004-2006 and 60.7% in 2006-2008. The record was more mixed for small businesses, where the percentage fell from 17% in 2002-2004 to 13.7% in 2004-2006 but then rose to 14.6% in 2006-2008 (Wojnicka, 2011).

The industries with the highest rates of innovative firms are, for the most part, oligopolistic ones such as tobacco, chemicals, coke and oil refining. Similarly, the highest rates of innovative firms (over 50%) are found in state sector (though this seems to be falling strongly, from 56% in 2002 to 51% in 2003). The rate is also higher in foreign-owned firms (47%) than private domestically-owned firms (35%). Geographically, innovation is strongly concentrated in the areas around Warsaw and Poznan and in Upper Silesia (out of Poland's 16 regions or voivodeships, over half of innovation-related spending was made in these three regions in 2003) (Central Statistical Office, 2005).

Table 8. Innovativeness of enterprises

	Innovative enterprises* as % of total enterprises (2006-2008)	Innovation expenditures as % of total turnover (2006-2008)	Patent applications to EPO (per million inhabitants) (2007)	High tech sector** value added (% of GDP) (2007)	Royalty and license fee receipts (% of GDP) (2007)
Poland	28	2.23	3.82	4.00	0.02
Czech Republic	56	2.11	15.78	5.21	0.02
Latvia	24	2.43	8.40	na	0.04
Germany	80	2.36	290.70	6.05	0.24

* Introducing new or improved products or processes
** High tech industries and knowledge intensive services
Sources: World Bank for royalty and license fee receipts; otherwise Eurostat

As we see in the international comparison contained in table 8, the starkest contrasts are observed with respect to the percentages of enterprises introducing new or improved

products or processes; only 24-28% of Polish and Latvian firms did this in 2006-2008, compared to 56% of Czech firms and 80% of German firms.

Consistently with the much better level of intellectual property protection in Germany, that country is the source of many more patent applications per million inhabitants, and generates much more royalty and license fee receipts as a share of GDP, than the three post-communist countries. Poland generates the fewest patent applications per capita in the group. (As we can see from Table A6 in the Appendix, in 2004-2006, 4.1% of firms with at least 50 employees filed at least one patent application, and 0.8% of those with over 9 employees did so.)

Another measure of the performance of the NIS is on the input side – spending on innovation and R&D. Table 8 shows that spending on innovation as a percentage of turnover is comparable across all four countries (although, as we will see, this probably masks differences in the composition of this spending, with the proportion spent on, e.g., R&D, varying greatly across countries). As we can see in Table 9, Polish GERD as a percentage of GDP is low (under 1%). More importantly, the table also shows us that the share of business in R&D spending (BERD) is very low (below one third). This is typical for less developed countries with low shares of R&D spending in GDP, but in countries which are world leaders in R&D expenditure (e.g., Japan, the USA, Sweden, and Finland), the proportions are reversed, with the share of industry in R&D spending around two thirds and that of government around one third (as we can see in the table, both Germany and the Czech Republic conform to the advanced country pattern, while Poland and Latvia conform to the developing country pattern). The table shows that both Germany and the Czech Republic perform much better than Poland, which is more comparable to Latvia.

Table 9. Gross and Business Expenditures on R&D (% of GDP), 2007

Country	GERD/GDP (%)	BERD/GDP (%)	BERD/GERD
Poland	0.57	0.17	0.30
Latvia	0.59	0.19	0.32
Czech Republic	1.54	0.95	0.62
Germany	2.53	1.77	0.70

Source: Eurostat

Table 10 shows that Poland is not only one of the lowest-spending countries in the OECD and the European Union in terms of GERD/GDP, but (more importantly) it has shown a declining trend over much of the last two decades. A low rate of R&D spending can be expected given the relatively low general level of development and the dominance of

traditional industries in Polish manufacturing5, which necessitates the prioritization of investment in modernization of production equipment rather than new product development. But as the economy modernizes and firms gradually increase their innovation capabilities, the share of R&D spending in GDP should rise, and precisely the opposite is happening in Poland. By contrast, if we look at other countries with low GERD to GDP ratios, we see a significant improvement in the Czech Republic in the same period (from 1.20% to 1.42%), and note that such laggard countries as Portugal and Turkey, while also experiencing stagnation in the 2000s, saw enormous improvements in the late 1990s, when Poland was also experiencing stagnation. Studies for the 1990s (e.g., Radosevic, 1999) found that innovation expenditures in ECE companies tended to cover the purchase of embodied technology, patents and licenses more frequently, and spending on R&D less frequently, than in their EU counterparts. The slow pace of modernization in Poland is illustrated by the findings of Instytut Badań Strukturalnych (2011), based on the Community Innovation Survey 2008, that this situation has continued well into the 2000s.

Table 10. GERD as % of GDP in the OECD, 1995-2005

	1995	2001	2005
Czech Republic	0.95	1.20	1.42
Finland	2.26	3.30	3.48
Germany	2.19	2.46	2.51
Poland	0.63	0.62	0.57
Portugal	0.54	0.80	0.81
Slovakia	0.92	0.63	0.51
South Korea	2.37	2.59	2.99
Sweden	3.32	4.25	3.86
Turkey	0.38	0.72	0.67*
United States	2.51	2.76	2.68*
EU-25	1.69	1.79	1.77
Total OECD	2.07	2.27	2.25*

*2004 value
Source: OECD, Main Science and Technology Indicators, December 2006

The share of R&D spending in total innovation-related expenditures is relatively low in Poland. It was only 11.1% in 2003, whereas, for example, innovation-related investments in buildings, machinery and equipment represented 78.9% of total innovation-related expenditures (Central Statistical Office, 2005). In the old European Union member states, on the average, over 60% of innovation-related spending goes to R&D activity, while innovation-related purchases of machinery and equipment represent under 10% of such expenditures.6

[5] For example, furniture is Poland's largest export industry.
[6] 1996 data based on Eurostat (2001).

In Poland, the share of R&D spending in innovation-related spending was higher in the public sector than in the private sector (13.0% and 10.8%, respectively) and much higher in companies with over 500 employees, where it was about 15%, than in SMEs, where it ranged between roughly 5% and 7% (Central Statistical Office, 2005).

There is some evidence that this situation is finally beginning to improve. CSO data show that in 2008 GERD edged up to 0.61% of GDP, which means that the increase in R&D spending in Poland in that period was higher than the country's high economic growth rate, and in the same period the percentage of GERD generated by businesses also rose (Wojnicka, 2011).

3. Knowledge-Intensive Entrepreneurship in Poland

We now turn to an examination of KIE in Poland. We will first provide a brief overview of SMEs in Poland with respect to new firm creation and survival as well as the education of the firms' founders. We then provide a comparative analysis of a number of KIE indicators, again using the Czech Republic, Germany and Latvia as points for comparison.

3.1. The SME sector in Poland

As Ubreziová and Wach (2010) note, the number of SMEs (i.e., firms with under 250 employees) in Poland grew from just under half a million at the beginning of the 1990s to about 2.5 million by 1997. But as we can see from Table 11, the situation in Poland has stabilized more recently (while Latvia, as of 2007, still had a high rate of new firm creation). By 2007, the number of SMEs was estimated at approximately 3.7 million (Ubreziová and Wach, 2010).

Table 11. New business creation and survival in four countries (2007)

	Net entry rate (net business population growth)	Five-year survival rate	5-year old enterprises' share of the business population (2007)
Poland	0.03	24.60	3.95
Czech Republic	-1.08	37.23	3.85
Latvia	6.22	37.86	5.58
Germany	0.90	na	na

Source: Eurostat Business Demography

However, strength in numbers of business startups does not translate into strength of Knowledge-Intensive Entrepreneurship. One problem for KIE in Poland is related to the skill base of Poland's entrepreneurs. According to PARP (2004), only about a quarter of Poland's new firms are founded by persons with higher education. Table 12 compares the educational attainment of Polish entrepreneurs with those from other EU New Member States for the period 1995-2000; we can see that Poland is performing below average in this group. Moreover, if we compare with Figure 1 in Section 2.2, we see that the percentage of Polish entrepreneurs with higher education is little higher than that for the general population in the 25-34 age group. If we narrow the focus to Poland's knowledge-intensive firms, research has shown the CEOs of those firms to much better educated than the average Polish entrepreneur; 96% of CEOs in a sample of 304 knowledge-intensive companies from six countries (including Croatia, the Czech Republic, Lithuania, Hungary, Poland, and Romania) had at least the equivalent of a bachelor's degree, and the figure was over 90% in Poland (Radosevic et al., 2010). However, KIE can be considered marginal against the backdrop of Polish entrepreneurship as a whole, and the general picture of entrepreneurship in Poland is one that is hardly flattering with regard to its knowledge intensity. And some studies show that even the more knowledge-based among Poland's entrepreneurial firms have important weaknesses. Kordel et al. (2010), for example, find that only one in eight Polish SMEs in their sample corresponds to their definition of an intelligent organization by meeting four criteria: possession of a formalized strategy; possession of a formalized personnel policy which covers the development of employees; the use of IT applications in management (47% of the sample met this criterion), and the exchange of knowledge with external partners (38% do this). Less than a third of the sample had formalized strategy and personnel policy documents. The authors find that companies that do meet all four criteria were much more successful at increasing revenues and employment. Similarly, Plawgo and Kornecki (2010) find that Polish SMEs with more educated managers are more competitive and innovative, able to increase their market share even during the ongoing economic downturn. However, Polish SMEs suffer from lack of leadership skills and a low level of ability to develop formal strategies and motivate employees. Worryingly, more than half of firms in the sector do not train either their employees or their managers.

Table 12. New enterprises whose founders have post-secondary and university education

Country	1995	1996	1997	1998	1999	2000	Average, 1995-2000
Bulgaria	39.4	36.8	29.6	27.4	33.7	40.8	34.6
Czech Rep.	15.0	17.3	22.5	12.9	17.9	18.1	17.3
Estonia	38.0	43.7	43.9	42.9	42.2	41.2	42.0
Hungary	30.2	33.7	32.0	38.8	36.7	38.2	34.9
Latvia	42.7	42.7	43.8	46.6	27.3	25.4	38.1
Lithuania	36.2	36.4	37.4	32.8	34.1	36.1	35.5
Poland	29.9	23.8	23.2	24.8	23.3	30.2	25.9
Romania	21.2	24.5	27.2	28.7	19.9	24.8	24.4
Slovakia	35.6	32.5	30.0	27.3	18.0	22.4	27.6
Slovenia	11.9	12.5	20.6	40.5	27.0	25.6	23.0
ECE total	27.9	26.2	25.6	25.6	24.7	29.5	26.6

Source: Commission (2002)

3.2. Knowledge-Intensive Entrepreneurship in Poland: A comparative perspective

Radosevic and Yoruk (2011) have constructed a composite Index of Knowledge Intensive Entrepreneurship (IKIE), defined as:

$$IKIE=NE+NTI+KI$$

where NE is an indicator for New Enterprises, NTI an indicator for New Technology and Innovations, and KI an indicator for Knowledge Intensity.

In this section we will compare Poland's score on the IKIE and its components with those of a number of other countries (table 13). These include the countries we have been using for comparison earlier – the Czech Republic, Denmark, Germany, Latvia, Sweden, and the United Kingdom – as well as three other countries that are interesting as benchmarks for the post-Communist countries (Estonia, Hungary, and Slovenia) and one that is a benchmark for all of Europe and indeed the OECD (Finland).

Overall, we observe the highest IKIE indicator values for the Nordic countries (between 57 and 72) and Germany (60). After these come our post-Communist benchmark countries, Estonia and Slovenia, as well as the United Kingdom (values between 41 and 47). The Czech Republic, Hungary, and Latvia all have values between 31 and 38, and Poland is bringing up the rear with a score of 24. What can we learn from the individual components about why some countries perform better than others and Poland – at least in this group of countries – performs worst of all?

Poland is the poorest performer on the New Enterprise component, the third worst (after Hungary and Latvia) on New Technology and Innovations, and the worst on Knowledge Intensity. So its performance is quite uniformly poor. If we look across the individual components, there are relatively few surprises, with the countries' positions being overall quite similar to those for the overall IKIE score. If we look at the New Enterprise component, the relatively surprising result is the high place of Estonia (first place). Latvia, in fifth place, is also quite entrepreneurial (Estonia and Latvia have the highest entry rates; we note that these are pre-crisis data). Apart from Finland, the Nordic countries are not distinguished by their entrepreneurship, and make up for this with their performance on other components; the same is true for Germany. The Czech Republic is only slightly better than Poland.

Sweden, Finland and Germany are all found in the top four for both New Technology and Innovation and Knowledge Intensity. Estonia does much worse on Knowledge Intensity than on New Technology and Innovation, which seems to indicate that Estonian innovators do not tend to own patents. The reverse is true of the UK. For Knowledge Intensity, there is a clear east-west divide, with all the western countries in the top four and all the post-communist countries in the bottom seven, clearly indicating differences with respect to patenting practices.

Table 13. Composite Index of Knowledge Intensive Entrepreneurship (IKIE) and its components

Country	NE (New Enterprises), 2007					NTI (New Technology and Innovations), 2006-2008			KI (Knowledge Intensity), 2007				IKIE
	Net entry rate (net business population growth), %	5- year-old enterprises' employment growth rate, %	5-year survival rate, %	5-year-old enterprises' share of business population	NE	Innovative enterprises as % of total	Innovation expenditures as % of turnover	NTI	Patent applications to EPO (per million inhabitants)	Royalty and license fee receipts (% of GDP)	Value added in high-tech industries and knowledge intensive services (% of GDP)	KI	
Czech Republic	-1.08	77.87	37.23	3.85	12.89	56	2.11	15.93	15.78	0.02	5.21	5.16	33.99
Denmark	2.83	107.88	48	4.29	18.32	52	3.3	19.89	194.05	0.63	5.77	19.28	57.49
Estonia	7.79	136.08	51.42	4.41	22.97	56	3.02	20.03	17.42	0.05	na	4.70	47.70
Finland	3.91	199.33	47.17	3.14	21.28	52	3.37	20.30	250.76	0.52	8.71	25.25	66.82
Germany	0.9	na	na	na	16.41	80	2.36	24.16	290.7	0.24	6.05	19.22	59.79
Hungary	-1.57	60.5	46.32	6.9	16.71	29	1.81	6.47	17.15	0.66	6.6	14.41	37.59
Latvia	6.22	74.75	37.86	5.58	19.19	24	2.43	7.79	8.4	0.04	na	4.45	31.43
Poland	0.03		24.6	3.95	12.85	28	2.23	8.01	3.82	0.02	4	2.69	23.56
Slovenia	4.59	116.04	62.89	3.93	21.13	50	1.83	12.98	51.47	0.04	5.87	7.84	41.96
Sweden	2.6	52.17	64.28	3.4	16.84	54	4.45	25.48	298.36	1.05	6.85	29.43	71.75
UK	4.21	42.23*	43.91	4.48	16.09	46	1.40**	9.69	89.16	0.54	7.65	17.59	43.37

* 2006 value

** 2004 value

Sources: Eurostat Business Demography for NE components; Eurostat (Community Innovation Survey) for NTI components; Eurostat for patent applications and high-tech value added; World Bank for royalty and license fee receipts; NE, NTI and KI indicators calculated by Radosevic and Yoruk (2011).

4. Conclusions

Reviewing the main trends discussed with respect to Poland's NIS and conditions for KIE, we have observed the following:

- With respect to the indices developed by Radosevic and Yoruk (2011) for knowledge intensive entrepreneurial opportunities and knowledge intensive entrepreneurship, Poland's performance is very poor for both indices and for all of their constituent components. However, looking at other aspects of our analysis, we can observe a few trends which give cause for optimism about the future.
- The European Union plays a greater role than the national government, and a much greater role than local government, in supporting innovation-related activity financially.
- Accordingly, EU accession has stimulated the prioritization of KIE-related issues by the government, which has been very low in the past.
- Polish firms collaborate with other firms and institutions significantly less frequently than not only Western European firms, but also in comparison with firms from the Czech Republic. Like firms throughout Europe, Polish firms find their partners in the innovation process mostly in the supply chain (e.g., suppliers and customers), but the S&T sector plays a non-negligible role, with the importance of universities increasing (however, problems remain with the state-owned industrial R&D institutes). Moreover, the examination of firms' partners reveals an extensive degree of internationalization of the innovation process.
- The level of activity of venture capitalists seems to be fairly high in Poland considering the relatively low degree of development of capital markets offering VC investors exit opportunities.
- After almost two decades of decline in the share of R&D spending in GDP, there are signs that this is beginning to rise, and that businesses are beginning to spend more on R&D. In spite of this, the percentage of firms stating that they have recently introduced product or process innovations is low and falling.
- Demand-side problems continue to be significant barriers for the development of KIE, due to the relatively low level of education and GDP per capita in the

country. However, the trends here are optimistic, with high rates of economic growth and improvements in the level of education of younger generations.

- The Polish business environment can largely be characterized as lying within the European norm, except with respect to the area of intellectual property protection, where significant improvement is needed. This may be a general characteristic of the eastern member states of the EU, as a comparison of patenting activity shows a clear east-west divide in this respect.

References

Aidis, R. (2005), Institutional Barriers to Small- and Medium-Sized Enterprise Operations in Transition Countries. *Small Business Economics* 25(4): 305-317.

Aidis, R. & Adachi, Y. (2007) Russia: Firm entry and survival barriers. *Economic Systems* 31(4): 391-411.

Aidis, R., Estrin, S., & Mickiewicz, T. (2008), Institutions and entrepreneurship development in Russia: A comparative perspective. *Journal of Business Venturing* 23(6): 656-672.

Aidis, R., Estrin, S., & Mickiewicz, T. (2010) Institutions, Finance and the Level of Development: the Impact on Entrepreneurship in Transition. *Review of Economics and Institutions* 1(1): 1-26.

Balcerowicz, E. (ed.) (2002), *Mikroprzedsiębiorstwa: Sytuacja ekonomiczna, finansowanie, właściciele*, Warsaw: CASE.

Central Statistical Office (Główny Urząd Statystyczny) (1998), *Działalność innowacyjna przedsiębiorstw w latach 1994 – 1996 (The innovative activity of enterprises, 1994-1996)*, Warsaw: Zakład Wydawnictw Statystycznych.

Central Statistical Office (Główny Urząd Statystyczny) (2005), *Nauka i technika w 2003 r. (Science and technology in 2003)*, Warsaw.

Cieślik, J. (2011), *Internacjonalizacja młodych innowacyjnych firm* (The internationalization of young innovative firms), Warsaw: PARP.

Commission of the European Communities (2002), *New enterprises and development of enterprises in Central European Countries: Data 1995-2001*, Luxembourg: Office for Official Publications of the European Communities

Eurostat Press Office (2007), Fourth Community Innovation Survey: More than 40% of EU27 enterprises are active in innovation (press release, 22 February). Available at http://europa.eu/rapid/pressReleasesAction.do?reference=STAT/07/27&format=HTML&aged=0&la??, last accessed 8 October 2011.

Finnish National Board of Education (2005), *Quantitative Educational Indicators* (amgali.pangea.org/finlandia/International_comparisons_Finland.pdf).

Gella, A. (1971), The Life and Death of the Old Polish Intelligentsia, in *Slavic Review* 30(1), 1-27.

Górzyński, M., Woodward, R., eds. (2003), *Innowacyjność polskiej gospodarki* (Innovativeness of the Polish economy). Warsaw: CASE. Chapter one: Finansowanie innowacynych MSP – czy pieniadze i innowacyjne idee spotykaja sie w Polsce? (The financing of innovative SMEs – do money and innovative ideas meet in Poland?)

Górzyński, M., Jakubiak, M., Woodward, R. (2006), Key challenges to the development of the knowledge-based economy in Poland, in Piech, K., and Radosevic, S. (eds.), *The Knowledge-based Economy in Central and Eastern Europe: Countries and Industries in a Process of Change*. Basingstoke: Palgrave Macmillan.

Hoshi, I., Balcerowicz, E., Balcerowicz, L. (2003), *Barriers to entry and growth of new firms in early transition: a comparative study of Poland, Hungary, Czech Republic, Albania, and Lithuania*, Boston: Kluwer.

Innovative Economy Programme web site (http://www.poig.gov.pl/WstepDoFunduszyEuropejskich/Strony/o_poig.aspx); accessed 18.05.2011.

Instytut Badań Strukturalnych (2011), Innovation Diagnostics in Poland, Warsaw.

Kordel, P., Kornecki, J., Kowalczyk, A., Krawczyk, K., Pylak, K., Wiktorowicz, J. (2010), *Inteligentne organizacje – zarządzanie wiedzą i kompetencjami pracowników* (Intelligent organizations: Managing the knowledge and competencies of employees), Warsaw: PARP.

Kraslawski, A., M. Gajewski (2000), *Development of a National and Regional Innovation System for Poland*. CNA Veneto Euro-In Consulting, Danish Technological Institute, and Uniconsult. Prepared for the Phare Sci-Tech II Programme (Phare PL96.11.02.05).

Krzemiński, J. (2002), Pieniądze ma dzielić minister (The minister is to divide up the money). *Rzeczpospolita*, 16 October 2002.

Kubielas, S. (2006), The Polish economy between transition and knowledge-based growth: From Ricardian success to Schumpeterian decline, in Piech, K., and Radosevic, S. (eds.), *The Knowledge-based Economy in Central and Eastern Europe: Countries and Industries in a Process of Change*. Basingstoke: Palgrave Macmillan.

Lundvall, B-Å. (ed.) (1992). *National Innovation Systems: Towards a Theory of Innovation and Interactive Learning*, London: Pinter.

Malerba, F. (2002), Sectoral systems of innovation and production. *Research Policy* 31(2): 247-264.

Malerba, F. (2010). Knowledge-intensive entrepreneurship and innovation systems in Europe, in F. Malerba (ed.), *Knowledge-Intensive Entrepreneurship and Innovation Systems: Evidence from Europe*. London: Routledge.

McDermott, G.A. (2002), *Embedded Politics: Industrial Networks and Institutional Change in Postcommunism*. Ann Arbor: University of Michigan Press.

National Bank of Poland (2005), *Sytuacja na rynku kredytowym: Wyniki ankiety do przewodniczących komitetów kredytowych, IV kwartał 2005* (Situation on the credit market: Results of a survey of credit committee chairpersons, 4th quarter 2005). October. Warsaw.

Nelson, R. (ed.) (1993), *National Innovation Systems: A Comparative Analysis*, New York/Oxford: Oxford University Press.

Osiecki, A. (2010), Ostatnie dotacje dla firm (Last subsidies for firms), *Rzeczpospolita*, 21 December 2010.

PARP (2004), *Raport o stanie sektora małych i średnich przedsiębiorstw w Polsce w latach 2002-2003*, Warsaw: Polska Agencja Rozwoju Przedsiębiorczości.

Plawgo, B., Kornecki J. (2010), *Wykształcenie pracowników a pozycja konkurencyjna przedsiębiorstwa* (The education of employees and the competitive position of the enterprise). Warsaw: PARP.

PricewaterhouseCoopers (2002), *Money for Growth – The European Technology Investment Report 2001*, London: PricewaterhouseCoopers.

Quevit, M. (1997), "Główne instrumenty wspierania innowacji technologicznych w kontekście restrukturyzacji polskiej gospodarki. Priorytety i testy ewaluacyjne istniejących instrumentów (Chief instruments for supporting technological innovations in the context of the restructuring of the Polish economy: Priorities and tests for evaluating existing instruments)," in T. Markowski, E. Stawasz, R. Zembaczyński (eds.), *Instrumenty transferu technologii i pobudzania innowacji: Wybór ekspertyz (Instruments of technology transfer and innovation stimulation: Selected papers)*. Warsaw: Zespół Zadaniowy ds. Polityki Strukturalnej w Polsce.

Radosevic, S. (1999), Patterns of innovative activities in countries of Central and Eastern Europe: An analysis based on comparison of innovation surveys. SPRU Electronic Working Papers No. 35, Brighton: University of Sussex.

Radosevic, S. (2004), What Future for Science and Technology in Central and Eastern Europe in the 21st Century? In W. Meske (ed.), *From System Transformation To European Integration: Science And Technology in Central and Eastern Europe at the Beginning of the 21st Century*, Münster-Hamburg-Berlin-Vienna-London: Lit Verlag.

Radosevic, S., Savic, M., Woodward, R. (2010), Knowledge-intensive entrepreneurship in Central and Eastern Europe: Results of a firm-level survey, in F. Malerba (ed.), *Knowledge-Intensive Entrepreneurship and Innovation Systems: Evidence from Europe*. London: Routledge.

Radosevic, S., and Yoruk, E. (2011), Entrepreneurial Propensity of Innovation Systems: A Preliminary Analysis with Composite Indexes in EU Countries. Paper presented at DIME Workshop on Regional Innovation and Growth: Theory, Empirics and Policy Analysis. University of Pecs, Hungary, 31 March-1 April 2011. Paper available at http://www.krti.ktk.pte.hu/index.php?p=contents&cid=76 (last accessed 14 October, 2011).

Rhodes, R. (2002), *Masters of Death: The SS-Einsatzgruppen and the Invention of the Holocaust*, New York: Alfred A. Knopf.

Rossino, A.B. (2003), *Hitler Strikes Poland: Blitzkrieg, Ideology, and Atrocity*, Lawrence, Kansas: University Press of Kansas.

Ubreziová, I., Wach, K. (2010), Role of small and medium-sized enterprises in economies of Poland and Slovakia - comparative analysis. *Argumenta Oeconomica Cracoviensia* 2010, no. 6, pp. 69-85. Available at http://mpra.ub.uni-muenchen.de/31594/ (last accessed 9 October 2011).

Wojnicka, E. (2011), Innovation dilemmas of Polish businesses, *Polish Market* 3(176).

Woodward, R. (2001), SME support in post-communist countries: moving from individual to cooperative approaches (Reflections on the Polish case), *MOCT-MOST: Economic Policy in Transitional Economies* 113: 275-294.

Woodward, R., Yörük, D.E., Koć, P. Pander, W. (2010), Knowledge-based entrepreneurship in Poland. CASE Network Studies & Analyses No. 408/2010. Warsaw: Center for Social and Economic Research.

Woodward, R., Yörük, D.E., Radosevic, S. (2011), Knowledge based firms from Central and East European countries: A comparative overview of case studies. CASE Network Studies & Analyses No. 428/2011. Warsaw: Center for Social and Economic Research.

World Economic Forum (2010), *The Global Competitiveness Report 2010-2011*. Geneva.

Appendix

Note: Figures in Tables A1-A4 refer to the number of firms indicating cooperation with a given type of partner.

Table A1.1 Types of firms with which firms cooperated in innovative activity, early 2000s

	Firms belonging to the same group								Suppliers								Customers							
	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Japan	Other countries	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Japan	Other countries	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Japan	Other countries
Firms with over 9 employees (2001-2003)	899	602	413	312	80	148	21	92	903	761	350	278	126	189	69	79	454	416	175	146	48	25	5	32
Firms with over 49 employees (2002-2004)	607	241	442	382	42	54	na	25	1466	1189	683	620	60	63	na	56	954	756	504	442	92	66	na	78

* - Croatia and Turkey
Source: CSO

Table A1.2. Types of firms with which firms cooperated in innovative activity, early 2000s (continued)

	Competitors and other firms								Consulting firms							
	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Japan	Other countries	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Japan	Other countries
Firms with over 9 employees (2001-2003)	285	189	132	119	16	82	5	11	266	251	77	65	5	10	-	1
Firms with over 49 employees (2002-2004)	424	338	190	166	33	22	na	28	487	422	133	121	8	12	na	5

* - Croatia and Turkey
Source: CSO

Table A2. Types of non-commercial partners with which firms cooperated in innovative activity, early 2000s

	Units of the Polish Academy of Sciences	R&D institutes	Foreign public sector institutions								Institutions of higher education							
			Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Japan	Other countries	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Japan	Other countries
Firms with over 9 employees (2001-2003)	72	317	188	144	94	74	38	23	14	32	185	183	37	28	10	16	3	17
Firms with over 49 employees (2002-2004)	105	443	77	23	59	42	6	7	na	10	512	510	12	9	-	-	na	3

* - Croatia and Turkey
Source: CSO

Table A3.1. Types of firms with which firms cooperated in innovative activity, 2006-2008

	Firms belonging to the same group							Suppliers							Customers						
	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Other countries	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Other countries	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Other countries
Firms with over 49 employees	593	283	404	369	59	18	48	1393	1189	763	712	106	73	84	949	807	554	535	80	28	110
Firms with over 9 employees	402	183	263	246	73	30	35	1143	999	358	323	101	50	21	726	697	177	174	36	13	71

* - Croatia and Turkey
Source: CSO

Table A3.2. Types of firms with which firms cooperated in innovative activity, 2006-2008 (continued)

	Competitors and other firms							Consulting firms						
	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Other countries	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Other countries
Firms with over 49 employees	504	400	262	244	35	27	42	559	487	168	163	15	2	10
Firms with over 9 employees	478	441	94	81	16	9	17	438	407	89	78	7	7	1

* - Croatia and Turkey
Source: CSO

Table A4. Types of non-commercial partners with which firms cooperated in innovative activity, 2006-2008

	Units of the Polish Academy of Sciences	R&D institutes	Foreign public sector institutions							Institutions of higher education						
			Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Other countries	Total	Poland	Foreign	EU & EFTA countries	EU candidate countries*	USA	Other countries
Firms with over 49 employees	134	458	121	53	78	70	12	1	8	653	646	23	18	1	-	7
Firms with over 9 employees	93	162	88	47	44	39	7	4	1	258	244	27	15	3	-	9

* - Croatia and Turkey
Source: CSO

Table A5. Firms that received public financial assistance for innovation-related activity, by source

	2004-2006					2006-2008				
	Total	From local authorities	From central authorities	From EU	6th Framework Program	Total	From local authorities	From central authorities	From EU	6th or 7th Framework Program
Firms with over 49 employees	11.9%	1.6%	4.1%	8.3%	0.9%	9.7%	1.5%	3.6%	6.4%	1.4%
Firms with over 9 employees	3.2%	0.4%	0.5%	2.6%	0.3%	1.4%	0.3%	0.3%	0.8%	0.2%

Source: Own calculation based on CSO data

Table A6. Firms that submitted patent applications, 2004-2006 (% of all firms reporting to Central Statistical Office)

Firms with over 49 employees	4.1%
Firms with over 9 employees	0.8%

Source: Own calculation based on CSO data