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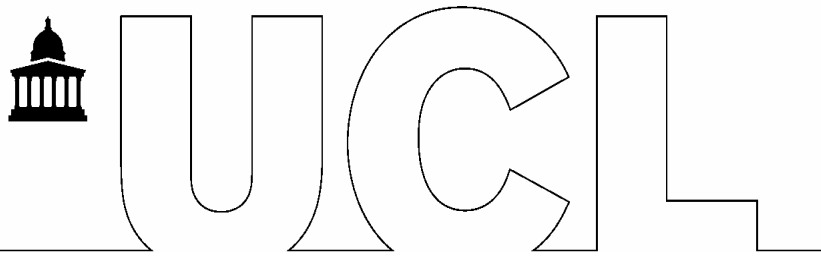

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GROWTH, INTEGRATION AND SPILLOVERS IN THE CENTRAL AND EAST EUROPEAN SOFTWARE INDUSTRY

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SUMMARY

This paper explores growth and competitive advantage in CEE software firms; it looks at the role of strategic partnerships and industry (spillover) effects. The empirical analysis is based on survey data from 224 software firms from six CEE countries (Bulgaria, Czech R, Estonia, Serbia, Slovenia, Romania). The results of the descriptive analysis are interpreted from the perspective of the role of capabilities in industrial development. The analysis shows that the patterns of growth are a mix of sector, region and sub--region specific determinants and show important national differences. This suggests that the CEE software industry cannot be considered as a homogenous phenomenon. There is no general tendency towards an expansion in exports; based on our sample only Romania is developing an export oriented software industry.

Research shows that the CEE software industry is populated by young, dedicated, domestic firms, which are independent, and privately owned and which are mainly oriented towards localisation of software. They are strongly dependent for trade and production on alliances and strategic partnerships with foreign partners and a small share of technology based partnerships. There is an extensive process of industry upgrading underway, involving country and sub-region specific changes. The spillover effects are significant, through links with clients and intensive intra-industry knowledge transfer through high employment turnover and potentially high knowledge transfer from foreign to local projects. Differences between central and eastern Europe are strong in terms of degree of diversification of software supply, industrial upgrading and quality of demand.

The pattern of software development in CEE differs from that in other emerging markets in the sense that it is domestic market oriented, but with an emerging export market for services. Its further growth and upgrading will be strongly dependent on the acquisition of organisational capabilities by local firms.

INTRODUCTION

There are several factors that suggest that the software industry may be important in the globalization and industrial upgrading of Central and Eastern Europe (CEE). Low barriers to entry, relatively strong human capital base, opportunities for knowledge spillovers between exports and local production, and the infrastructural importance of software in a knowledge-based economy suggest that the software industry may be a driver of growth and catch-up. However, the CEE countries are not a major software industry location and this industry still ranks quite low in terms of economic importance.
Compared to other emerging markets little is known about the software industry in CEE. While several systematic academic accounts of the software industries in other emerging markets exist (for recent contributions see Commander, 2005; Arora and Gambardella, 2005), there have been few detailed studies of the software industry in CEE beyond consultancy and business circles. Where does CEE stand in relation to other emerging software industry markets? What is the potential of the CEE software industry to facilitate growth and catch up in these economies? Such issues, which are the motivation for this paper, require an understanding which goes beyond case studies or aggregate data available from EITO reports.

This paper addresses three key issues. First, it explores growth and competitive advantage in CEE software firms. Second, it analyses the role of strategic partnerships in the growth of these firms. Third, it explores industry or spillover effects. The analysis is based on data from a survey of 224 firms from six CEE countries. This is the first comprehensive output of the survey and reports the results of a descriptive analysis[1].

The paper is structured as follows. First, we discuss broad context and perspective within which this research falls. Second, we describe the database and methodology. Second, we report key results under three main headings: growth and competitive advantage of the CEE software firms; strategic partnerships of CEE software firms; and industry effects. The paper concludes with a summary of the key findings and a comparison with other emerging markets.

1. SOFTWARE, INTEGRATION AND GROWTH IN GLOBALIZED ECONOMY

The software industry activities in CEE feed into the broader activities that constitute the global software industry. In this section we briefly highlight the context within which growth and integration of the CEE software industry takes place.

The software industry is a very young industry whose growth as an independent industry sector has been driven by the confluence of several trends: separation of hardware from software (Campbell-Kelly, 1995), increasing accessibility of high speed telecommunications links for collaborative working processes across remote locations (Friedman, 2006), and increasing incentives for outsourcing software tasks driven by liberalization and large international differences in the labour costs for software engineers.

[1] The research will be extended by exploring data based on several regression and multivariate models.

These developments have enabled production in software to be increasingly organized as a set of discrete processes or steps, which can be undertaken in different parts of the world. Given the advancements in telecommunications technology and transportation, these production activities in principle could be located just about anywhere. However, in reality the choice of location depends on a number of factors including resource availability, cost and infrastructure (Lateef, 1996). Activities that are most likely to be located off shore are software design, programming (software development based on general guidelines or exact specifications), testing, and maintenance, including troubleshooting, upgrading and improving.

The pronounced human capital intensity of software coupled with relatively low capital requirements represents a window of opportunity for some developing and transition countries to embark on the process of technology accumulation in this sector.

Software is a high tech sector that has developed and expanded outside the core of the advanced economies of North America, the European Union (EU) and Japan. India, Ireland and Israel, countries that are very different in many respects, including size and stage of development, are examples of locations that appear to have benefited from this opportunity (Arora and Gambardella, 2004; Giarratana et al., 2003; Arora et al., 2001). The emergence of China and Russia as important exporters of software services has further reinforced this trend towards the dispersion of software activities on a global scale.

Factors that are usually cited as explaining this trend include: low barriers to entry, skilled human capital, strong cost advantages, low physical capital requirements and high labour intensity (Commander, 2005). Indeed, in all countries, the software industry could not have got off the ground without strong, prior investment in human capital (ibid). However, these factors alone (cf. human capital) are not sufficient to ensure technological integration and catch up. It seems that sustainability of catch-up in software generally depends on whether local software firms are able to develop organizational capabilities and appropriate business models. These factors lie behind the outstanding growth of the Indian software industry. As Athreye (2004) argues, strong firm capabilities lie behind the growing productivity of the Indian software sector, and the development of such capabilities is very relevant for CEE.

What areas of the software industry are most conducive to new entry? Historical analysis suggests that newcomers have been most successful when security considerations have protected them from US competition, or where local knowledge has differentiated them from US firms (Campbell-Kelly, 1995, p. 102). The success stories broadly conform to this argument, i.e. new entrants have been successful in niche areas requiring specialized capabilities. These can be services (India), R&D based SW products very often defence related (Israel) or low value added localization (Ireland). From the perspective of CEE localization is the major area of opportunity for new entrants . There are fewer entry opportunities in package and product developments, but more in customization and maintenance. Foreign players benefit most from packaged software, which represents one of the fastest growing segments of the ICT market in CEE (PricewaterhouseCoopers, 1999; EITO, 2000). However, as shown in EITO (1999) on the supply side there is a lack of "any kind of long term development of local packaged applications".

Although many developing and transition economies are trying to emulate the successes of the non-G7 economies, there continues to be scepticism about whether software can become an engine of growth. Currently high growth rates are from a very shallow base. Also, software has a low share in GDP (except for the case of India, it is generally less than 1%), it is concentrated spatially and has limited inter-industry linkages (Commander, 2003).

2. DATA, METHODOLOGY AND SAMPLE DESCRIPTION

The data for the analysis in this paper were collected from 224 software firms in six CEE countries (Bulgaria, Czech Republic, Estonia, Serbia, Slovenia, and Romania). The selection of countries was driven by desire to explore the differences across CEE countries at different stages of development and different rates and nature of institutional transformation. Hence, we wanted to include central European (Slovenia, Czech Rep, Estonia) as well as east European (Romania, Bulgaria, Serbia) countries.

Data collection was based on a two-page questionnaire consisting of 25 questions. The small size of the questionnaire was conducive to a high response rate, not typical in academic research. The questions related to three issues: growth and competitive advantage of firms; relationships of firms with foreign partners; and industry related issues, particularly spillovers and demand. The data refer to 2003 and, except in the case of Bulgaria where there are data for 2004, changes are estimated by firms for the five year period 1999- 2003.

The total number of employees in the firms in the sample is 12,980, which represents between 8% and 35% of overall industry employment (Table 1). In this respect, the representativeness of sample is quite good. Share of firms with only one employee ranges from 85% (Czech R) to 45% (Estonia) while our sample does not include such firms. This bias of our sample towards firms with more than 1 employee does not seem to be a problem as we are interested in issues of growth and integration of software firms with at least minimum organisational capabilities.
A questionnaire was sent to a large number of firms based on lists of members of local associations of software firms. Response rates differed across countries and were dependent both on firms' willingness to cooperate and on networking among local experts. We tried to obtain a similar number of responses across countries; the number of actual responses varied from 23 (Slovenia) to 50 (Bulgaria) and partly reflects the sizes of countries[2].

Table 1: Description of sample

	No of firms		No of employees		Representativeness	
	All firms	Sample	All firms	Sample	No of firms	Employees
Slovenia	1892	23	5931	1116	1.2%	18.8%
Czech	23611	34	34514	4775	0.1%	13.8%

[2] We also tried to collect data for Latvia and Hungary but despite several reminders by Email, letters, telephone, we only received six and four responses respectively. These countries had to be dropped from the analysis.

Estonia	738	38	3424	739	5.1%	21.6%
Serbia	509	38	2984	974	7.5%	32.6%
Romania	7316	41	25627	2021	0.6%	7.9%
Bulgaria	2640	50	9535	3355	1.9%	35.2%
Total	36706	224	82015	12980	0.6%	15.8%

Source: Eurostat , http://epp.eurostat.ec.europa.eu/, except for Serbia, National Statistics Office

The software industry is a young industry, and particularly so in CEE where independent software firms mostly did not emerge until the 1990s. The average age of the firms in our sample is 9 years with differences ranging from 6 (Romania and Estonia) to 12 years (Czech Rep) (Table 2). The year of firm establishment and entry to the software industry is fairly similar. The correlation coefficient for year of establishment and year of entry into the software business is 0.99 for most of the countries.[3] Eighty eight per cent of firms are dedicated software firms, i.e. they were initially set up as software businesses. This suggests that these firms have been able to develop new organizational practices and have not been burdened by corporate governance issues i.e. privatisation.

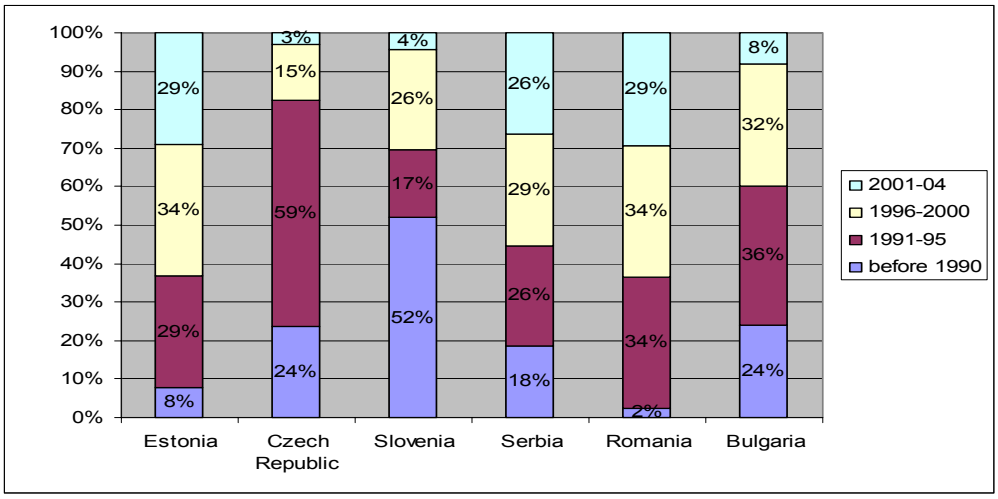
Table 2: Age of firms in software business

	Average	Median
All	9	9
Romania	6	5
Estonia	6	6
Serbia	8	8
Bulgaria	10	10
Slovenia	11	13
Czech R	12	12

Figure 1 shows the distribution of firms by year of establishment. The highest share of pre-1990 firms is in Slovenia (52%), the highest share of early-1990s firms (1991-1995) is in Czech Republic, while youngest firms (established in 2001-2004 period) are in Estonia, Serbia and Romania. Many CEE software firms were set up by IT professionals who previously worked in R&D institutions, or by recent graduates in IT.

Figure 1: Distribution of sample firms by year of establishment

[3] The overall correlation coefficient for the sample is 0.97 which is due to the few firms in Estonia that were established in the socialist period, but which entered into software only in the post-socialist period.



Almost three quarters (73%) of firms are independent, i.e. they are not part of a business group. Inter-country differences in this respect are not significant (see Table 3) except in case of Romania where 37% of firms belong to a business group.

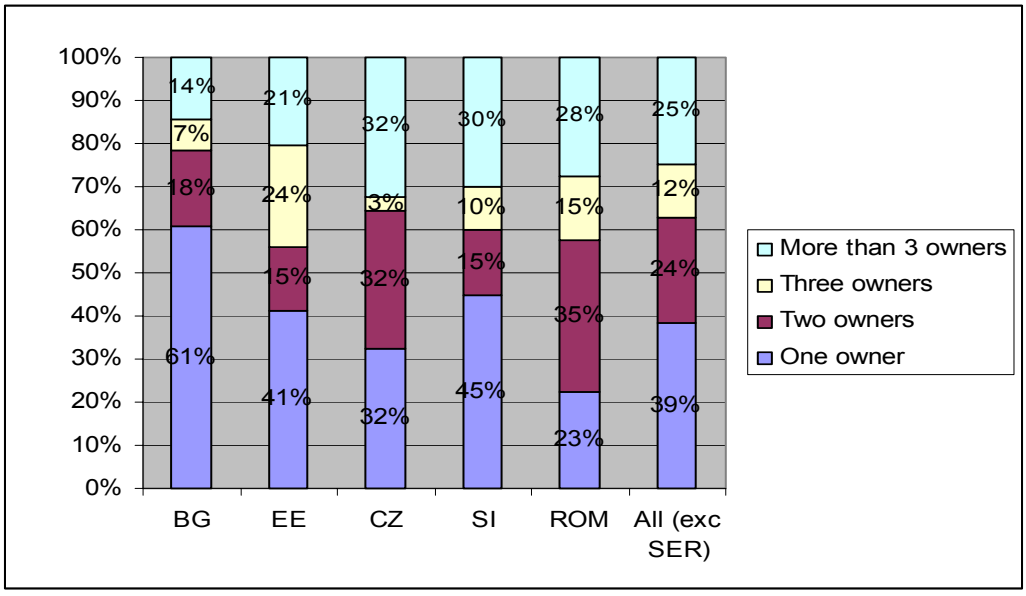
Table 3: A share of firms as part of business group

	Romania	Estonia	Bulgaria	Serbia	Slovenia	Czech R	All countries
Yes	**36.6%**	**27.0%**	**25.0%**	**24.3%**	**23.8%**	**23.5%**	**27.1%**
No	63.4%	73.0%	75.0%	75.7%	76.2%	76.5%	72.9%

On average software firms in CEE have very concentrated ownership structures (see Figure 2) with predominantly domestic private owners (Table 4). In five CEE countries (we do not have data for Serbia) the share of firms with up to three owners ranges from 67% (Czech R) to 86% (Bulgaria). Inter-country differences are small and concentrated ownership structure seems to be a strong regional characteristic.

Domestic private ownership dominates in 80% of firms with small country differences. Share of foreign ownership ranges from 15% (Czech R) to 28% (Bulgaria) with Serbia being the only country with no foreign ownership in this sector and with three firms still under state ownership. This could be expected given Serbia's delayed transition due to its international isolation in the 1990s.

Figure 2: The structure of ownership



In CEE foreign ownership is dominant in many sectors of economy, and foreign firms dominate the export markets (Hunya, 2006). Contrary to this pattern of foreign led modernization in the rest of economy, the software sector is dominated by domestic firms. This can be explained from the industry organization perspective by insignificant firm specific or ownership specific advantages of the CEE firms, especially when taking into account the software segments in which they are active (services, localisation). We have explained this elsewhere as being due to gaps in technology, finance and market access (see Radosevic, 1999). Here we summarize and somewhat simplify the argument. When local firms are only able to control one of the three gaps we can expect a pattern of foreign led modernization. Where local firms can close two out of three of the gaps we can expect domestic led modernization. In customized software local enterprises enjoy the advantage of access to local clients and good understanding of their needs. The finance gap in this sector is not large and domestic entrepreneurs can raise the necessary capital from local capital markets. Technology is accessible from generic solutions providers who are also dependent on domestic firms for localisation and customisation. In localisation software activity two out of three gaps can be closed and hence we can expect domestic, not foreign led modernization.

Table 4: Ownership structure by nationality and dominant owner

	Estonia	Czech R	Slovenia	Serbia	Romania	Bulgaria	All countries
Domestic private	73.7%	82.4%	82.6%	92.3%	80.0%	69.4%	79.4%
Foreign	23.7%	14.7%	17.4%	0.0%	20.0%	28.6%	17.9%
Other (state and joint – ventures)	2.6%	2.9%	0.0%	7.7%	0.0%	2.0%	2.7%

The software industry includes Software publishing, consultancy and supply (NACE 722), Data processing (723), Hardware consultancy (721), Database & on line (724), Maintenance & repair of computer machinery (725), and Other computer related activities (729). Software firms in CEE are highly focused on software activities. As Table 5 shows, between 87% (Romania) and 100% (Czech R) of firms are active in

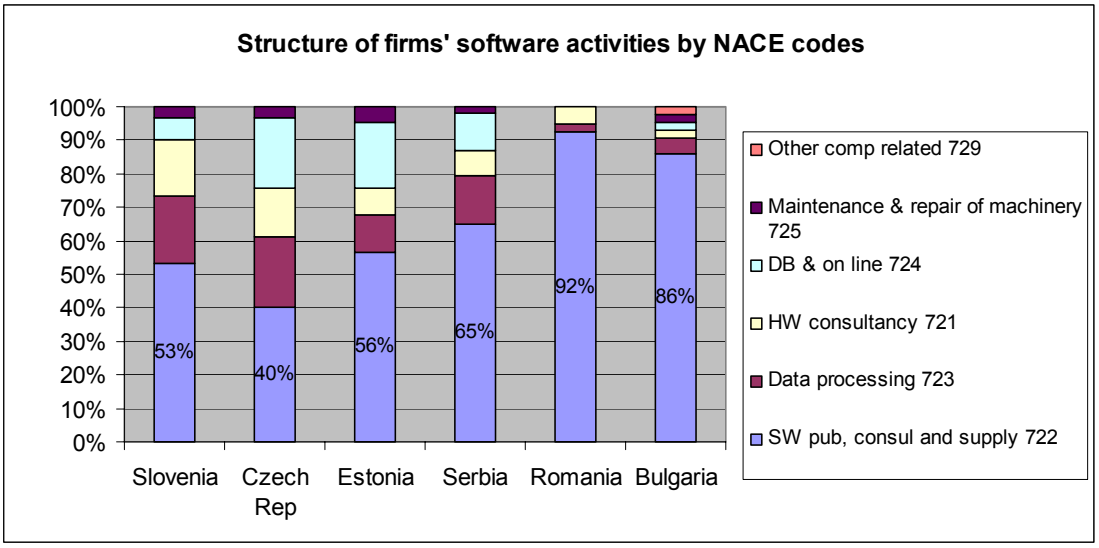
only software activities. This is in line with our previous conclusion that 88% of firms were originally established as dedicated software businesses. Again, Serbia is the exception with 23% of firms being active in non-software and non-computer related areas.

Table 5: Structure of software vs. non-software activities by countries

	NACE codes	Slovenia	Czech R	Estonia	Serbia	Romania	Bulgaria
SW related activities	721-725	93.8%	100.0%	95.4%	77.1%	86.7%	95.5%
Other comp related	729	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%
Non-SW	Other	6.3%	0.0%	4.6%	22.9%	13.3%	2.3%

However, the structure of software only activities shows interesting country differences in the degree to which firms are specialised in software activities. If we take share of firms' software NACE codes as a proxy for diversity of software supply i.e. division of labour, then software firms in eastern Europe (Bulgaria, Romania, and partly Serbia) have much more mono-structured software industries, in which NACE category 722 dominates, compared to central Europe (Czech R, Slovenia, and Estonia). We believe that this reflects levels of development and consequently division of labour and local demand for software rather than differences in rates of transition.

Figure 3: Structure of firms' software activities by industry activities



Revenue structure by types of products and services shows two important features (see table 6). The first is a high share of software products compared to services. Given that software products are often localisation of generic solutions from abroad, they indicate the degree to which the software market is undeveloped. However, within CEE the two most developed markets are Slovenian and Czech R. where the share of services is higher than products. In Eastern Europe (Romania, Serbia and Bulgaria), and Estonia, as the least developed of the six CEE economies, the share of products is higher. This contrasts sharply with the EU12 structure of revenues where share of services is 64% and products 36% (EITO, 2000).

Table 6: Structure of revenues by types of products and services (in %)

	Application SW	System infrastructure SW	Application tools	*Total SW Products*	Operation management	Implementation	Consulting	Support services	*Total SW services*	Non-SW
Slovenia	30	9	1	*40*	3	17	14	11	***45***	14
Czech R	31	9	5	*45*	2	17	14	14	***47***	7
Estonia	44	8	3	***55***	5	11	11	8	*35*	9
Serbia	38	11	9	***58***	3	8	7	7	*25*	17
Romania	39	10	4	***53***	1	16	8	10	*35*	12
Bulgaria	29	18	10	***57***	4	12	14	5	*35*	7
average	35	11	5	*51*	3	14	11	9	*37*	11

Note: Systems software is used to manage the components of a computer system, e.g. computer operating systems that control input and output operations. **Applications software** is designed to apply computer power to the performance of tasks such as materials and facilities in hospitals, budget and payroll administration or computer-aided design of turbines and pumps. **System integration (infrastructure)** is the process of identifying and bringing together various technologies in order to define and deliver a complete information package, including large and small computers, packaged and custom-designed software. Application software, system infrastructure software and application tools are frequently lumped together under the common label of "packaged software", which, unlike customised programs, refers to an application or system software product written in a generic form for the use of many different customers.

Second, Table 6 shows a very high share of 'localization activities'. By this we mean activities that are focused on the application of generic solutions, usually developed and licensed by global software firms through sale of packaged software, to a local context. These include application software (e.g. packaged software), implementation, and consulting and support services. The joint share of these activities ranges from 60% (Bulgaria and Serbia) to 76% (Czech R). The share of revenues based on sales of advanced software functions, such as system infrastructure software (system management, software, middleware, server-ware, system level software) and application tools (database engines, AMD) is very low, as is the revenue from software in operations management. Inter-country differences do not seem to be significant here, which suggests that localization activities are the dominant function of the CEE software industry. As we will show later in the paper, this is supported by the dominantly local market orientation of sales.

With a few exceptions (Graphisfot and Recognita from Hungary, Softwin from Romania), the software industry in CEE is mainly related to localization activity. These include custom software development, body shopping, professional services (maintenance, consulting, etc.), and packaged application solution development. The core localization activity is induced by the branded software companies which utilize the services of local firms and by authorized resellers and distributors, for marketing and applications development based on their standard software. Analysis of these activities in Romania shows that the local companies develop applications using the standard packages to meet the requirements of their customers. Localization and content creation are the main service areas for the local companies. Many existing companies have been converting themselves into service providers for large

corporations such as IBM, Compaq, Hewlett-Packard, Dell, Acer, Cisco, 3COM etc. (Semine and Kerma, 2001)

The revenue structure across firms by types of products and services shows a distribution in which the share of applied software forms the diagonal i.e. it divides firms into those exclusively oriented towards applied software and those for which localised activities (implementation, consulting, support services) and more advanced activities (application tools, system infrastructure software or operations management) dominate. Figure 4 shows the distribution of revenues by sample firms in Estonia, which shows a pattern that is typical, of that in other countries. Figure 5 shows the share of applied software revenues across firms and countries, which confirms a homogenous pattern of 'diagonal' division of firms. Figure 6 divides firms' activities on localisation activities, applied software and other (advanced) activities. It shows that diagonal distribution of activities across the entire sample which is already indicated in figures 4 and 5. A relatively advanced activities like application tools, system infrastructure software or operations management are restricted to a few firms.
Thus, localization of packaged software is the main activity in CEE software firms; this includes a quite varied 'soft' localization component (implementation, support services and consulting) across firms, and a low share of 'advanced' activities such as application tools, system infrastructure software or operations management.

Figure 4: Structure of revenues by type of product and service: Estonia

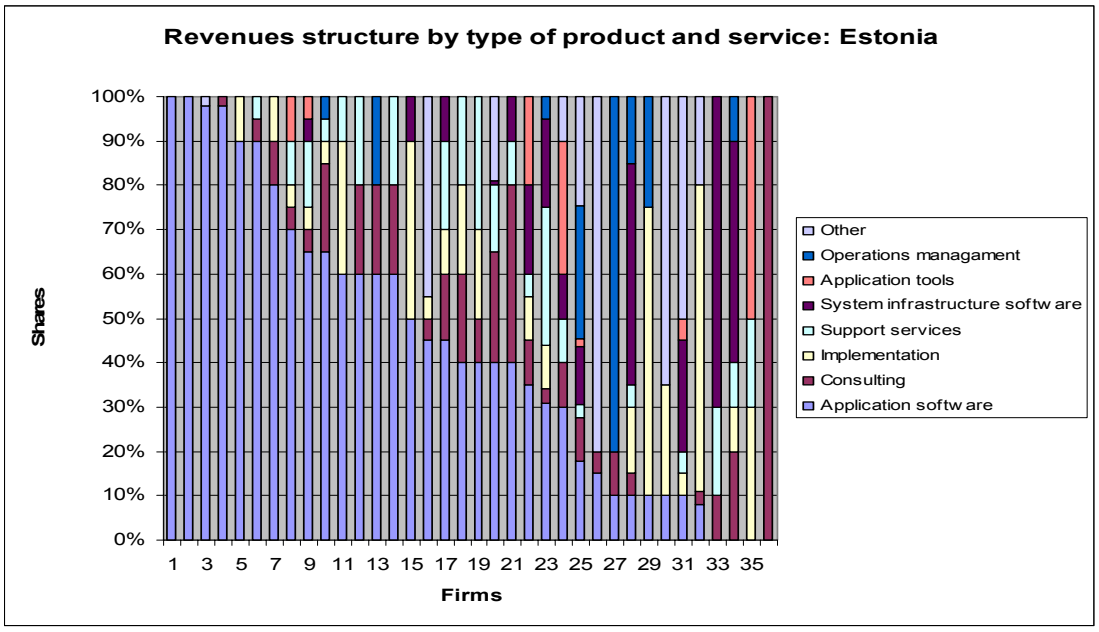


Figure 5: Shares of revenue realized by applied software activities across firms and countries

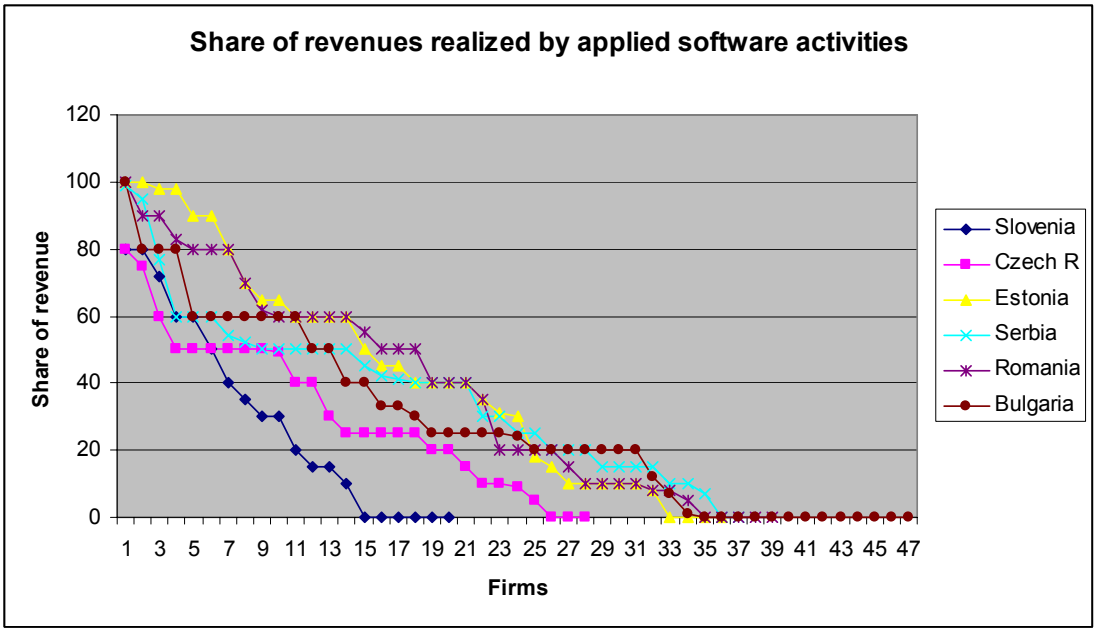
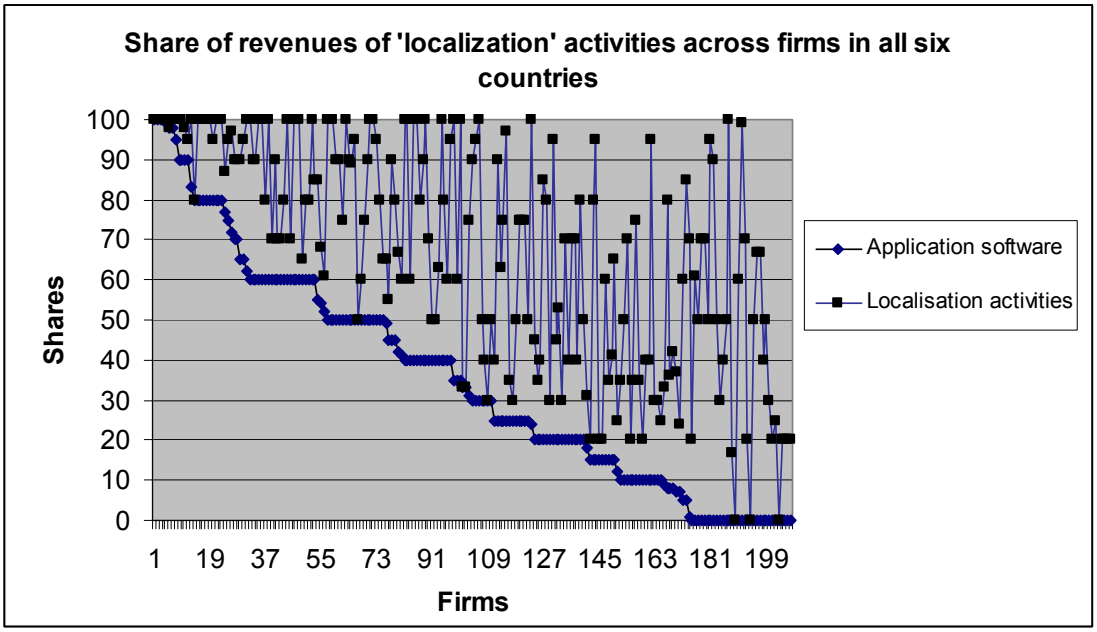


Figure 6: Shares of revenues from 'localization' activities across sample firms (all six countries)



Note: Localisation activities include implementation, consulting and support services.

Grundey and Heeks (1998) and Semine and Kerma (2001) list following segments as being dominated by local software developers in CEE:

- Accounting and administration (book keeping, HR modules, stock-keeping, sales records) software for the small and medium sized enterprise (SME) sector (due to affordable price, local language and the need for frequent modifications to follow changing regulations);
- Individual database developments;
- Individual software development for specific sectors (local governments, libraries etc.);

- Educational software including dictionaries, program to support the National Curriculum at primary/secondary level;
- Language-specific interface modules in any software;
- Anti-virus software packages; providing a good export market.

As is the case elsewhere (Campbell-Kelly, 1995) the languages of the CEE, specific legal, government and business practices and security considerations provide a continuing 'natural protection' for the local software industry which does not apply to hardware (Grundey and Heeks, 1998). Development for export of anti-virus software packages by a few Romanian and Hungarian companies shows that the opportunities for new entrants have been exploited only in relatively protected areas.

The issue is whether this natural protection will persist or be eroded over time. Grundey and Heeks, (1999) argue that it is already being eroded due to the increasing willingness and ability to use English language interfaces, the willingness of clients to adjust to procedures provided by generic solutions providers, and the decreasing costs of localizations and the willingness of foreign providers to invest in software localizations to match their packages to the languages and practices of individual country markets.

In summary, our sample demonstrates that CEE software firms are young dedicated firms that are mainly oriented towards localization of software. They are mainly private, independent, domestically owned firms with concentrated ownership. An important difference between central European firms and eastern European firms is the much less diversified structure of software supply in the latter. A high share of 'localization' of packaged software is the main activity of the CEE software firms, with a quite varied 'soft' 'localization' component (implementation, support services and consulting) across firms, and a low share of 'advanced' activities.

2. GROWTH AND COMPETITIVE ADVANTAGE OF THE CENTRAL AND EAST EUROPEAN SOFTWARE FIRMS

In this section, we explore growth features and factors of competitive advantage of software firms. First we explore whether software firms have expanded in terms of employment, and investigate the source of this employment (new firms or expansion of existing firms).

Employment data suggest that growth in the CEE software industry has been dynamic with big differences across countries. In the five year period (1999-2003; for Bulgaria 1999-2004) employment in our sample increased by 37%, with country differences ranging from increases of more than 200% in the case of Romania to much smaller increases of 11% in Czech Republic (Table 7). This suggests that the software sector is relatively dynamic in Slovenia, Serbia and Estonia, and is booming in Romania which makes it difficult to generalize about CEE.

Software firms are generally small with an average size of 20 in Estonia to 67 in Bulgaria (Table 7). Firms in the Czech R are bigger on average (140) due to the presence of one large software firm, which was established in 1954, whose employment has declined from 2,372 (1999) to 1,480 (2003).

Table 7: Employment and company size in sample of the CEE firms

	Total employment			Employees per company		
	2003	**1999**	**Index 2003/1999**	**2003**	**1999**	**Index 2003/1999**
Romania	1935	601	322%	52	15	339%
Slovenia	1116	616	181%	51	32	156%
Serbia	988	648	152%	26	24	108%
Estonia	729	502	145%	20	23	86%
Bulgaria*	3355	2723	123%	67	57	118%
Czech R	4775	4306	111%	140	139	101%
Total	12898	9396	137%	59	51	117%

Note: * 2004

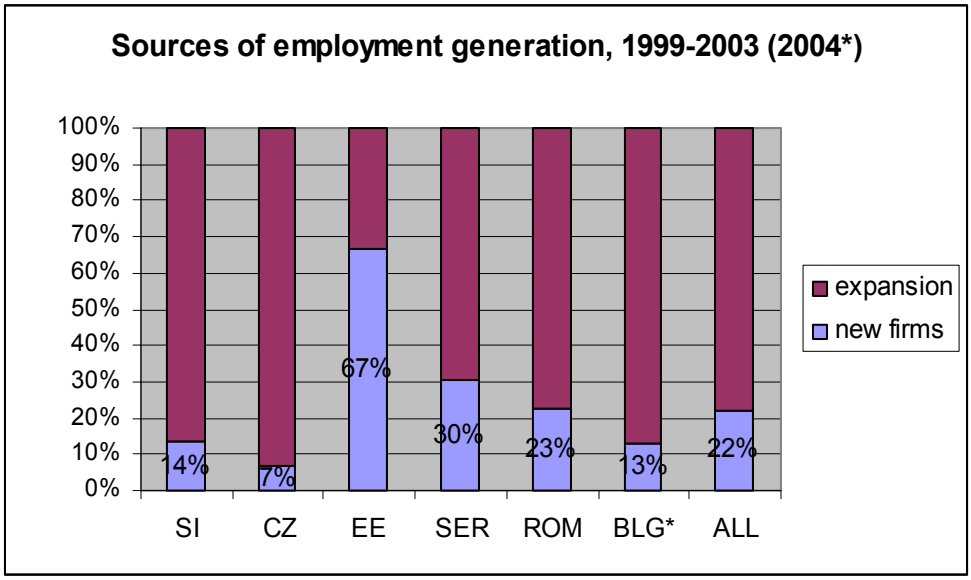
The distribution of size of firms is highly skewed with only a few large players and a large number of small firms. Based on the top 1, 3 and 5 firm concentration ratios Slovenian industry is the most concentrated while Estonia has the least concentrated (see Table 8). In five countries the top 1, 3 and 5 firms' concentration has declined between 1999 and 2003 while in Romania it has increased.

Table 8: Shares of top one, three and five firms in employment

	Slovenia		Czech Rep		Estonia		Serbia		Romania		Bulgaria	
	1999	2003	1999	2003	1999	2003	1999	2003	1999	2003	1999	2003
top 1	**60%**	**49%**	55%	31%	20%	12%	21%	21%	7%	**22%**	20%	25%
top 3	**66%**	**58%**	61%	55%	43%	27%	60%	50%	21%	**44%**	39%	35%
top 5	**75%**	**65%**	68%	63%	54%	38%	70%	59%	42%	**60%**	45%	41%

The average size of firms has increased by 17%, i.e. from 51 to 59 (Table 7). The biggest relative increase was in Romania (from 15 to 52 employees per company). Growth in the Estonian software industry is based on new entry as the average size of firms has actually fallen from 23 to 20. A decomposition of employment generation (see Figure 7) shows that 67% of new employment in the Estonian software industry in 1999-2003 was based on entry of new firms. The contribution of new entrants is significantly less in other countries, ranging from 7% (Czech R) to 30% (Serbia). This may be a biased conclusion as there is a natural tendency in surveys to select older and hence more established firms which may reduce the share of new entrants in a sample. However, at least for those countries at either end of the range, these differences (Estonia vs. Czech R) do hold.

Figure 7: Sources of employment generation, 1999-2003/4



Note: Bulgaria 2004

Software firms are predominantly oriented towards the local market whose share in total sales ranges from 57% (Romania) to 81% (Czech R) (Table 9). An increase in export share is noticeable only for Serbia (by 21 percentage points) and Romania (13 percentage points). Serbia's increase to 25% of exports in sales may represent catching up after a period of isolation from the world software market, while Romanian export growth would seem to be a combination of a large pool of software engineers and low wages. There does not seem to be a tendency in CEE towards a strong expansion in exports, though there is a noticeable reorientation of the Romanian and Serbian software sectors towards export. Given its high share of exports in sales (43%) and strong growth of exports Romania seems to be the only CEE country which is developing an export oriented software industry. The relative export intensity of CEE is still very low; it lies between the strongly domestically oriented software industries of Brazil (1-2%), and China (11% of sales) and the strongly export oriented industries of India (80%), Ireland (85% and Israel (70%) (Arora and Gambardella, 2004, p. 36).

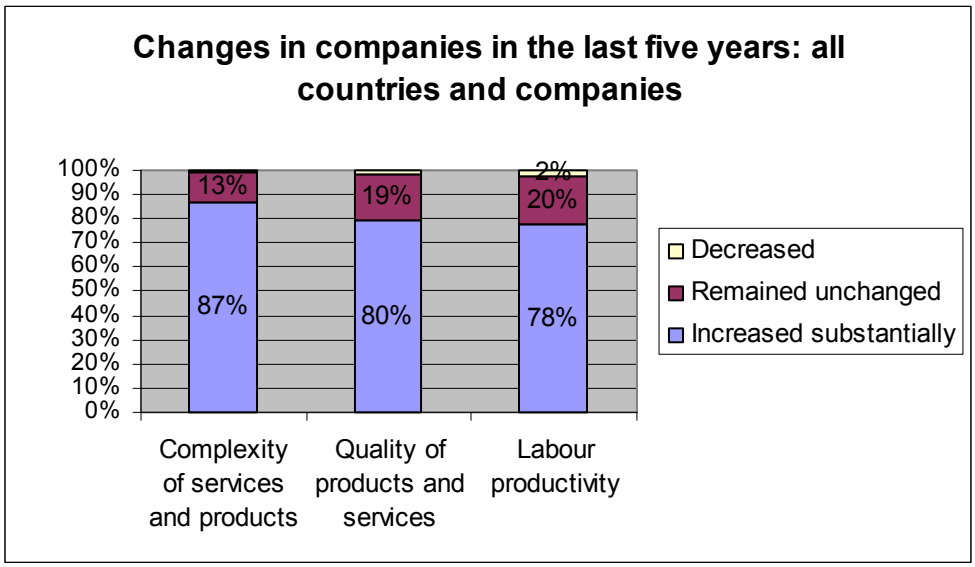
Table 9: Export orientation of software firms
(Average share of export in total sales)

	1999	2003	Change in percentage points, 2003-1999
Romania	30	43	13
Slovenia	23	30	7
Serbia	4	25	21
Bulgaria	18	21	3
Estonia	17	21	3
Czech R	14	19	5
average	18	27	9

Expansion of employment in the existing companies and via entry of new firms suggests that this growth may have been accompanied by intensive industrial upgrading. As industrial upgrading is a multi-faceted process we asked companies to

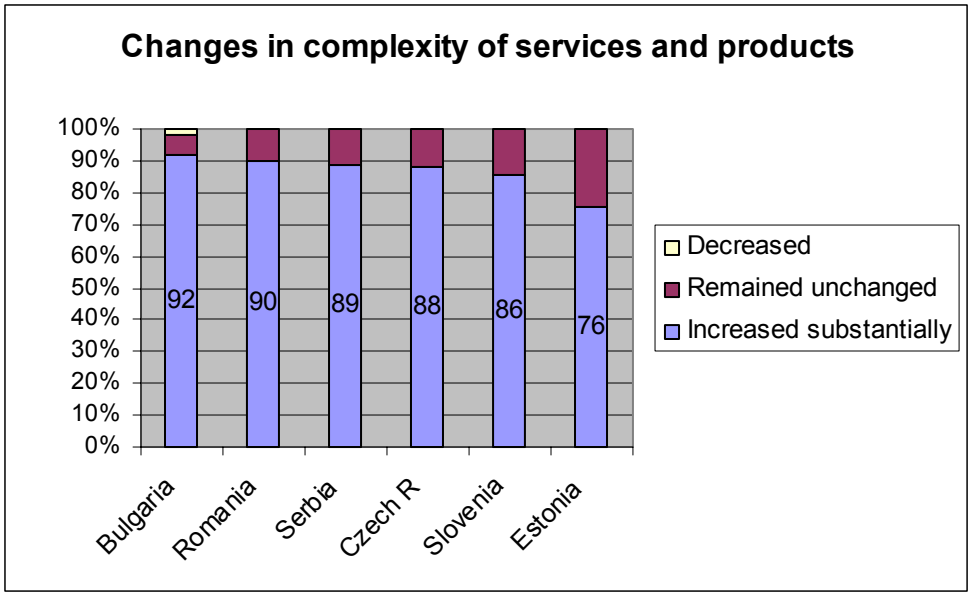
assess the degree of change in the last five years in terms of complexity and quality of their products and services, and in terms of labour productivity.
Overall, it seems that industrial upgrading was most intensive in terms of complexity of products and services, followed by quality and then labour productivity (Figure 8). Eighty seven per cent of companies stated that the complexity of their products and services had 'increased substantially'. This probably reflects both increasing technological progress in software and more sophisticated demands from local users. Quality of products and services as well as labour productivity have 'increased substantially' in 80% and 78% of companies respectively. This seems a relatively high share though it is lower than for changes in complexity of products and services. This would be expected given the still very low degree of automation of software activities, problems in controlling quality, and the labour intensive nature of software.

Figure 8: Changes in companies 1993-2003: countries and companies



The complexity of services and products has 'increased substantially' and fairly uniformly in four out of five countries (Figure 9). The share of firms with substantially increased complexity of services and products ranges from 86% to 91%. Estonia has substantially lower share at 76% which again may reflect a large number of new entrants (Figure 9).

Figure 9: Changes in complexity of services and products



Changes in the majority of the components of industrial upgrading were strongest in countries with lower GDP per capita (Romania, Bulgaria and Serbia) (see Figures 9-11). This probably reflects some sort of 'catch up' rather than differences in rates of transition. Estonia has the lowest degree of change in the three types of upgrading, which could be attributable to a high share of new entrants that have had less time to improve the components of industrial upgrading.

Figure 10: Changes in quality of products and services

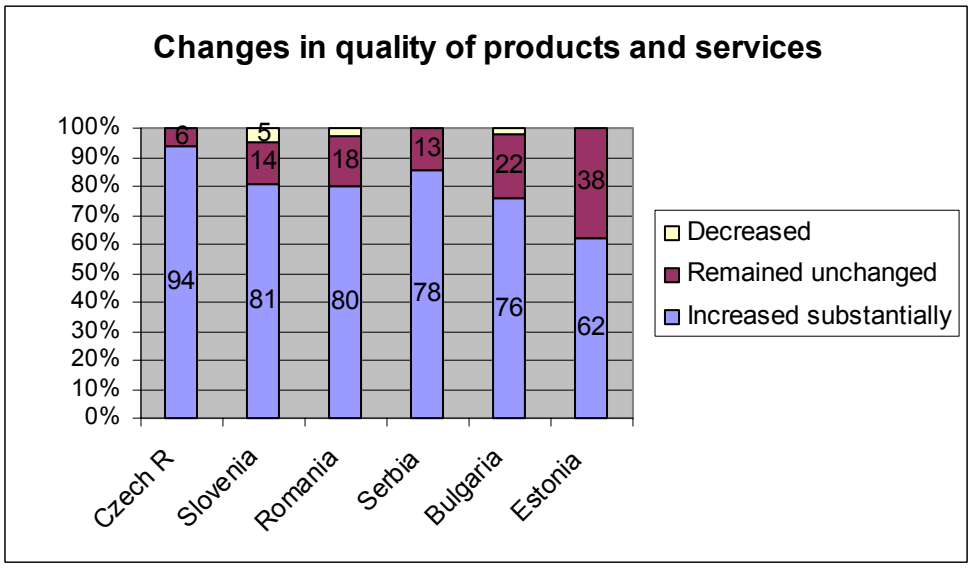
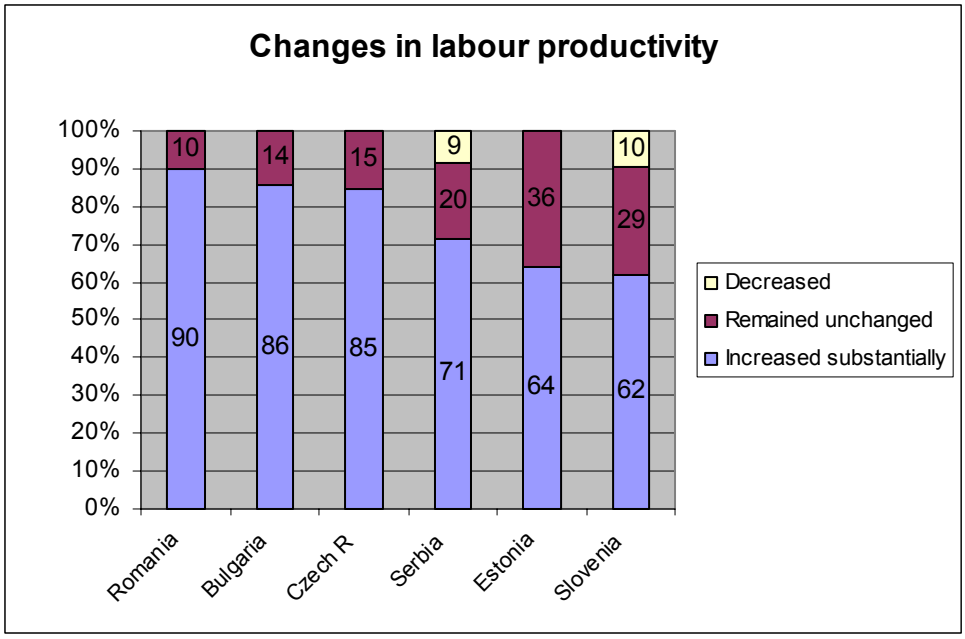
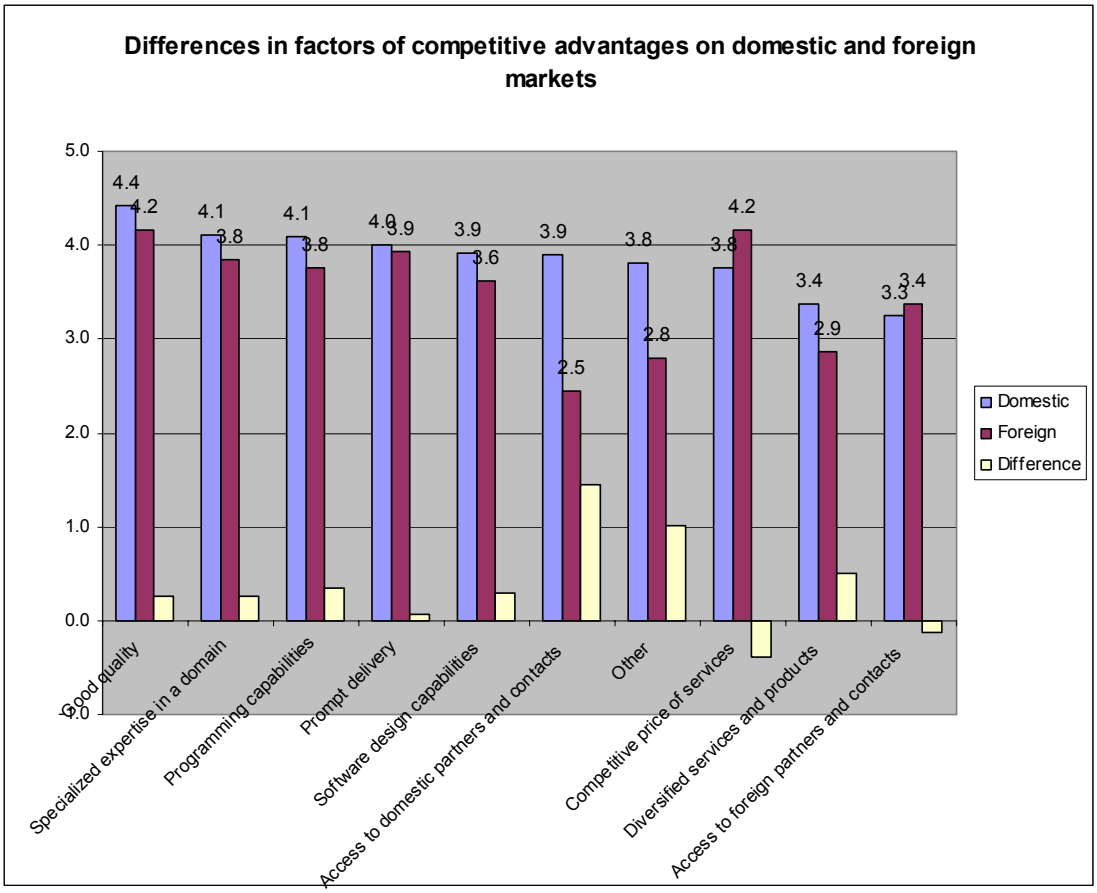


Figure 11: Changes in labour productivity



The nature of competitive advantage plays an important role in industrial upgrading. Our data show that the factors of competitive advantage differ between domestic and foreign markets. First, in eight out of ten factors of competitive advantage software firms estimate that they are stronger in local than in foreign markets (see Figure 12). Second, good quality, and specialist expertise in domain and programming capabilities are the three factors that render competitive advantage in the local market. In foreign markets, good quality and price competitiveness are the most important factors. Technological capabilities (specialist expertise in domain, programming and software design capabilities) are less important for competitive advantage in foreign than domestic markets. Third, the biggest difference between local and foreign markets in terms of competitive advantage is in access to domestic partners and contacts. This is to be expected given the 'localization' orientation of CEE software firms. Fourth, local firms have the advantage in competitive pricing of services for the local market. This is also to be expected given relatively lower technological capabilities of local firms in foreign markets

Figure 12: Differences in factors of competitive advantages on domestic and foreign markets



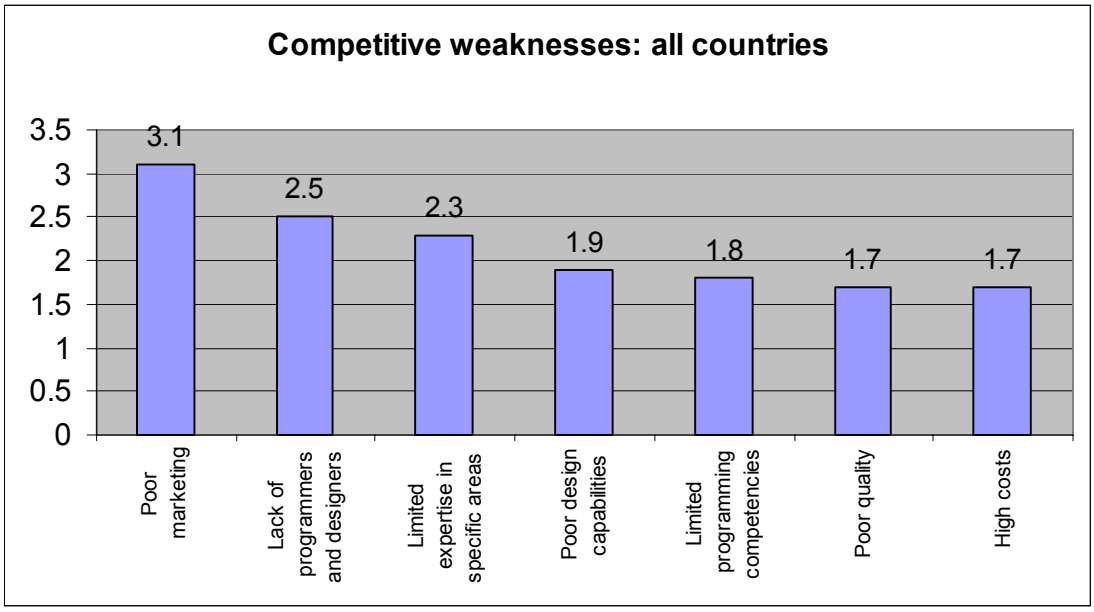
When differences in the factors of competitive advantages are compared across countries two features can be seen to dominate (Table 10). First, access to domestic partners and contacts is more important in domestic than export markets. Second, price of services and products is much more important factor of competitive advantage in export markets. For all other factors the picture is mixed. A detailed examination of the factors of competitive advantage in foreign markets shows that they are fairly even across countries; for local markets they are more diverse. The average standard deviation of competitive advantages across different factors and countries for domestic markets is 0.364 while for foreign markets it is 0.269.

Table 10: Differences in factors of competitive advantage between domestic and foreign markets

	Software design capabilities	**Programming capabilities**	**Competitive price of services**	**Good quality**	**Prompt delivery**	**Specialized expertise in a domain**	**Diversified services and products**	**Access to foreign partners and contacts**	**Access to domestic partners and contacts**
Slovenia	0.2	0.2	**-0.4**	-0.2	-0.2	0.3	-0.2	-0.3	***0.5***

Czech R	0.2	0.2	**-0.3**	0.1	0.1	0.0	0.1	-0.4	***0.8***
Estonia	0.2	0.4	**-0.6**	0.3	-0.1	0.1	0.5	-0.2	***1.0***
Serbia	0.0	-0.1	**-0.1**	0.0	0.0	0.0	0.6	-0.5	***1.4***
Romania	-0.3	-0.2	**-0.6**	0.2	-0.1	0.3	0.1	-0.4	***1.1***
Bulgaria	1.4	1.3	**-0.5**	0.9	0.5	0.6	1.1	0.5	***2.9***
All	0.3	0.3	**-0.4**	0.3	0.1	0.3	**0.5**	-0.1	***1.4***

Figure 13: Competitive weaknesses: all surveyed firms

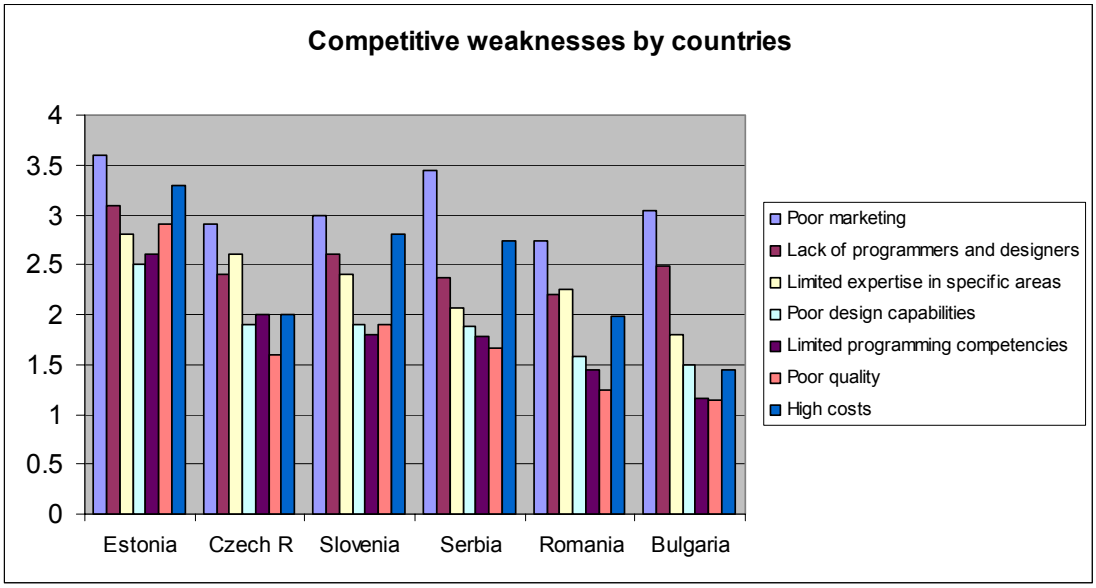


Companies were less harsh in their evaluation of their competitive weaknesses; they did not rate them as 'very important' (4) or 'extremely important' (5) for any of the categories. This may be the result not of subjective bias among respondents, but rather of the localisation strategies of software firms oriented towards local clients and activities where they enjoy more advantages than weaknesses.

In relative terms, firms evaluated poor marketing (3.1) as their greatest competitive weakness, followed by lack of programmers and designers (2.5) and limited expertise in specific areas (2.3). Poor marketing is the most important hindrance for developing exports as firms already enjoy advantages of access to domestic clients on domestic market (Figure 12). In the case of new global software exporters such as India, Ireland and Israel firms have been able to compensate for weak marketing by building on Diasporic linkages. This is not so much of a possibility for the CEE countries.
Low ranking of costs and quality corresponds with these two factors being the main factors of competitive advantage of the CEE software firms (Figure 12). Also, weaknesses in programming and design capabilities corresponds to their relative importance in competitive advantage. Limited expertise in specific areas is accompanied by an assessment of specialist expertise in a domain. This suggests possible mismatches in structure of competencies which may be based on the second ranked, but still moderate weakness - lack of programmers and designers. Overall, relatively less pronounced weaknesses compared to competitive advantages suggest that the CEE software industry has great scope for further industrial upgrading.

There are substantial differences across countries primarily in assessed level but not ordering of competitive weaknesses. On average, the competitive weaknesses seem to be the strongest in Estonia and weakest in Bulgaria and Romania (Figure 14). In all countries, poor marketing is the major weakness; the disadvantage of high labour costs varies largely across countries, from being important in Estonia to unimportant in Bulgaria and Romania.

Figure 14: Competitive weaknesses by countries



Adoption of international quality certification is one mechanism for integrating software firms into international subcontracting networks (Arora and Asundi, 1999; Feakins, 2003). In this respect, there are big country differences with 81% of Estonian firms with international certification but only 12% of Serbian firms (see Table 11). This difference may be result of different international contexts (proximity of Estonia to the Scandinavian economies vs. international isolation of Serbia during the 1990s). The relatively big difference between Bulgaria (78%) and Romania (12%) is difficult to interpret without probing industry specific factors, such as types of certificates and nature of international linkages, especially in view of the relatively strong export orientation of the Romanian software industry.

Table 11: Share of companies with international quality certificates (in %)

	Estonia	Bulgaria	Czech R	Slovenia	Romania	Serbia	All countries
Yes	81	78	65	55	39	12	45
No	19	22	36	45	61	88	55

In summary, expansion of the software industry in terms of employment across CEE is country specific. However, industry upgrading is substantial and represents a common regional trend. Changes in the majority of the components of industrial upgrading have been the strongest in countries with lower GDP per capita, which may reflect a 'catching up' rather than different progress of transition.

The CEE software industry is predominantly oriented towards the local market. There does not seem to be a general CEE tendency towards a strong export expansion though there has been a noticeable reorientation of the Romanian software sector towards exporting.
The factors of competitive advantage differ for domestic and foreign markets. A detailed examination of the factors of competitive advantage in foreign markets shows that they are fairly uniform across countries, while they differ for domestic markets. Relatively less pronounced weaknesses compared to competitive advantages suggest that the CEE software industry has great scope for further industrial upgrading.

3. STRATEGIC PARTNERSHIPS OF CENTRAL AND EAST EUROPEAN SOFTWARE FIRMS

Software is one of the most internationalized (globalized) industries not only in terms of production and services, but also increasingly in terms of technological development. A close international integration in software originates from need to localize generic software solutions and tools and from low barriers in its use and adaptation. Hence, modes and patterns of strategic partnerships in software are an important ingredient in understanding how this industry integrates, and what are the effects of integration on its growth and industrial upgrading.

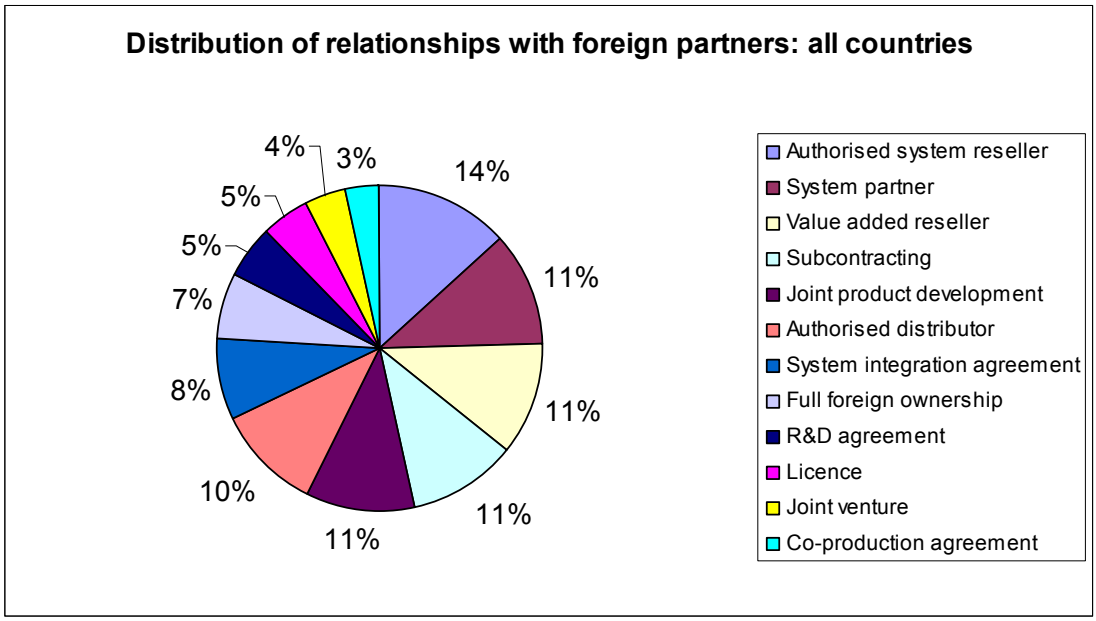
The intensity of alliances in the CEE software industry is illustrated by data on numbers of strategic partnerships by firms and by countries. Of the 178 firms for which data are available only 2 firms in Serbia do not have strategic partnerships. The number of partnerships is on average 2-3 per firm. The sixty eight per cent of firms have two or more partnerships (see Table 12). This distribution varies across countries with Bulgarian and Czech R firms showing the highest share (79% and 74% respectively) of networked firms (2 or more) and Estonian firms showing the smallest share (48%) of networked firms. It is not clear what determines these differences in networking. In the case of Estonia, a contributory factor may be younger age and smaller size of firms.

Table 12: Software firms by number of strategic partnerships by countries

No of partnerships	Slovenia	Czech Rep	Estonia	Serbia	Romania	Bulgaria	Total
0	0%	0%	0%	6%	0%	0%	1%
1	43%	26%	52%	25%	33%	21%	31%
2-5	57%	65%	32%	67%	52%	74%	60%
6>	0%	9%	16%	3%	15%	4%	8%
	100%	100%	100%	100%	100%	100%	100%

The typology of international strategic partnerships in software is highly diversified and industry specific (see Figure 15). The distribution of relationships for all countries shows that no single partnership mode dominates (Figure 15). Also, a breakdown by countries shows that there is no one dominant mode.

Figure 15: Distribution of relationships with foreign partners: all six countries



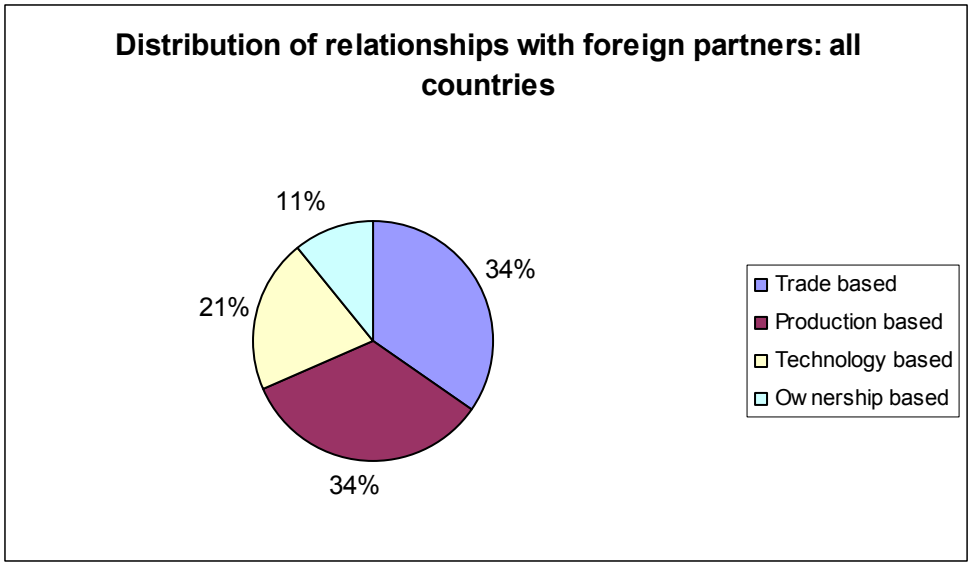
However, the aggregation of types of partnerships based on dominant 'factors' - trade, technology, production or ownership – produces an interesting picture (Table 13, Figures 16, 17).

Table 13: Typology of strategic partnerships based on dominant factor

Trade based (Authorized distributor, Value added reseller, Authorised system reseller)
Production based (System partner, Subcontracting, Co-production agreement, System integration agreement)
Technology based (Joint product development, R&D agreement, Licence)
Ownership based (Full foreign ownership, Joint venture)

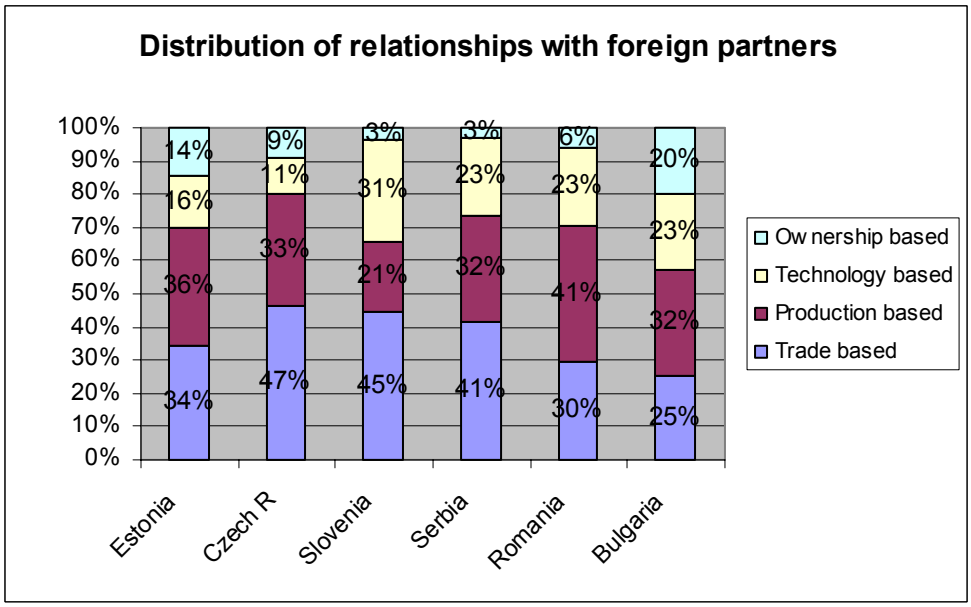
The dominant types are trade and production based relationships, each with a share of 34%. This could be expected given the dominant 'localization' orientation of strategic partnerships. Production based partnerships include both local and export market oriented partnerships. The share of technology based partnerships is smaller, but nevertheless represents a significant share. The share of equity linkages is small which is to be expected given the low ownership-specific advantages in the software industry.

Figure 16: Distribution of relationships with foreign partners: all six countries



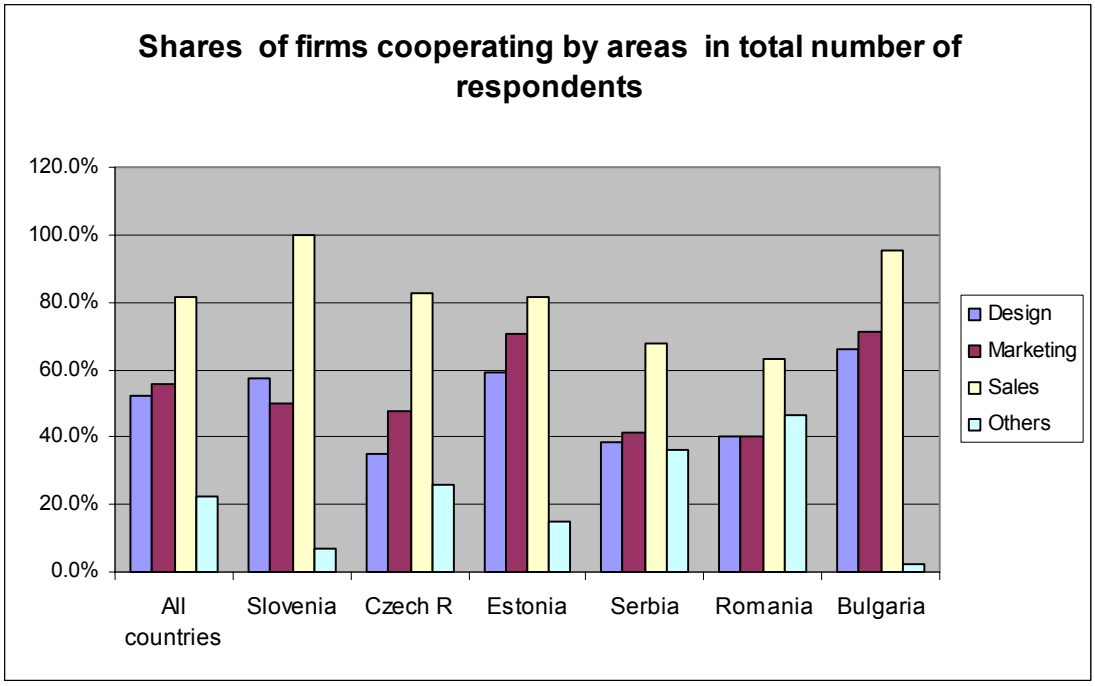
The distribution of relationships with foreign partners by country does not show significant differences across individual countries (figure 17). In view of the approximate nature of our data, these country differences should be interpreted with caution .

Figure 17: Distribution of relationships with foreign partners by countries



Local market orientation of software firms is confirmed by data on firms which have foreign partners in the areas of sales, marketing and design. Figure 18 shows that 85% of firms have sales agreements with foreign partners, 56% have marketing and 52% have design agreements (Figure 18). This ordering is generally similar across the six countries with the exception of Slovenia, which has a higher share of design than marketing agreements. Once again, this suggests the focus on localization in the CEE software industry. However, a part of the industry is oriented towards export and technology generation as suggested by cooperation with foreign partners in design.

Figure 18: Shares of firms cooperating by area and by country



Firms assessed that links with foreign partners were more advantageous for competitiveness than links with local partners. In total, 81.8% of firms evaluated foreign links as either very (19.9%) or extremely important (61.9%). The assessment varied from 'very' and 'extremely' important for foreign links in Bulgaria, Romania and Slovenia to much less importance in Czech R where 48% of firms evaluated such links only as 'important' (Table 14).

On the other hand, links with local partners were seen as being significantly less important; only 22% of firms evaluated them as very important and 33% as extremely important. Inter-country differences in relation to local links are much smaller than in foreign links and their ordering is different. In Serbia and Slovenia, local links are relatively the most important with 65% and 60% of firms respectively assessing them as 'very' or 'extremely' important. In Estonia 52% of firms evaluated domestic and foreign links as being equal in importance.

Table 14: Importance of links with foreign and domestic partners (as %)

Foreign	**All**	**Estonia**	**Czech R**	**Slovenia**	**Serbia**	**Romania**	**Bulgaria**
Not relevant	2.8%	3.7%	0.0%	0.0%	3.1%	3.0%	4.3%
Not very important	2.3%	3.7%	0.0%	6.7%	6.3%	0.0%	0.0%
Important	13.1%	18.5%	**47.8%**	0.0%	15.6%	6.1%	0.0%
Very important	19.9%	18.5%	17.4%	20.0%	25.0%	27.3%	13.0%
Extremely important	**61.9%**	55.6%	34.8%	**73.3%**	50.0%	**63.6%**	**82.6%**
Local	**All**	**Estonia**	**Czech R**	**Slovenia**	**Serbia**	**Romania**	**Bulgaria**
Not relevant	6.2%	0.0%	4.3%	0.0%	2.9%	9.7%	12.5%
Not very important	12.9%	22.2%	13.0%	13.3%	5.9%	12.9%	12.5%
Important	**26.4%**	22.2%	30.4%	26.7%	26.5%	29.0%	25.0%
Very important	**21.9%**	25.9%	30.4%	**13.3%**	**26.5%**	22.6%	14.6%
Extremely	**32.6%**	29.6%	21.7%	**46.7%**	**38.2%**	25.8%	35.4%

important							

Inter-country differences are reflected in weighted averages of importance of links which confirm the ordering of countries in Table 14 (see Table 15). Bulgaria, Slovenia and Romania assessed foreign links as being the most important while Slovenia and Serbia considered local links to be relatively the most important. The biggest differences in the importance of foreign and domestic links occurs in Bulgaria (1.2 points) and Romania (1.1) while the smallest differences occur in Serbia (0.2) and Czech R (0.3).
Romanian and Bulgarian firms seem to be the most dependent on foreign links. The relatively similar weight given to local and foreign links by Serbian firms may be due to the still limited role of exports of services, while in Czech R it is likely the result of the locally oriented nature of the software industry.

Table 15: Average importance of links with foreign and domestic partners

	Foreign	Local	Difference
All	4.4	3.7	0.7
Bulgaria	**4.7**	3.5	**1.2**
Slovenia	**4.6**	**3.9**	0.7
Romania	**4.5**	3.4	**1.1**
Estonia	4.2	3.6	0.6
Serbia	4.1	**3.9**	0.2
Czech R	3.9	3.5	0.3

Foreign links related to quality and sales are the most important, with an average importance of 3.7 and 3.6 respectively. Links in design are significantly less important than those oriented towards the local market (sales, marketing and quality). Also, differences in the importance of links in design are small, ranging from 3.0 to 3.1, while inter-country differences in the importance of sales and marketing links are much bigger, ranging from 4.0 to 3.6 and 3.0 to 3.8 respectively. The importance of foreign links in sales is highest in Estonia, Czech R, Slovenia and Bulgaria, while importance of foreign links in quality is highest in Serbia, followed by Estonia, Slovenia, Romania and Czech R. The ordering of countries by the importance of links in sales and marketing is shown in Table 16.

Table 16: Average importance of foreign links in specific areas across countries

	Sales	Quality	Marketing	Design
Estonia	**4.0**	**3.7**	**3.8**	3.0
Slovenia	**3.8**	**3.7**	**3.7**	3.1
Czech R	**3.9**	**3.6**	3.4	3.0
Bulgaria	**3.7**	3.3	**3.6**	3.1
Romania	3.4	**3.7**	3.0	3.1
Serbia	3.2	**3.9**	3.1	3.0
All	3.6	**3.7**	3.4	3.0

Depth of knowledge transfer can be proxied by the share of firms participating in training programmes organized by foreign partners. Seventy six per cent of CEE

software firms, a very high share, participate in training programmes. Across countries, this share ranges from 94% (Bulgaria) to 61% (Estonia).

Table 17: Share of firms participating in training programs organized by foreign partners (as %)

Bulgaria	Serbia	Czech R	Slovenia	Romania	Estonia	All countries
94	79	75	71	62	61	76

Thus, the CEE software industry is strongly dependent on strategic alliances with foreign partners. The dominant types of relationships are trade and production based. The share of technology based partnerships is smaller, but nevertheless is significant. The share of equity linkages is small, which is to be expected given the low ownership-specific advantages in the software industry.
Links with foreign partners are more important than links with local partners for firms' competitive advantage. The biggest differences in the importance of foreign and domestic links occur in Bulgaria and Romania. In Slovenia domestic and foreign links are equally important while Romanian and Bulgarian firms are more dependent on foreign links. Firms have links with foreign partners through provision of training programmes.

4. INDUSTRY EFFECTS OF THE GLOBAL INTEGRATION OF THE SOFTWARE INDUSTRY

The software industry is an important sector in the small but increasing knowledge based economies in CEE (see Piech and Radosevic, 2005). The software industry has some significant intra- and inter-industry effects on other sectors . In this section, we investigate four industry or spillover effects: the extent of software firms acting as knowledge providers through training for local clients; rates of personnel turnover in software firms; share of software personnel that left firms, but remained within the sector; degree of transferability of knowledge from foreign to domestic projects. We also look at differences in the quality of demand in foreign and local markets.

In terms of CEE software firms acting as knowledge providers (Table 18), a high proportion of software firms (89%) provides training for local users. This proportion is higher than the percentage of firms that receive it from foreign partners (76%) (cf. Table 17). All software firms surveyed in Bulgaria and Slovenia offer training to local clients

Table 18: A share of companies offering training to local clients (in %)

	Slovenia	Bulgaria	Czech R	Serbia	Estonia	Romania	All
Yes	100	100	91	86	79	79	89
No	0	0	9	14	21	21	11

The software firms' rather high personnel turnover rate of 83% is calculated as the sum of percentages of employees that left and joined firms. However, there are big differences across countries (Table 19). Turnover rates are the highest in Romania and

Estonia for both leavers and joiners components. This seems to reflect the high rates of new entrants in Estonia and the strong expansion of existing firms in Romania. In all countries, rates of joining are higher than leaving rates, which is compatible with the general picture of expansion in the software sector in CEE. However, the differences across countries suggest that in Slovenia and to an extent in Serbia, the sector dynamics are weaker than in the other countries.
High rates of personnel turnover can be interpreted negatively and seen as hampering firms' accumulation of organizational capabilities. However, in our case they may indicate an increasing demand for skilled engineers and an intensive process of restructuring. In the medium-term, both factors are conducive to the accumulation of organizational capabilities.

Table 19: Percentages of personnel turnover 1999-2003

	Left %	Joined %	Turnover % (left + joined)
All	31%	52%	83%
Romania	**69%**	**101%**	**170%**
Estonia	**44%**	**72%**	**116%**
Czech R	25%	48%	73%
Bulgaria	22%	35%	57%
Serbia	22%	27%	50%
Slovenia	11%	33%	44%

The third spillover effect we investigate is the share of software personnel that left firms, but remained within the sector. This intra-industry effect is quite strong; 70% of software personnel leave to join other software firms (Table 20). This intra-industry spillover effect is particularly high in Bulgaria and Romania where 88% and 87% of personnel respectively leave to join other software firms. In Slovenia, Serbia and Estonia intra-and inter-industry effects are similar, with only slightly more than 50% of personnel joining other software firms.

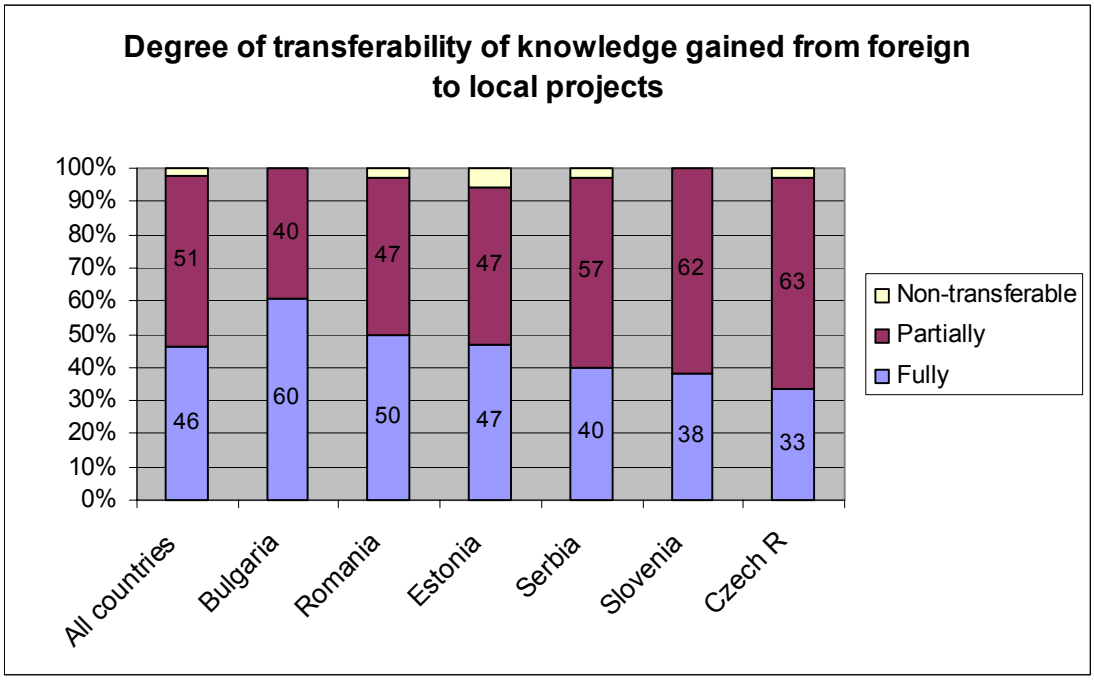
Table 20: Average percentage of those that remained in software business

Bulgaria	88
Romania	87
Czech R	66
Slovenia	54
Serbia	54
Estonia	52
All	70

An important determinant of spillover effects is the nature of the knowledge, i.e. degree of transferability from foreign to local projects of the knowledge gained. In highly cumulative activities knowledge is firm specific and rarely transferable to other enterprises. In these cases, the scope for spillovers is limited. In other sectors, the knowledge base may be codified in manuals and hence highly transferable across different projects or firms. Software activities are highly intangible, and combine elements of proprietary knowledge in the form of patents, copyrights, source code, with human specific know-how and programming and system design capabilities.

Forty six per cent of firms consider knowledge gained from foreign projects to be transferable to local projects, while 51% consider it to be only partially transferable. The ratio of firms that considered the knowledge to be fully transferable varies from 60% in Bulgaria to 33% in Czech R (see Figure 19). These differences are significant and it would be interesting to discover their basis. The share of firms that consider the knowledge gained from foreign projects to be non-transferable to local firms is very small. The share is highest in Estonia (6%), is 3% in Romania, Serbia and Czech R and nil in Bulgaria and Slovenia.
The overall high share of firms that consider there is complete or partial transferability of knowledge from foreign to local projects suggests that there are potentially high spillover effects in the software sector. This, combined with the high share of personnel that remain in the software sector, offers some positive potential for growth in the CEE economies.

Figure 19: Degree of transferability of knowledge gained from foreign to local projects

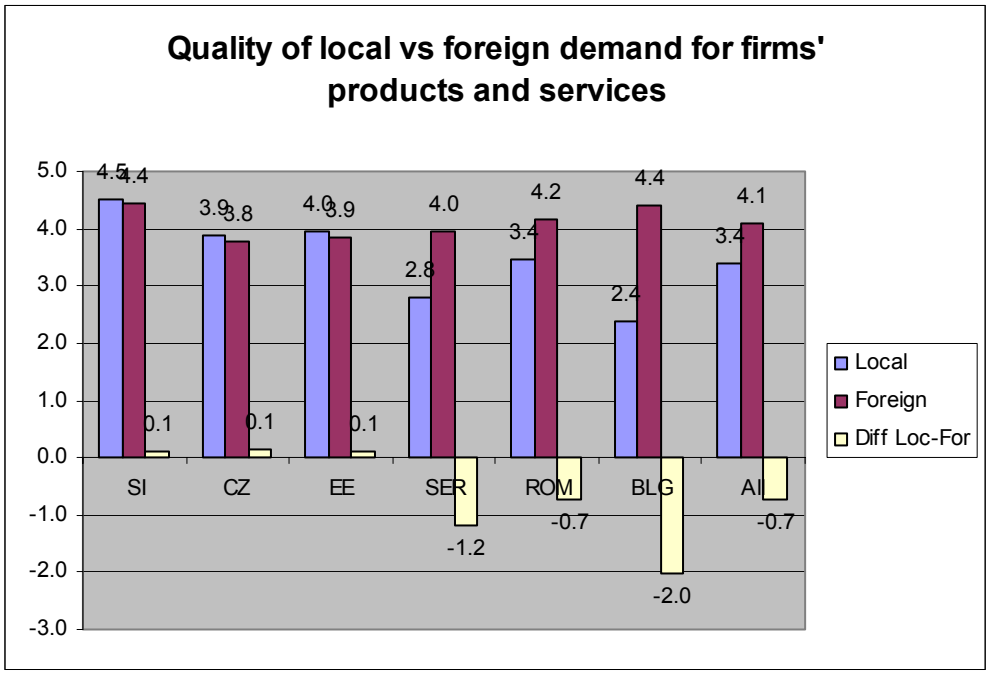


An important determinant of spillovers is quality of demand, both foreign and local. The stricter are the requirements of clients/users the more this puts pressure on software firms to improve the quality and diversity of their products and services.

This demand side factor acts in conjunction with transferability of knowledge from foreign to local projects – a supply side factor. Models of critical success factors in software exports highlight demand as being among the most important factors (see Heeks and Nicholson, 2002; Carmel, 2003). Generally, pressure from foreign clients will be stronger than the pressure exerted by local clients, i.e. the quality requirements of foreign customers are higher than of local users. Our data confirm this as, on average, firms evaluated foreign requirements in relation to their products/services as 'very important' (average of 4.1) and quality of local demand as 'important' (3.4).

However, this aggregate result hides the fact that in central Europe (Slovenia, Czech R, and Estonia) and east Europe (Romania, Serbia, Bulgaria) the situations are quite different. In the first group of countries, foreign demand is in fact less important than local demand, while in the second group the situation is reversed (see Figure 20). The difference in importance between foreign and local demand in central Europe is not high, while in eastern Europe it is significantly biased towards foreign demand.

Figure 20: Quality of local vs. foreign demand for firms' products and services



These differences in the relative importance of foreign and local demand between central and eastern Europe are confirmed in Table 21. The share of firms in central Europe that consider local demand to be important, very important and extremely important is higher than in east Europe. In terms of foreign demand, this difference is clear if we group 'important,' 'very important' and 'extremely important' responses together, but not if we consider only 'very important' and 'extremely important' responses (Table 21). Nevertheless, these results are compatible with the data in Figure 20.

Table 21: Importance of local and foreign demand for firms' products and services

Local	All	Slovenia	Czech R	Estonia	Romania	Serbia	Bulgaria
Not relevant	10.4%	0.0%	3.3%	0.0%	6.5%	13.9%	29.3%
Not very important	15.5%	0.0%	10.0%	2.9%	16.1%	19.4%	34.1%
Important	24.4%	9.5%	23.3%	32.4%	29.0%	33.3%	14.6%
Very important	21.8%	28.6%	20.0%	29.4%	19.4%	22.2%	14.6%
Extremely important	28.5%	61.9%	43.3%	35.3%	32.3%	11.1%	7.3%
Very & Extremely	50.3%	**90.5%**	**63.3%**	**64.7%**	51.6%	33.3%	22.0%

important							
V&E&Important	74.6%	**100.0%**	**86.7%**	**97.1%**	80.6%	66.7%	36.6%
Foreign	All	Slovenia	Czech R	Estonia	Romania	Serbia	Bulgaria
Not relevant	2.2%	0.0%	0.0%	0.0%	3.2%	6.9%	2.4%
Not very important	6.1%	0.0%	7.1%	3.3%	9.7%	3.4%	9.8%
Important	18.9%	14.3%	39.3%	36.7%	9.7%	13.8%	4.9%
Very important	24.4%	28.6%	25.0%	30.0%	16.1%	41.4%	12.2%
Extremely important	48.3%	57.1%	28.6%	30.0%	61.3%	34.5%	70.7%
Very & Extremely important	72.8%	**85.7%**	53.6%	60.0%	**77.4%**	**75.9%**	**82.9%**
V&E&Important	91.7%	**100.0%**	**92.9%**	**96.7%**	87.1%	89.7%	87.8%

Also, in central Europe, foreign and local demand are both evaluated higher than in eastern Europe. This points to the importance of demand as a coupling mechanism for generating spillovers which works in association with supply side factors. Eastern European countries, which are behind in terms of levels of development, seem to be faced with the lower quality of demand than central Europe. This may weaken the operation of supply side spillover mechanisms and generate weaker spillover effects on growth. This further reinforces the importance of software exports in eastern Europe to compensate for poorer quality domestic demand. It is in the area of demand support that government policy in the CEE countries may have the strongest effects.

In summary, industry or spillover effects from the CEE software industry are quite substantial. A very high share of software firms operate as knowledge providers by offering training to local clients. High employment turnover rates indicate that a process of knowledge transfer is occurring across organizational boundaries. This is primarily intra-industry transfer as 70% of software personnel leave to join other software firms. A high share of firms consider knowledge gained from foreign projects to be fully or partially transferable to local projects. These results somewhat contradict the pessimism in the literature regarding spillovers from the software sector. However, the spillovers we identified are intra-industry or value chain based; we did not find the presence of horizontal or economy wide spillovers . On the demand side, quality is more important in relation to foreign demand than local demand. However, there are important differences here between central and eastern Europe in that in the latter case local demand represents a constraint to further growth in the sector.

5. CONCLUSIONS

Our research reveals a complex picture with strong common sectoral features, some common regional features, and some sub-regional and country specific differences.

The strong ***sectoral*** features are represented by:
- young dedicated domestic software firms, mainly independent, privately owned with concentrated ownership, mainly oriented towards localization of software
- CEE software industry strongly dependent on strategic alliances with foreign partners and a low share of equity links.

Strong ***regional*** features are represented by:
- dominant relationships being trade and production based with smaller share of technology based partnerships
- links with foreign partners more important for firms' competitive advantage than links with local partners
- substantial industry upgrading, with changes in the components of industry upgrading being country and sub-region specific
- factors of competitive advantage differ between foreign and domestic markets
- factors of competitive advantage in foreign markets are relatively uniform across countries compared to factors in local markets which are more diverse
- substantial spillover effects as a result of a very high share of software firms operating as knowledge providers by offering training to local clients
- intensive intra-industry knowledge transfer through high employment turnover rates as 70% of software personnel leave to join other software firms
- high share of firms consider knowledge gained from foreign projects to be fully or partially transferable to local projects.

There are also important ***sub-regional differences***:
- structure of software supply in eastern European countries (Bulgaria, Romania and Serbia) is less diversified than in central Europe (Slovenia, Czech R, Estonia)
- changes in the majority of the components of industrial upgrading are strongest in countries with lower GDP per capita (eastern Europe) which may reflect 'catching up' rather than differences in transition rates
- quality is more important in terms of foreign than local demand in all countries, with important differences between central and eastern Europe: in the latter case local demand is a much stronger constraint to the further growth of this sector.

It seems that these three sub-regional differences reflect and are caused more by differences in levels of development than by differences in transition.

Two important ***country specific*** patterns were revealed by the analysis:
- expansion of the software industry in CEE is not a common regional trend, but rather a country specific pattern and hence it is difficult to talk about the CEE software industry as a homogenous phenomenon
- there does not seem to be a general CEE tendency towards a strong export expansion as, based on our sample, only Romania is developing an export oriented software industry.

In what respects is the CEE software industry different to that in other emerging markets, such as China, India, Russia and Latin America? To provide an answer to this question more systematic research is needed. Our study provides a fairly rough picture of the position of the CEE software industry from an international perspective.

Our analysis shows that there is a specific CEE pattern of upgrading and globalization which is different from that in Brazil, Russia, India, China, Ireland and Israel (see below).

- **India (services, export oriented)** (Athreye, 2002; Commander, 2003)
- **China (products 40%, services 60%, domestic market oriented)** (Commander, 2003, Tschang and Xue, 2003, Tschang, 2003)
- **Israel (product and export oriented)** (Commander, 2003, 2005; de Fontenay and Carmel, 2001)
- **Brazil (services, domestic market oriented)** (Commander, 2003, 2005)
- **Russia (export oriented services and R&D based services)** (Russoft, 2006)
- **CEE (domestic market oriented, emerging export of services)**

The pattern in CEE is of a local market oriented software sector, but with emerging exports of services especially from Romania. A small number of software product exporters does not represent a dominant trend. Exports of software services on a large scale, comparable perhaps with those of India, seem unlikely in CEE due to the weak organizational capabilities of local firms, which are unable to satisfy the requirements of large foreign clients. Also, the export of software packages is limited by the structural gaps that exist in technology and market access. Successful cases of package producers (Graphisfot and Recognita in Hungary) suffered takeovers precisely because they could not overcome the marketing barriers. Production of packages for the domestic market is difficult given the small size of these markets. However, in cases where the localization component is strong, e.g. in banking, or where security issues (for example, Kurt Rt, Hungary) are paramount, there have been some successes. Also, R&D based software firms are much rarer in CEE, than in Russia for instance, because of their much less populated R&D sectors. As a result, selling software services to the domestic market, based on foreign generic solutions, is favoured by most CEE software enterprises. This should not be interpreted as a 'survival strategy' (Heeks, 1999), but as exploiting an opportunity. Trading or supporting imported packages may, for some time, be more profitable and more attractive for these firms. However, the opening of CEE economies is forcing local companies to develop export oriented services and products which go beyond locally-produced packages for local niche markets. The current successful industrial upgrading if accompanied by further improvements, will open up new opportunities for building organizational capabilities and experimenting with different business models. Building organizational capabilities in localization activities, which are relatively protected, and experimenting with new business models may allow CEE firms to develop export oriented strategies.

We do not have a detailed picture of products and services exports. Analysis by Mroczkowski et al. (2002) suggests that the CEE firms focus on high-end tasks, such as new development of a fully integrated system, and new development of system components, as well as on low end services such as testing, maintenance and support. This combination enables learning and experimentation necessary for integration into the global software industry.

Whether, or how soon, we will see the emergence of a CEE software export market on a large scale will be crucially dependent on how successful local firms are at organisational capability building and introduction of new business models. A study

of firm capabilities and performance in the software services industry shows that both client specific (learning from repeated transactions) and project management capabilities (Ethiraj et al., 2003) are involved. Factors such as low wages, human and financial capital and IT infrastructure are necessary but not sufficient preconditions for growth and catch-up. A recent study of Estonian telecommunications by Hogselius (2005) nicely illustrates the problem. Estonia has become not only user, but also a generator of creative services in innovation. Hogselius documents a range of developments that occurred during the 1990s, including mobile commerce solutions (mobile positioning services, mobile telematics, value added SMS and WAP based solutions), banks as lead IT users, and E-government applications. Inherited competencies are central in explaining why Estonia has become innovative in telecommunication services. Estonia inherited a large number of electronics production enterprises and the radio engineering competencies, which are necessary for mobile communications. Central to its telecommunication developments are the advanced R&D skills in informatics and computer engineering that were located in what was formerly the Institute of Cybernetics. However, these developments have had relatively unimportant commercial and economic effects in Estonia. As Hogselius (2005) points out, they were customized innovations, which, by definition, are not directly transferable to other contexts, are easily imitable and whose innovation is in service provision rather than in any unique firm specific accumulated technological competencies. Also, the Estonian firms faced barriers to exporting. It can be seen, therefore, that inherited competencies at the level of individuals are not sufficient in the absence of firm specific organizational capabilities. How and whether organizational capabilities in the CEE software industry will develop will determine what we can expect in terms of growth and catch-up in the sector.

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