Patterns of Intermediate Consumption and Productivity in the Knowledge Intensive Business Services in Transition Economies[1]

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Abstract

This paper analyses development of the knowledge intensive business services (KIBS) in the Czech and Slovak Republics and Hungary. It examines patterns of KIBS intermediate consumption and looks at the role of KIBS as a factor of production. It compares value added-based and gross output-based production functions for KIBS in aggregate and labour-intensive forms. The paper also relates foreign trade in KIBS to entry by the multinational companies into transition economies and integration of these economies to global markets.

Key words: *knowledge intensive business services, transition economies, productivity, foreign trade*

JEL Classification: O32, O33

Introduction

Growth in the service sector was a major feature in structural change in the OECD members in last three decades. While share of manufacturing and extractive industries decreased steadily, service sectors accounted for major growth increases in terms of employment, gross output and value added. Impressive growth in the service sector, however, was not equally spread among all services industries.

Shares of distributive and public services in total value added, for example, stagnated or decreased in most of the OECD members. It was knowledge intensive business services (KIBS), which became the most rapidly growing sector in

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advanced OECD-member countries in 1980s and 1990s.[2] While high- and medium-high technology manufacturing accounted for about 9 per cent, knowledge-based „market" services accounted for 18 per cent of total OECD value added by the end of the 1990s (OECD, 2001).

Role of services in economic growth and productivity had for a long time been considered marginal. Globalisation and rapid increases in international trade were considered major impetuses for sectoral changes in economies of the advanced OECD member countries. Growth in services sector was attributed to wage competition and crowding out manufacturing industries from advanced to less developed economies. Global markets for manufactured goods were much more integrated then those for services, which were less tradable. Services were considered a substitute rather than complementary production activities to manufacturing.

This view referred to theories, which considered technology change one of the basic production factors (Sollow, 1956; Romer, 1990; Sala-i-Martin, 2001). Services industries were considered less innovative and identified with users of technology, rather than their carriers and/or producers. Studies concerned with factors of growth concentrated on technology change in manufacturing industries, rather than service sector. Inputs of knowledge, however, can be hardly done without knowledge intensive services. In fact, firms engaged in generation and diffusion of KIBS use to contribute to product and process innovation much more than firms involved in manufacturing or agriculture (Cowan and van de Paal, 2000). Hauknes (1998) exemplifies several technological and non-technological service innovations in trade (formats and formulae in retailing, automated inventory), transport and logistics (containerisation, third party logistics), financial services (derivatives, share funds, database management, internet banking), consultancy services (Intangible asset valuation, rapid design and prototyping, environmental impact analysis) and telecom services (cellular telephony systems, broad band ISDN). These innovations had profound impacts on sectoral changes in advanced economies. KIBS hold a specific position in innovation systems. They are • purchasers of knowledge from other industries • providers of knowledge and services for other sectors • transferors of knowledge between particular sectors.

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[2] Particular KIBS can be found among all industrial and service sectors. For practical reasons, most KIBS are ranked to sectors 64 – 74 of the NACE classification: 64 – Post and telecommunications, 65 = Financial intermediation services, except insurance and pension funding services, 66 – Insurance and pension funding services, except compulsory social security services, 67 – Services auxiliary to financial intermediation, 70 – Real estate services, 71 – Renting services of machinery and equipment without operator, 72 – Computer activities and software supply, 73 – Research and development , 74 – Other business services (Legal activities, accountancy, advertising).

In this way, services act as „bridges for innovation" and contribute to economic performance and growth (Muller and Zenker, 2001).

Traditional view of the services as „producer" or „user" sectors is increasingly replaced by „function view" of services in general and knowledge intensive business services in particular. In this view, KIBS-based firms became providers, users, originators and intermediary institutions of the transfer of technological and non-technological innovation (Šarmír, 2002; Czarnitzki and Spielkamp, 2003). Some authors recognise *quaternarisation* as a process which is distinctly characterised by the substantial effect of technological and organisational change on sectoral development (Peneder, Kaniovski, and Dachs, 2003).

Role of technology-based KIBS in technology advance and growth in productivity is increasingly recognised as fundamental. Less debate concentrated on role of non-technological KIBS in productivity growth. Should the business services, for example, considered a growth factor? Some studies (OECD 2002) indicated that countries with better financial systems, for example, accounted for higher growth rates than those with less developed financial industries. Similar evidence was found for other non-technology KIBS. Like technology advances, organisation changes have become the primary source of competitive advantage. Impacts of organisational changes on economic growth and productivity were particularly strong in transition economies of Central Eastern Europe.

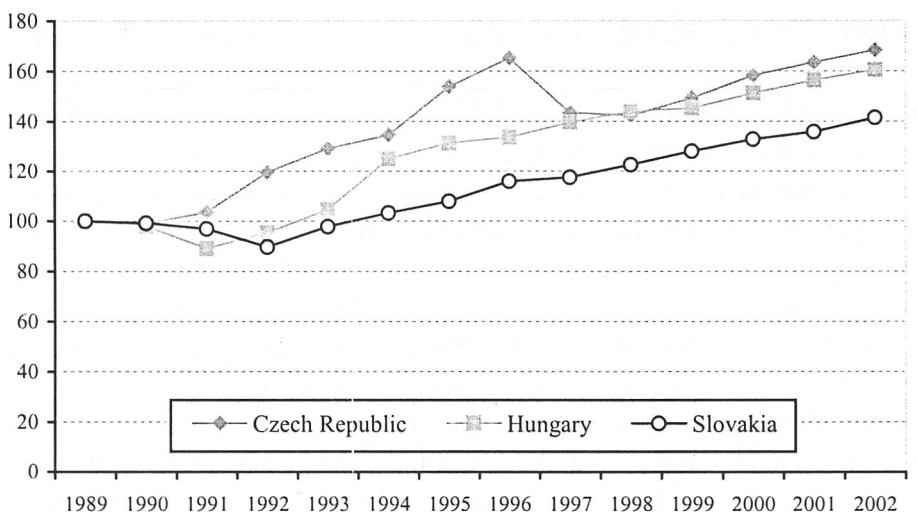
Post-communist countries experienced a double economic shock after 1989. The first one was caused by difficult transition from a centrally planned to a market economy, while the second one by territorial restructuring of foreign trade. Collapse of the Council for Mutual Economic Assistance (CMEA) had a profound impact on producers and exporters in Central Eastern Europe (Němec, Prachár, 2000). The Czech and Slovak Republic and Hungary were small open economies, whose foreign trade turnovers exceeded volume of their GDPs. Among other CMEA members, the abovementioned 3 countries were heavily dependent on exports of manufactured goods to the former Soviet Union and other CMEA members. Introduction of market economy and territorial re-orientation were basic conditions for economic survival. These changes came rather costly – a cumulative decrease in GDP was 28.1 per cent in Slovakia, 21.3 per cent in the Czech Republic and 19.0 per cent in Hungary in period 1989 – 1993 (Kárász, 2003). By 1994 however, recession was over with economic system definitely transiting toward market and territorial structure of foreign trade deeply restructured. Private sector generated from 65 to 75 per cent of the total GDP and exports the EU accounted for 50 per cent to 60 per cent of the total exports. (Williams, Baláž, and Zajac, 1998). These changes were closely related to growth in output and value added in the KIBS (Baláž, 2003).

KIBS certainly did exist in the former communist countries, they role in national economies, however, was limited by system of central planning. Introduction of market system had fundamental implications for the economic agents in the region. The privatised firms had to reconfigure their resources by divesting inappropriate ones, acquiring complementary ones, upgrading existing ones, and integrating all of them (Uhlenbruck; Meyer and Hitt, 2003). A reduction of products and services offered allowed privatised firms to focus on core competences rather than continuing to provide for a larger community as previously required by state agencies (Frydman et al., 1999). Strategic reduction of the product portfolio and vertical integration, through spin-offs or closure, allowed for deeper organizational transformation than general,.operational downsizing (Ericson, 1998). Knowledge intensive services became subject of business for thousands of newly-established firms in transition economies. These firms were able to specialise in selected activities and provide these with higher efficiency than enterprises with multiple production programmes (Zajac, 1996).

Change in the economic system was reflected in overall increases in economic efficiency. Former centrally planned economies were burdened with overemployment and accounted for low productivity levels. Transition to a market system was typical with decreasing numbers of employment and increasing levels of productivity. GDP per worker increased by 40 per cent in Slovakia and over 60 per cent in the Czech Republic and Hungary in period 1989 – 2002 (Figure 1).

Figure 1

GDP per Employee, 1989 = 100 per cent (constant prices 1995)



Sources: OECD (2003c): National Accounts of the OECD Countries and National Statistical Offices of the respective countries.

Input-output provided a valuable tool for examining role of KIBS in economic growth in advanced OECD members. Works by Antonelli (1998 and 2000), Windrum and Tomlinson (1999), Kartsoulacos and Tsounis (2000) and Drejer (2001) established effects of inputs by KIBS on growth in output and productivity. Were these effects visible also in less advanced countries, e. g. transition economies?

Czech and Slovak Republics and Hungary are small open economies. Since early 1990s, they become heavily dependent on foreign trade with advanced OECD member countries. Was this integration into the global economic structures reflected also in trade with KIBS?

This paper deals with several aspects of development of the knowledge intensive business services in the Czech and Slovak Republics and Hungary and compares these to six advanced economies (Belgium, Denmark, Sweden, Japan, Italy and the UK). Firstly, it analyses patterns of intermediate consumption in national economies. Role of KIBS is examined via shares of KIBS in total intermediate consumption, intra-KIBS trade and relation between consumption of KIBS and manufactured goods. Second part of the paper looks at the role of KIBS as a factor of production. It compares value added-based and gross output-based production functions for KIBS in aggregate and labour-intensive forms. Third part of the paper is concerned with foreign trade in KIBS. It relates exports and imports of KIBS to global markets of manufactured goods and entry by multinational companies into transition economies.

Patterns of Intermediate Consumption

KIBS industries played important roles in each economy in this analysis. There, however, some remarkable differences in consumption of KIBS between transition and developed economies. Table 1 displays simplified input-output tables for 9 countries. National economies were divided into 3 sectors: manufacturing industries, KIBS industries and other industries (the latter include agriculture, extractive industries and distributive and public services). The table reveals several interesting facts about consumption patterns in several OECD-member countries:

- Transition economies accounted for lower inputs by KIBS industries than developed ones. The lowest share of KIBS inputs in total inputs was in Slovakia (18.1 per cent), while the higher in the UK (32.7 per cent).
- The Czech and Slovak Republics maintained large manufacturing sectors, which accounted for almost half of the total intermediate consumption. Hungarian economy was rather different and accounted for low shares of manufacturing, medium shares of KIBS and high shares of other industries in total intermediate consumption.

Table 1

Intermediate Consumption Patterns in Selected OECD Economies

	Man	*KIBS*	*Others*	*Total*	*Man*	*KIBS*	*Others*	*Total*	*Man*	*KIBS*	*Others*	*Total*
	Czech Republic 1999				Hungary 1998				Slovakia 1998			
Man	32.4	1.8	12.6	46.8	13.0	2.0	11.7	26.7	27.0	2.0	14.4	43.4
KIBS	3.0	7.6	10.2	20.9	3.7	6.4	13.4	23.5	3.6	5.0	9.5	18.1
Others	9.4	2.2	20.7	32.3	18.3	4.2	27.3	49.8	9.8	2.1	26.6	38.5
Total	44.8	11.6	43.6	100.0	34.9	12.6	52.4	100.0	40.3	9.1	50.5	100.0
	Belgium 1999				Denmark 1998				Sweden 1999			
Man	27.1	2.8	12.7	42.6	11.4	2.1	10.0	23.4	25.8	3.4	11.6	40.8
KIBS	3.2	11.2	14.2	28.6	3.7	8.6	19.8	32.1	3.4	10.0	19.1	32.6
Others	7.3	2.6	18.9	28.8	13.6	5.6	25.2	44.5	13.8	5.9	6.9	26.6
Total	37.6	16.7	45.7	100.0	28.7	16.3	55.0	100.0	43.0	19.3	37.7	100.0
	Italy 1997				Japan 1995				United Kingdom 2000			
Man	21.0	0.7	9.8	31.5	32.8	5.8	15.7	54.3	18.2	2.6	12.0	32.8
KIBS	5.1	6.0	14.1	25.2	5.7	11.4	6.1	23.1	3.6	14.3	16.6	34.5
Others	16.0	2.7	24.6	43.3	8.1	5.2	9.3	22.6	5.1	4.3	23.3	32.7
Total	42.0	9.5	48.5	100.0	46.6	22.4	31.1	100.0	26.9	21.2	51.9	100.0

Sources: National statistical offices of the respective countries and author's own computations. Notes: Man – manufacturing industries, KIBS – knowledge intensive business services.

• Consumption of KIBS inputs by the manufacturing industries seemed remarkably stable across countries in the comparison and varied from 3.0 per cent in the Czech Republic to 5.7 per cent in Japan. Manufacturing inputs, on the other hand, were little consumed in the KIBS industries. This implies relatively low integration of these sectors in countries compared. Japan seemed the only significant exception, with manufacturing to KIBS inputs accounting for 5.8 per cent of the total intermediate consumption. Windrum and Tomlinson (1999) remarked on relatively high integration of the manufacturing and KIBS sectors in Japan and relatively low integration of these sectors in the UK in the 1990. Analysis of the 1995 Japanese and 2000 British data seemed to confirm validity of these assumptions for the later periods.

• Most of the inputs by KIBS were consumed within the same sector in all countries taken into comparison. KIBS products, for example, accounted for some 67 per cent of the total inputs in the UK and Belgium, 65 per cent in the Czech Republic and 63 per cent in Italy. Developed economies accounted for the higher shares of the intra-KIBS trade in total intermediate consumption than transition ones. While the intra-KIBS trade accounted for some 14.3 per cent of the total intermediate consumption in the UK, the respective shares were only 5.0 per cent for Slovakia, 6.4 per cent for Hungary and 7.6 per cent for the Czech Republic.

• KIBS sector generated significantly higher inputs than it consumed in all economies in comparison. It indicates above average productivity of KIBS. Share of the value added in gross output in the KIBS sector ranged from 44.6 per cent (UK) to 65.2 per cent (Italy) in developed economies and from 37.3 per cent (Slovakia) to 61.2 per cent in Hungary (Table 2). The gap between inputs by/to KIBS sector was significant. In the UK, for example, KIBS sector consumed 21.2 per cent of the total inputs, but generated some 34.5 per cent of total intermediate consumption. In Slovakia, KIBS supplied 18.1 per cent of total inputs, but consumed only 9.1 per cent of these. All the 3 transition countries had considerably lower levels of intermediate inputs to KIBS sector than developed ones.

• In summary, transition economies had their domestic KIBS sectors significantly less developed than advanced OECD countries. KIBS industries in transition economies seemed to be little integrated with their manufacturing sector, but this pattern was valid for all countries in this comparison, except Japan. Among transition economies, Hungary accounted for the most developed sector of KIBS industries.

Table 2

Productivity Measures

Country and Year	Per centage Share of Value Added in Gross Output			Share of Employees Compensation in Total Value Added
	KIBS	manufacturing	total economy	
Czech Republic 1999	41.4	51.8	34.0	36.6
Hungary 1998	61.2	52.4	54.0	43.0
Slovakia 1998	37.3	49.8	37.3	37.3
Belgium 1999	45.9	57.8	38.3	42.5
Denmark 1998	52.4	63.5	45.0	51.9
Sweden 1999	49.0	61.0	43.7	47.7
Italy 1997	65.2	33.3	53.4	52.2
Japan 1995	63.9	54.1	44.3	53.9
UK 2000	44.6	62.6	44.1	46.0

Sources: National statistical offices and author's own computations. Notes: p-values in parenthesis.

Patterns of Output and Productivity

Measuring Output and Productivity: Value Added-Based versus Gross-Output Based Models

There are two basic approaches for measuring impacts of the knowledge intensive business services on output and productivity.

1. The first approach refers to Cobb-Douglas production function. Output (measured in terms of gross value added is expressed as a function of labour costs, capital stock and the flow of inputs of knowledge intensive business services on the input side:

$$ln\ Y = \delta + \alpha\ ln\ L + \beta\ ln\ K + \gamma\ ln\ KIBSVA \quad (1)$$

where

ln Y – natural logarithm of value added in particular sectors
ln L – natural logarithm of labour costs
ln K – natural logarithm of capital stock (estimated from investments)
ln KIBSVA – natural logarithm for inputs of KIBS in terms of value added
$\delta, \alpha, \beta, \gamma$ – parameters to be estimated.

Logarithm form of the production function provided for coefficients to read directly as output elasticity parameters. This model was used, for example by Antonelli (1998, 2000). Equation (1) can be expressed also in the labour intensive form

$$ln\ Y/L = \delta + \beta\ ln\ K/L + \gamma\ ln\ KIBSVA/L \quad (2)$$

which estimates productivity measure (Y/L) that is a function of K/L and KIBSVA/L. Data for capital stock were approximated via investments. A yearly 20per cent depreciation rate was used, so $K_t = I_t + 0.8\ I_{t-1} + 0.6\ I_{t-2} + 0.4\ I_{t-3} + 0.2\ I_{t-4}$

2. The second approach goes back to Georgescu-Roegen (1971) and is based on idea that the production process is identified with the application of labour and knowledge to inanimate matter. Windrum and Tomlinson (1999) formulated two version of a gross output-based production function. Equation (3) estimates gross output in each sector as a function of the inputs by labour and intermediate consumption of manufactured products and KIBS:

$$ln\ Q = \delta + \alpha\ ln\ L + \beta\ ln\ MANi + \gamma\ ln\ KIBSi \quad (3)$$

where

ln Q – natural logarithm of gross output in particular sectors
ln L – natural logarithm of labour costs
ln MANi – natural logarithm of inputs by purchased manufactured goods
ln KIBSi – natural logarithm of inputs by purchased KIBS
$\delta, \alpha, \beta, \gamma$ – parameters to be estimated.

Equation (3) also can be expressed in the labour intensive form

$$ln\ Q/L = \delta + \beta\ ln\ MANi/L + \gamma\ ln\ KIBSin/L \quad (4)$$

which estimates productivity measure (Q/L) that is a function of MANi/L and KIBSi/L.[3]

[3] For details of this derivation see Windrum and Tomlinson (1999).

Each approach has some limitations. Lack of exact data on consumption of fixed capital is major shortcoming in the Antonelli-type models. As few countries only publish data on actual consumption of fixed capital, inputs of capital are approximated by capital stock and gross fixed capital formation with unified depreciation rate (e. g. 20 per cent). Depreciation rates, however, vary significantly between countries and industries. There also are considerable problems with deflation of capital inputs done in different years and industries. Availability of data on consumption of fixed capital may have a profound impact on explanation power of the production function model. In this study, consumption of fixed capital data was available only for the Czech and Slovak Republic and Japan. Gross fixed capital formation was used for approximation of stock of fixed capital for other countries.

Tomlinson-type models drop capital inputs and replace these with inputs by manufactured goods plus inputs by knowledge intensive services. A major reservation towards this approach is rather philosophical, as it did not recognise role of extractive industries and/or distributive and social services to generation of gross output.

A common problem, hardly mentioned in literature on KIBS, is multicollinearity. Inputs of labour are highly inter-correlated with inputs of KIBS. This is understandable, because compensation of employees accounted for substantial part of the value added. It ranked, for example, from 36.6 per cent in the Czech Republic to 53.9 per cent in Japan (Table 2).

Inputs of capital were also inter-correlated with inputs of labour in most countries in this survey. Tomlinson-type models dropped capital inputs, but did not avoid problems with multicollinearity. They modeled gross output as a function of the inputs by labour and intermediate consumption of manufactured products and KIBS. Significant part of the inputs by manufacturing and KIBS industries was generated by labour. Hence inputs by labour were correlated with other independent variables, namely inputs by manufacturing and KIBS industries.

Condition index provides for a good detection of potential problems with multicollinearity. The index is the square roots of the ratios of the largest eigenvalue to each successive eigenvalue[4]. A condition index greater than 15 indicates a possible problem and an index greater than 30 suggests a serious problem with collinearity.

[4] Eigenvalues provide an indication of how many distinct dimensions there are among the independent variables. When several eigenvalues are close to zero, the variables are highly intercorrelated and small changes in the data values may lead to large changes in the estimates of the coefficients.

Problem generated by collinearity of labour inputs with production factors can be reduced, if the production function is expressed in its labour-intensive form, which estimates productivity measures (equations *(2)* and *(4)*). Decreased explanation power of the model is a price for this operation. Labour-intensive forms of production function also do not remove collinearity between inputs by capital per worker and KIBS value added per worker.

Major Findings

Computations on value added and gross output in this part of the paper are based on national input-output tables. Slovak data for analysis were provided by Slovak Statistical Office in Commodity-Industry Input-Output Tables. Czech, Belgian, Swedish, Italian, Japanese and British data were available on homepage of the national statistical offices, while Hungarian and Danish data were provided by courtesy of the national statistical offices. KIBS industries in particular countries under analysis are listed in Annex 1.

Findings for aggregate value added-based and gross output-based production functions are summarised in Table 3. Both types of models for all 9 countries for statistically highly significant on 0.000 levels. Explanation power of all models under observation (given by values of R^2) was high and ranked from 0.880 to 0.949 for Antonelli-type models and from 0.648 to 0.966 for Tomlinson-type models.

- Estimated parameters for labour and KIBS were highly significant (on 0.001 levels) and appeared with right signs in the value added-based models. Parameters estimated for capital, however, were not significant on the 0.05 levels for the UK and Czech Republic and appeared with incorrect signs for Belgium, Denmark and Sweden for Antonelli-type models. Collinearity diagnostic (condition index values) indicated severe problems with multicollinearity. Elasticity coefficients for KIBS value added seemed higher in Hungary than in the Czech Republic and Slovakia. Direct comparisons between particular countries, however, were difficult given multicollinearity problems and different classification of production activities.
- Tomlinson-type models provided somewhat more consistent results than Antonelli's ones. Most parameters estimated were significant and appeared with right signs, except for labour parameters in case of Hungary, Czech Republic and Japan and KIBS inputs in Belgium.[5] Like in previous model, Hungary appeared to have the highest elasticity coefficient among transition economies. The Tomlinson-type models also coped with high levels of multicollinearity.

[5] The same problem with parameter for labour was detected by Windrum and Tomlinson (2000) in 1990 Japanese data.

Interestingly, KIBS elasticity coefficients were higher in the gross output-type production function than in the value added based ones in the Czech Republic and Slovakia. In Hungary, KIBS accounted for higher elasticity in generating value added rather than gross output. Established pattern confirmed findings (mentioned in previous chapter) on share of value added and intermediate consumption in gross output in transition economies.

Table 3

Elasticity of Output – Aggregate Function

Regression Equation (1): $\ln Y = \delta + \alpha \ln L + \beta \ln K + \gamma \ln KIBS$								
	constant (δ)	labour (α)	capital (β)	KIBS VA (γ)	N	R^2	F	condition index
Czech 1999	0.860	0.504	0.194	0.319	56	0.880	129.319	35.618
	(0.128)	(0.000)	(0.095)	(0.000)			(0.000)	
Hungary 1998	1.446	0.522	0.071	0.375	55	0.949	319.653	39.846
	(0.000)	(0.000)	(0.001)	(0.000)			(0.000)	
Slovakia 1998	1.655	0.471	0.347	0.155	44	0.939	214.910	65.050
	(0.014)	(0.000)	(0.000)	(0.001)			(0.000)	
Belgium 1999	1.293	0.729	–0.015	0.232	56	0.947	324.292	15.844
	(0.000)	(0.000)	(0.812)	(0.000)			(0.000)	
Denmark 1998	1.559	0.719	–0.028	0.205	128	0.904	394.221	19.804
	(0.000)	(0.000)	(0.039)	(0.000)			(0.000)	
Sweden 1999	3.919	0.299	–0.032	0.591	55	0.932	91.071	39.803
	(0.001)	(0.043)	(0.467)	(0.000)			(0.000)	
Italy 1997	6.300	0.182	–0.014	0.543	91	0.928	69.238	107.564
	(0.000)	(0.200)	(0.484)	(0.000)			(0.000)	
Japan 1995	2.799	0.316	0.156	0.410	92	0.925	354.559	38.043
	(0.000)	(0.000)	(0.000)	(0.000)			(0.000)	
UK 2000	1.075	0.688	0.007	0.259	120	0.948	321.064	33.945
	(0.000)	(0.000)	(0.553)	(0.000)			(0.000)	
Regression Equation (2): $\ln Q = \delta + \alpha \ln L + \beta \ln MANi + \gamma \ln KIBSi$								
	constant (δ)	labour (α)	manufactured inputs (β)	KIBS inputs (γ)	N	R^2	F	condition index
Czech 1999	2.343	0.060	0.470	0.366	56	0.868	115.769	41.195
	(0.000)	(0.636)	(0.000)	(0.000)			(0.000)	
Hungary 1998	3.063	–0.076	0.592	0.371	55	0.844	95.884	49.796
	(0.000)	(0.619)	(0.000)	(0.000)			(0.000)	
Slovakia 1998	1.310	0.275	0.459	0.287	44	0.957	310.466	60.215
	(0.023)	(0.000)	(0.000)	(0.000)			(0.000)	
Belgium 1999	1.311	0.804	0.253	–0.018	56	0.947	323.907	11.664
	(0.000)	(0.000)	(0.000)	(0.678)			(0.000)	
Denmark 1998	4.648	0.229	0.205	0.223	128	0.648	77.382	19.212
	(0.000)	(0.000)	(0.000)	(0.000)			(0.000)	
Sweden 1999	2.498	0.369	0.261	0.283	55	0.945	284.669	41.189
	(0.000)	(0.000)	(0.000)	(0.000)			(0.000)	
Italy 1997	4.113	0.304	0.144	0.426	91	0.966	342.056	70.105
	(0.000)	(0.001)	(0.001)	(0.000)			(0.000)	
Japan 1995	4.789	0.009	0.542	0.232	92	0.809	125.390	24.845
	(0.000)	(0.767)	(0.000)	(0.000)			(0.000)	
UK 2000	2.153	0.393	0.167	0.385	120	0.952	783.055	35.882
	(0.000)	(0.000)	(0.000)	(0.000)			(0.000)	

Sources: National statistical offices and author's own computations. Notes: p-values (significance levels) in parenthesis.

Table 4 displays productivity pattern for (labour-intensive) Antonelli- and Tomlinson-type production functions:

- In models based on value added multicollinearity problems associated with labour inputs decreased, but explanation power of these models decreased as well for some countries (Denmark, Belgium, UK and the Czech Republic). Estimated parameters for capital turned insignificant on the 0.05 levels and/or had wrong signs for these countries. Hungary again seemed to have much higher productivity patterns than the Czech Republic and Slovakia in terms of generating value added per employee.
- As for the gross output-based models (Tomlinson-type), these brought much better results than value added-based ones. Explanation powers (R^2) of these models ranked from 0.439 for Italy to 0.853 for Slovakia. All the estimated parameters were highly significant (on 0.001 levels) and appeared with correct signs. Note that parameters for KIBS intermediate inputs were higher than those for KIBS value added in the Czech and Slovak Republic. Different pattern emerged for Hungary, which accounted for higher elasticity of KIBS value added than gross output. Hungary also accounted for high elasticity coefficient for manufactured inputs.

Gross output-based models seemed better in fitting the productivity patterns in particular OECD members than value added-based ones. They did not rely on hardly-to-get data on capital consumption. They recognised manufactured inputs as basic production factor and were particularly suitable for those countries, where manufacturing played an important role in national economy. This was case both of the developed and transition economies analysed in this study.

It is tempting to compare production and productivity patterns between different countries. Particular OECD-member countries however used their own classification of the industrial and production activities. Many sub-sectors were not directly comparable among various countries, as even the most detailed subgroups embraced very heterogeneous production activities. These sectors were not comparable and could not be aggregated. Lack of comparative statistics at a sufficiently disaggregated level has been a major obstacle for comparative analysis of KIBS in particular countries (Preissl, 1997). For these reasons, results computed from the OECD-member statistics were not directly comparable among different countries. As there was no consistent database on KIBS using the NACE classification for 1990s, any cross-country comparison must be observed cautiously. If the elasticity coefficients for KIBS inputs were not comparable among particular countries it does not mean that they made no contribution to analysis of role by KIBS in national economies. They at least provided a robust evidence for assumption on KIBS as a factor of production.

Table 4

Elasticity of Output – Labour Intensive Function

Regression Equation (3): ln Y/L = δ + β ln K/L + γ ln KIBSVA/L							
	constant *(δ)*	capital (β)	KIBSVA (γ)	N	R^2	F	condition index
Czech 1999	1.025	0.184	0.324	56	0.410	18.725	2.697
	(0.000)	(0.096)	(0.000)			(0.000)	
Hungary 1998	0.414	0.085	0.564	55	0.649	49.007	2.484
	(0.000)	(0.000)	(0.000)			(0.207)	
Slovakia 1998	1.236	0.348	0.153	44	0.655	40.843	3.795
	(0.000)	(0.000)	(0.000)			(0.000)	
Belgium 1999	0.898	0.005	0.216	56	0.305	11.957	3.361
	(0.000)	(0.941)	(0.002)			(0.000)	
Denmark 1998	0.779	–0.011	0.195	128	0.210	16.768	3.125
	(0.000)	(0.413)	(0.000)			(0.000)	
Sweden 1999	1.163	–0.024	534	55	0.505	10.732	3.158
	(0.000)	(0.494)	(0.000)			(0.001)	
Italy 1997	1.460	–0.028	0.418	91	0.319	3.984	3.258
	(0.000)	(0.318)	(0.012)			(0.038)	
Japan 1995	1.155	0.190	0.312	92	0.631	74.352	2.955
	(0.000)	(0.000)	(0.000)			(0.000)	
UK 2000	0.765	0.022	0.270	120	0.382	16.676	3.448
	(0.000)	(0.145)	(0.000)			(0.000)	
Regression Equation (4): ln Q/L = δ + β ln MANin/L + γ ln KIBSin/L							
	constant *(δ)*	manufactured inputs (β)	KIBS inputs (γ)	N	R^2	F	condition index
Czech 1999	1.444	0.494	0.401	56	0.524	29.711	2.459
	(0.000)	(0.000)	(0.000)			(0.000)	
Hungary 1998	1.890	0.611	0.369	55	0.468	23.761	4.360
	(0.000)	(0.000)	(0.000)			(0.000)	
Slovakia 1998	1.633	0.453	0.288	44	0.853	124.585	3.026
	(0.000)	(0.000)	(0.000)			(0.000)	
Belgium 1999	1.911	0.421	0.537	56	0.683	59.361	2.145
	(0.000)	(0.000)	(0.000)			(0.000)	
Denmark 1998	2.110	0.215	0.343	128	0.439	49.385	4.312
	(0.000)	(0.000)	(0.000)			(0.000)	
Sweden 1999	1.730	0.319	0.276	55	0.508	26.357	2.452
	(0.000)	(0.000)	(0.001)			(0.000)	
Italy 1997	2.030	0.169	0.335	91	0.519	19.955	3.052
	(0.000)	(0.001)	(0.000)			(0.000)	
Japan 1995	2.080	0.344	0.603	92	0.700	105.121	2.919
	(0.000)	(0.000)	(0.000)			(0.000)	
UK 2000	1.733	0.203	0.360	120	0.429	44.672	3.177
	(0.000)	(0.000)	(0.000)			(0.000)	

Sources: National statistical offices and author's own computations. Notes: p-values (significance levels) in parenthesis.

Conclusions

KIBS played an important role in economic development of transition countries of Central Eastern Europe. Increases in productivity, economic restructuring and re-orientation of foreign trade were directly related to inputs of knowledge, which in turn, were generated and/or transmitted via KIBS industries.

This assumption was confirmed also in input-output models (whether based on value added or gross output) for the Czech and Slovak Republics and Hungary in late 1990s. While direct international comparisons of KIBS elasticity coefficients were obscured by differences in national systems of production classification, contribution of KIBS to growth in gross output and value added was found significant in all countries in the analysis. Labour-intensive, gross output-based model seemed to generate the most consistent results for a sample of compared countries. The model suggested that KIBS industries were more productive in Hungary than the Czech and Slovak Republics. In the latter countries, KIBS inputs were better in generating gross output rather than value added. Hungary had a relatively large service sector before 1989. An early start of market reforms (dating back to 1970s) and large-scale privatisation of Hungarian manufacturing industries and financial sector by foreign investors in early 1990s were likely to be behind Hungarian success in building strong KIBS industries. Slovakia, on the other hand emerged as a country with the least developed KIBS sector. Slovakian economy was heavily dependent on manufacturing exports before 1989 and had to cope with a painful industrial restructuring during transition period. Undemocratic practices of the Slovak government in period 1992-1998 distracted foreign investors and slowed down entry by multinational companies and introduction of new technologies and organisational changes. Technology gap and lagging productivity in KIBS sector coincided with low share of the value added in gross output in KIBS sector and low share of KIBS in GDP in Slovakia by late 1990s.

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Annex 1

List of KIBS Industries in Particular Countries

Czech Republic *Technology* Postal and telecommunication services, Renting services, Computer and related services, Research and development services Non technology Financial intermediation services Insurance and pension fund services, Services auxiliary to financial intermediation, Real estate services, Other business services	**Hungary** *Technology* Postal and telecommunication services, Renting services of machinery and equipment, Computer and related services, Research and development services Non technology, Financial intermediation services, Insurance and pension funding services, Services auxiliary to financial intermediation, Real estate services, Other business services	**Slovakia** *Technology* Postal and telecommunication services, Data procession and computer services, Research Non technology Financial services, Insurance and financial intermediation, Real estate agencies and rental services, Other business services
Belgium *Technology* Post and telecommunication services Renting services of machinery and equipment, Computer and related services, Research and development services Non technology Financial intermediation services, Insurance and pension fund services, Services auxiliary to financial intermediation, Real estate services, Other business services	**Denmark** *Technology* Post and telecomm., Renting of machinery and equipment etc., Computer activities exc. software consultancy and supply, Software consultancy and supply, Research and development (market), Re search and development (other non-market), Consulting engineers, architects etc. Non technology Monetary intermediation, Other financial intermediation, Life insurance and pension funding, Non-life insurance, Activities auxiliary to fin. intermediat., Real estate agents etc., Dwellings Letting of non-residential buildings, Legal activities, Accounting, book-keeping, auditing etc., Industrial cleaning, Other business activities	**Sweden** *Technology* Post and telecommunication services, Renting services of machinery and equipment, Computer and related services, Research and development services Non technology Financial intermediation services, Insurance and pension fund services, Services auxiliary to financial intermediation, Real estate services, Other business services
Italy *Technology* Communication services, Research and development services Non technology Credit and insurance services, Rent of buildings, Other business services	**Japan** *Technology* Civil engineering, Communication, Research, Goods rental and leasing services Non technology Commerce, Finance and insurance, Real estate agencies and rental services, House rent, Broadcasting, Advertising, survey and information services, Other business services	**UK** *Technology* Postal, courier services, Renting of machinery etc, Telecommunications services, Computer services, Research and development, Architectural activities and technical consultancy Non technology Banking and finance, Insurance and pension funds, Auxiliary financial services, Owning and dealing in real estate, Letting of dwellings, Estate agent activities, Renting of machinery etc, Legal activities, Accountancy services, Market research, management consultancy, Advertising, Other business services