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FDI, R&D AND HUMAN CAPITAL IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

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FDI, R&D and Human Capital in Central and Eastern European Countries[♣]

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Abstract

The recent literature dealing with the determinants of Foreign Direct Investments (FDI) has increasingly emphasised the importance of technological aspects, as both attractive factors and FDI-related technological transfer effects. Focusing on the second perspective, this paper explores the theoretical and empirical relationships between innovative inputs (particularly FDI) and innovative outputs in the EU-27 countries, focusing in particular on the Central and Eastern European countries (CEECs). Findings provide evidence of strong East/West specificities, but also of marked heterogeneity within the CEECs, thus supporting our approach, which emphasises complexity and the specificities of productive and economic conditions.

JEL Classification: O33, P33, P20

Keywords: FDI, Technological spillovers, Knowledge complementarity, Innovative inputs and outputs

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1. Introduction

The role of Foreign Direct Investments (FDI) in favouring the transition of Central and Eastern European Countries (CEECs) towards a market-based economy has been widely debated in recent economic literature. Although some critical views have highlighted the uncertain and uneven effects of foreign capital inflows (e.g., Pavlinek, 2000, 2002 and 2004; Damijan *et al.*, 2003; Pavlinek & Smith, 1998; Szanyi, 2000; Iliuta & Ram, 2005), extensive literature also stresses their potential for industrial modernisation, productivity improvement, increases in quality and competitiveness of outputs. These effects have been connected, in different conditions, with organisational restructuring, technological transfer, worker training, inflows of management practices, and renewal of productive and organisation strategies (e.g., among many others, Sharp & Barz, 1997; Hamar, 1999; Lankes & Stern, 1997; Estrin *et al.*, 2000, Stephan, 2005, Castellani & Zanfei, 2006).

The debate on the possible roles of FDI is closely related to the more general question of the construction of a knowledge-based economy in the CEECs (Radosevic & Piech, 2006). In particular, Radosevic (2006) noted that, during the transition period in the 1990s, neither domestic nor foreign R&D expenditures played a crucial role in supporting economic growth. Conversely, large-scale productive reallocations and provisions of new equipment were implemented to boost innovation and productivity. According to a large theoretical base, described in the following section, inflows of capital investments may also be important vectors or sources of innovation, especially in the short term; however, the generation of domestic technological capabilities remains a priority target to establish conditions for a knowledge-based economy, which in turn underpins long-term sustainable growth.

In this paper, we aim at contributing to this debate by exploring the role played by FDI in a large sample of European countries (including all the CEE members of the EU) in the last few years. More precisely, we set up an interpretative framework within which the mix between various types of innovative inputs (some of them FDI-related), may play a key role in creating domestic innovative outputs and improving productivity levels. We make this scheme of interpretation explicit in the following section, where it is placed in the framework of the most closely related literature. In the second part of the paper, we translate our interpretative outline into empirical evidence for the EU-27 countries, focusing in particular on the Central and Eastern European Countries, and assigning particular importance to industry specificities in manufacturing due to different technology intensities. We are of course aware that complex phenomena such as complementarity or substitution relationships may be very difficult to detect at national levels, where many interacting factors come into play. Similarly, the marked heterogeneity between the contexts considered renders the identification of unique and generalised relationships very unlikely. For these reasons, our empirical strategy is articulated into a first descriptive step in which we also provide, by means of simple correlation analysis, a first idea of possible generalised (i.e., valid for all the countries included in the analysis) coexistences of the different factors considered. On the bases of the results obtained, in the second, more analytical, step we use multivariate statistical techniques (i.e., cluster and canonical linear discriminant analyses) to highlight if sector-specific classifications of countries emerge which are compatible with the stylised models described in the theoretical section, in which the role of FDI is combined with various technological inputs and outputs. The final section summarises the main findings and provides some concluding remarks.

2. A Theoretical Interpretative Framework

2.1. FDI and Domestic Assets

There has been a remarkable effort in the last few years towards systematisation of FDI studies and, more generally, towards re-arranging literature on multinational enterprises (MNEs). As regards their existence, Dunning (1993; 2001a; 2001b) formulated and corroborated over time the so-called "eclectic" or OLI paradigm, in which the juxtaposition of three inter-related large groups of motivations emerge: 1) *ownership-specific* motivations (O), in the sense that foreign production activities allow large firms to achieve scale and scope economies; 2) the strand of motivations which lies on *location advantages* (L) such as: *i)* jumping tariff-barriers; *ii)* lowering the cost of labour or other inputs; *iii*) exploiting technology/knowledge assets; *iv*) benefiting from externalities due to agglomeration economies of the host country; 3) integration of the previous groups of motivations in the *internalisation theoretical framework* (I), which explicitly refers to the transaction cost-based theory of international production.

It is worth noting that these motivations derive from very different theoretical approaches (product cycle theory; normative macro-economy theory; institutional and evolutionary theories; Coasian, Williamsonian and Penrosian theories of the firm), so that attempts to integrate them into an eclectic paradigm have given rise to many criticisms. However, we agree with Dunning (2001b) in considering the OLI paradigm a generic set of conceptual instruments from which "ingredients" to explain particular types of foreign activities may be drawn. Therefore, to underpin our explorative analysis, it seems more useful to move from a classification of MNE strategies formulated by the same author (Dunning, 1993) and re-arranged by Castellani and Zanfei (2006), which relies on the same motivations and, at the same time, can be integrated into a single theoretical paradigm (the Resource Based Theory – RTB[1]), considered by Birkenshaw (2001) as the most fruitful in explaining the headquarter-subsidiaries relationships in MNEs. According to this scheme, the internationalisation of production is pursued for: i) market seeking; ii) resource seeking; iii) efficiency seeking; and iv) strategic asset seeking (Dunning, 1993). By re-arranging this taxonomy, Castellani & Zanfei (2006) grouped the first three strategies into a more general category named "*asset exploiting*", and used it in contrast to the fourth category "*strategic asset seeking*". In some cases, MNEs may simply seek to exploit prior advantages from the market (market seeking), low cost factors (resource seeking) or other externalities and location factors (efficiency seeking) stemming from foreign investments. Therefore, foreign activities appear as substitutes of domestic ones, even though they are carried out more efficiently, and a traditional strategy of *asset exploiting* emerges. In other cases, MNEs may search for complementary assets to be combined with their own. The outcome of this process is the creation of new assets which may also benefit host country firms. In these cases, an *asset seeking* strategy is performed. According to Birkinshaw (2001), the theoretical framework developed within the RBT paradigm offers great potential for study of innovative activities in MNEs and, in our opinion, it easily adapts to explain differences between *asset exploiting* and *strategic asset seeking*. Indeed, in the first case, by means of FDI, MNE pursue a static efficiency that improves their own positions in the international value chain; however, this behaviour may be short-lived for the host countries, since it relies in simply taking advantage of changeable market conditions and other location factors. Conversely, in the second strategy, FDI trigger original combinations of pre-existent technological knowledge and competencies, which in turn may generate dynamic capabilities and long-term competitive advantages for both MNEs and host country firms (Teece *et al*., 1997; Grant, 1998).

2.2. FDI in Search of Complementarities

Several authors highlighted the fact that *strategic asset seeking* needs complementarity between knowledge and technologies. In general terms, Cassiman and Veugelers (2003) deal with the co-occurrence of internal and external knowledge sourcing activities, by formulating a testable hypothesis of complementarity that relies on the concept of supermodularity[2]. An oversimplified result that we can draw from this formulation is that "*two activities that are complementary will be positively correlated*" (Cassiman & Veugelers, 2003, p.6). In more specific terms, Kathuria and Das (2005) showed that, on one hand, MNE need a minimum amount of adaptive R&D expenditure in order to modify their own technologies and suit them to local conditions. On the other hand, they take advantage of forward and backward linkages and produce knowledge spillover effects only when an adequate knowledge base exists in the host country/sector and if domestic firms carry out R&D expenditure to improve the absorptive capacity of foreign technology. Borensztein *et al.* (1998) deal in a very similar way with complementarity between FDI and the human capital of the host country. It is worth noting that the question of spillover effects enlarges the theoretical point of view from which we study complementarity and the recombination of knowledge treated within RBT. Thus, from a firm level, where only relationships between the head office and its own subsidiaries are taken into account, we shift to a country and sector perspective by considering, at a more macro-economic level, the consequences and determinants of FDI localisation, related in particular to the diffusion of technology.

Direct FDI effects may result from increases in the demand for labour, R&D expenditure, on-the-job training and, above all, injection of additional capital into the host economies (Blomstrom & Kokko, 1997). Sectoral specialisation is also often considered a determining factor of FDI localisation: firms in the same industry are attracted by productive contexts which have substantial endowments of skilled workers, since they will avoid labour shortages or bottlenecks (Clausing & Dorobantu, 2005; Carnstensen & Toubal, 2004; Kinoshita & Campos, 2003; Bronzini, 2004). In addition, other external economies typical of agglomeration processes may take place, as highlighted by very extensive literature in various and interrelated theoretical directions, e.g., MAR- Marshall (1920), Arrow (1962), Romer (1986) - externalities in the growth theories; external economies in the New Economic Geography approaches (Krugman, 1991a; 1991b) and in the Porter (1990) or neo-Marshallian

[1] Resource Based Theory basically relies upon Penrosian theories of the firm.
[2] The function of pay-off derived from two activities performed by two different firms is supermodular when adding one activity while the other is already being performed, has a higher incremental effect on total pay-off than adding the activity in isolation.

(e.g., Becattini 2004; Cossentino *et al.*, 1996) theories of local development. At the same time, the international fragmentation of production, also favoured by FDI (Grossman & Rossi-Hansberg, 2006), plays a key role in redefining specialisation patterns, especially in CEE-EU(15) trade relationships (De Simone, 2005). In this case, FDI may generate new sectoral specialisation, thereby affecting the formation of labour skills and *learning-by-doing* processes. In addition, voluntarily or not, FDI may become an informal channel for technology transfer (Blomstrom & Kokko, 1997). One of the main reasons for policy interventions aimed at attracting FDI is the belief that domestic firms can benefit from the presence of foreign multinationals, by means of positive spillovers that will improve their productivity (Girma *et al.*, 2004, Kneller & Pisu, 2005). This has also been verified for some specific sectors in the CEECs (Keren & Ofer, 2000; Radosevic & Rozeik, 2005).

Some indirect FDI benefits concern the possibility of some spillover of *firm specific assets* from multinationals to domestic firms. *Horizontal spillovers* (or intra-industry) regard sector-specific knowledge which, independently of the multinationals' will, favours domestic competitors (Blyde *et al.*, 2004); for instance, the domestic firm acquires knowledge as a result of hiring workers who have worked or/and been trained in foreign firms. Reverse engineering (imitation) is another way of taking advantage of relevant knowledge created within multinationals. *Vertical spillovers* (or inter-industry) involve general rather than sector-specific technological knowledge and benefit firms in upstream (supplier) and downstream (buyer) industries. These firms are stakeholders for multinational enterprises, not direct competitors. The creation of buyer-supplier linkages between foreign and domestic firms is crucial in order to achieve a real technological transfer that boosts productivity and favours sustained long-term growth (Dunning, 1993, Rodriguez Clare, 1996, Markusen & Venables, 1999).

Thus, as already stated, the presence of these direct and indirect effects provides support to study complementarity between FDI and innovative input (R&D and human capital) at macro-level[3]. At the same time. this complementarity may trigger other positive complementarities among other innovative inputs. The possibility of activating a virtuous knowledge-creating spiral, in which tacit and explicit (codified) knowledge is continuously being combined and remixed (Nonaka & Takeuchi, 1995) has been treated not only at firm level. For example, some aspects of endogenous growth theory emphasise that complementarity between R&D and human capital plays a crucial role in obtaining innovative outputs (patents, overall innovations), higher productivity levels and growth rates. In particular, Young (1991, 1992, 1993), following what the history of technical change suggests, combined a model of invention in which technical change is the outcome of costly and deliberate research aimed at developing new technologies, with a *learning-by-doing* model in which technical change is the serendipitous by-product of experience gained during the production of goods. The idea underlying this theoretical work is that, if no new technical processes are introduced, it is unlikely that *learning-by-doing* can be sustained, since the amount of knowledge that must be serendipitously acquired from experience in productive activities is finite in any given environment. Conversely, although most new technologies are initially markedly inferior (in terms of immediate productivity gains) than the older ones they try to replace, incremental improvements over time allow new technologies ultimately to overcome older production systems across a wide variety of activities.

To sum up this discussion, we hypothesise that, when MNEs follow a *strategic asset seeking*, there are more probabilities that the improved growth performance of host country will rely on complementarity between FDI and innovative inputs, that in turn trigger complementarity among innovative inputs (R&D and human capital). The concurrent presence of FDI, innovative inputs, innovative outputs and good productivity performance highlights the fact that host country should gain long-term advantages from FDI, since the recombination of knowledge is responsible for the augmented levels of innovation and productivity. Conversely, in the *asset exploiting* case, all the above-mentioned ingredients are not present at the same time; hence complementarities are not at work and FDI may not provide host countries with long-term advantages.

In this paper, we provide initial empirical evidence of these stylised models using national-level aggregated data. In particular, we look for correspondences between forms of the above-mentioned complementarity (in which FDI play a key role), quantity of innovative outputs and levels of productivity. We obviously acknowledge that analysing FDI and technology complementarities at country level may be questionable. In any case, beyond the theoretical reasons explained before, there are also elements in our empirical work that counterbalance this weakness. First, one innovative aspect of our research is that the analyses were carried out using a sectoral breakdown based on the various technological intensities of manufacturing, under the hypothesis that this is useful for identifying the technological environment from which complementarity may emerge. By performing

[3] For example, Borensztein *et al.* (1998) model and test the effect of complementarity between FDI and human capital in the process of economic growth, by maintaining the theoretical scheme of endogenous growth theory.

this distinction, we can also contribute to the interesting debate concerning the real domestic technology capabilities of high-tech industries in those CEECs where investments and exports have remarkably improved in recent years (Srholec, 2006). Second, country-level analysis ensures that the analysis covers a large geographical range: this allows our explorative analysis to offer a general picture of European economies by articulating *strategic asset seeking vs asset exploiting* hypothesis, in both Western and Eastern European countries.

3. Empirical Analysis

The objective of empirical analysis is to provide first (descriptive) support to the conceptual framework illustrated in the previous section, focusing in particular on Central and Eastern European Countries. For this aim, the next sub-section describes the main characteristics of the data and variables used; then we present the results of simple comparative descriptive statistics and some correlation analyses. The latter are simply aimed at identifying possible generalised relationships and coexistences between the features considered; however, given the high heterogeneity of the units observed and the variety of possible combinations of innovative inputs and outputs, we do not expect clearcut indications from simple correlations. For these reasons, in the last part of the empirical analysis, by means of multivariate statistical techniques, we try to identify different groups of countries which share similar features with respect to the aspects considered, and to assess if these characterisations are compatible with the models described in the theoretical section.

3.1 Data and Variables Used

All indicators used in the analysis were drawn from the Eurostat database and range between the years 2000 and 2005. Some proxies of innovative inputs and outputs are derived from surveys carried out in different periods (e.g., the Community Innovation Survey is available for 2000 and 2004), or present missing values that were reconstructed by linear interpolation. In order to render our analysis more robust, for all variables we divided our dataset into two sub-periods (2000-2002, 2003-2005) and used the corresponding averages rather than the single year values. The dataset includes the EU-27 countries, but our focus is on the group of the ten Central and Eastern European (CEE-10) countries.

Apart from the first descriptive table (table A1), in which both aggregate stocks and flows are listed, when the sectoral breakdown is introduced we only consider inward FDI[4] stocks. In particular, manufacturing economic activities were reclassified into four macro-sectors: High-Tech Sectors (HTS), Medium High-Tech Sectors (MHTS), Medium Low-Tech Sectors (MLTS) and Low-Tech Sectors (LTS) (Table 1). This classification is the same as that used by Eurostat[5].

Table 1. Manufacturing technological intensity macro-sectors

Technological intensity	NACE Rev.1.1 Sectors
High-Tech Sectors (HTS)	Aerospace (35.3); Pharmaceuticals (24.4); Computers, Office machinery (30); Electronics-communications (32); Scientific instruments (33)
Medium High-Tech Sectors (MHTS)	Electrical machinery (31); Motor vehicles (34); Chemicals - excl. pharmaceuticals (24 excl. 24.4); Other transport equipment (35.2+35.4+35.5); Non-electrical machinery (29)
Medium Low-Tech Sectors (MLTS)	Coke, refined petroleum products and nuclear fuel (23); Rubber and plastic products (25); Non-metallic mineral products (26); Shipbuilding (35.1); Basic metals (27); Fabricated metal products (28)
Low Tech-Sectors (LTS)	Other manufacturing and recycling (36+37); Wood, pulp, paper products, printing and publishing (20+21+22); Food, beverages and tobacco (15+16); Textile and clothing (17+18+19)

[4] It should be noted that, besides *green field* investments, FDI also include acquisitions of existing firms. In this second case, we consider an investment as an FDI only if the direct investor acquires at least 10% of the equity capital of the firm resident in the reporting economy.

[5] See "High-technology manufacturing and knowledge intensive services sectors", Eurostat metadata web page, http://europa.eu.int/estatref/info/sdds/en/htec/htec_base.htm".

R&D expenditure intensity on GDP (R&D_GDP) is the most classically used innovative input; in the industrial context it is also usually used to proxy the codified form of knowledge (Young, 1993). R&D results may be embodied in patents, products or process innovations, blueprints, books, etc. Starting with the work of Griliches (1979), a new theoretical and empirical field of economic research has attempted to specify and estimate a *knowledge production function* and R&D expenditure is the main productive factor (Jaffe, 1989; Jaffe *et al.*, 1993; Acs *et al.*, 1992, 1994, 2002; Feldman, 1994). Unfortunately, this indicator is not available at the desired sectoral level due to many missing data at industry breakdown; in order to show explicitly the importance of R&D at a sectoral level, we also considered R&D personnel by sectors standardised out of the country population (R&D_P_LT, R&D_P_MLT, etc.).

R&D activities are of course not the only innovative input. As already argued, sectoral specialisation may be a proxy of *learning-by-doing* processes and tacit knowledge accumulated within the labour force (Serrano *et al.*, 2003; Paci & Usai, 2000), independent of the initial determinants of the agglomeration processes (i.e., advantages in labour costs rather than in learning opportunities). This may provide important external positive effects on productivity, in which the crucial role of the effectiveness of circulation of specific knowledge is placed within a wider set of agglomeration economies. It is obviously debatable to what extent a country-level analysis would be able to capture properly these effects, which are typically studies in regional and sub-regional detail. However, the country specialisation pattern may in any case reveal the presence of a (relatively) diffused productive specificity from which positive external effects may derive. To proxy sector specialisation, we use a *Balassa* specialisation index for the four sub-sectors (SPEC_LT, SEPC_MLT, etc.).

In addition, formation of skills within firms may be the result of a combined effect of formal training processes and *learning-by-doing* (Freeman, 1998); in particular, training is often considered to be an important condition for good performance of FDI in CEE countries (Radosevic & Rozeik, 2005). As a proxy of training activity, we selected a Life-Long Learning (LLL) indicator, i.e., participation of adults aged 25-64 in all learning activities undertaken throughout life (number of participants out of total population), in order to improve knowledge, skills and competences.

As mentioned in the previous section, proxies of human capital are usually used in the literature as innovative inputs and are often considered complementary to R&D activities (Young, 1991, 1992, 1993). In our case, we chose the traditional higher education indicators: (i) the population aged 15 and over with upper secondary and post-secondary non-tertiary levels of education (ED_DIP), and (ii) the population aged 15 and over with tertiary education (ED_LAU) (ISCED 1997 classification). These data were standardised out of the total population.

Regarding innovative output, we considered patents (per million inhabitants) and the share of innovative manufacturing enterprises out of the total of manufacturing firms. The number of patent applications is the most frequently used indicator for describing successful innovative activities (Griliches, 1990). It is well-known that this measure, although widely used, is controversial, the main problems associated with its application being institutional bias (the patent application trend is very often closely related to specific national laws and norms) and sectoral bias (propensity of patents to depend on the different technological regimes that characterise various industries). We attempt to overcome the first problem by using patent applications presented to the European Patent Office (EPO). Regarding sector specificities, Eurostat data are arranged according to the International Patent Classification (IPC), and not to economic activities. For this reason, we were not able to reach the sector breakdown illustrated in table 1; consequently, a second-best solution in which the number of groups was reduced (hi-tech and low-tech sectors) was adopted (IPC_LT and IPC_HT). Following several relatively recent contributions (Acs *et al.*, 1992, 1994, 2002; Feldman, 1994), we also introduced a second innovative output indicator, i.e., the percentage of manufacturing enterprises with innovation activities (INN_ENT). This information was obtained from the Community Innovation Survey (CIS) for the years 2000 and 2004, and concerns all enterprises that introduced new, or significantly improved, products or processes. This measure not only includes drastic or important innovations that are worthy of patent application, but also the small improvements in products or production processes that stem from informal innovative activities.

Productivity levels are simply arranged according to the country's value added per worker (PROD), since it was not possible to arrange this indicator at the desired sectoral level.

Summarising, we were able to refer the following variables to the adopted sectoral breakdown: FDI stocks, sectoral specialisation and R&D personnel; for the patent data, we distinguished two sectors (high- and low-tech); the indicators of innovative enterprises and productivity refer to the manufacturing sector.

3.2 First Descriptive Evidence

We present here the main comparative evidence for the EU-27, with particular attention to the Central and Eastern European Countries (CEECs). Data refer to the second and more recent period considered (all variables are averages 2003-2005).

As Table A1 (appendix) shows, FDI inflows in the CEECs in the period 2003-2005 do not seem to be particularly remarkable in absolute values, compared with the values of the Western economies. Nevertheless, FDI stocks and/or flows, calculated with respect to national GDP, are clearly above the levels of the Western members, and this shows that FDI are a crucial component for the development of CEE economies. Table A1 also shows that geographical proximity influences the investment source, i.e., the share of FDI coming from the EU-15 partners is notable, and is similar in the EU and CEE countries.

The picture of inward FDI by macro-sectors (with respect to GDP), concerning only stocks, is quite complex (Table A2). In general terms, we find the primacy of the total services sector in almost all countries, although there are important shares of GDP for manufacturing in some CEE countries (Hungary 21.2%, Slovakia 20.6%, Czech Republic 18.9%) as well as in the old EU-15 countries (Ireland 47.8%, Netherlands 25.5%, Sweden 25.1%,)[6]. As regards the total services sector, there are also higher FDI values among the CEE countries (Estonia 52.8%, Czech Republic 24.1%, Hungary 23.9, Slovakia 22.0%, Latvia 20.0%) than in some EU-15 countries, like Sweden, Italy and Greece. This is probably partly due to liberalisation in the financial, banking and other business services within these transition economies (UN-ECE, 2005; Pavlìnek, 2004).

The next two descriptive tables in the appendix focus on FDI data in the manufacturing sector, broken down according to the classification of Table 1. Table A3 again depicts the importance of FDI in the four technology-intensity sectors out of country GDP; Table A4 illustrates the specialisation patterns of manufacturing FDI by means of a classical Balassa index (share of FDI in sector *j* and country *i* out of total FDI in country *i*, standardised on the corresponding average of the countries considered), so that a value above one means above-average specialisation in the sector, and *vice versa*. Data are provided for the two sub-periods considered (averages 2000-2002 and 2003-2005). The two tables provide a very complex picture, in which a clear dichotomy between Western and Eastern countries does not emerge. As regards the LT sectors, the highest shares of FDI on GDP are indeed recorded in the most recent period in Ireland and Netherlands, and, among the CEE, only Estonia overtakes Sweden. In all the remaining Eastern countries, FDI in low-tech sectors account for an important share of GDP (between 3% and 4%), with the important exception of Slovenia. A similar role is played in CEE by MLT sector FDI, which are particularly high (and growing) in Slovakia and Lithuania but relatively weak in the other two Baltic countries. Surprising information emerges from the data on FDI in MHT sectors, where the Czech Republic, Hungary, Slovenia (and Slovakia in the second period) show the relatively strongest inflows (compared with the other sectors and to the majority of Western countries). As regards HTS, only Hungary shows a remarkable attractive capacity, which is however only overtaken by Ireland. Complementary outcomes emerge in terms of FDI specialisation (table A4), with the majority of CEE countries persistently specialised in low- and medium-tech FDI, but also with the important exceptions of Hungary, Slovenia (and the Czech Republic in the second period), which show above-average specialisation in high- and medium high-tech FDI. This diversity of outcomes within the CEEC group clearly shows that it is not possible to identify a single pattern or model of FDI localisation, and that the stylised models discussed in the theoretical section may not simply help in explaining East-West differences, but also the complexity of FDI behaviour in transition economies. Moreover, it should be noted that the strong specialisation and importance of FDI specialisation in LT sectors of many Eastern countries should not necessarily lead to the conclusion that these FDI are simply export-seeking. The industries included in the LT sector are indeed not only labour-intensive but also resource- (e.g., wood, pulp and paper) or capital- (e.g., textile) intensive; or compatible with a market seeking objective (e.g., food, beverages)[7]. In any case, as stressed in the theoretical section, all these strategies may be included in a more general category termed asset exploiting, if the co-occurrence of innovative ingredients and productivity does not emerge. For this reason, we performed a correlation analysis in the first step and a multivariate analysis in the second step.

3.3 Correlation Analysis

Again for purely descriptive purposes, we also carried out simple correlation analysis (Tables A5-A8) for all the European countries, focusing on the differences between the four manufacturing sectors. Correlations are of course calculated for the whole sample, so, given the strong heterogeneity of the countries considered and the

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[6] In particular, the high value recorded in Czech manufacturing seems to reflect the attractive power displayed in the last few years by sectors such as the automotive industry (Radosevic & Rozeik, 2005; Pavlìnek, 2004).

[7] We owe this specific remark to one referee’s comment on the complexity of sectoral specialisation of FDI in Central and Eastern Europe.

complexity of FDI patterns, *ex-ante* expectations are not for an identification of clear and stable relationships. The analysis is simply aimed at providing a first picture about possible generalised co-existences of the factors which may characterise the FDI models stylised in the theoretical section. Each table lists the correlation coefficients of all the variables in levels in the two sub-periods (average 2000-2002 and 2003-2005)[8] and their significance levels. We also calculated correlations in changes (% changes between 2000 and 2005) in order to assess the possible co-movements of the variables considered; however, results are in many cases quite misleading due to the fact that changes are obviously influenced by the starting levels of the variables, often rendering the correlation coefficients poorly informative[9].

A first comment can be made regarding the relationships between the variables which are not taken at sectoral level (R&D expenditures, levels of human capital, life-long learning, innovative firms, and productivity). R&D_GDP is, as expected, positively correlated to high levels of human capital (EDU_LAU), training (LLL), innovative output (INN_ENT and patents) and productivity (PROD). These variables also show highly significant and positive correlations between themselves. These co-existences would support, in general terms (i.e., not taking into account industry specificities), the idea of complementarity between these innovative inputs envisaged under various theoretical perspectives, which can translate into high levels of innovative output and productivity performance.

The remaining correlation coefficients for the LT specific variables show remarkable stability over the two periods (Table A5). A first interesting point is the absence of any significant correlation between FDI sectoral localisation and all the other variables. A negative relationship is found between sectoral specialisation and R&D_GDP, LLL, innovative output and productivity. At the same time, IPC_LT is strongly associated with high levels of human capital, training, R&D and productivity performance. This suggests that, in general, the LT sectors with high innovation propensity probably need injections of codified knowledge, rather than the presence of specific external productive conditions, to perform their processes and to pursue good economic performance. Continuous reorganisation of production processes, which is the result of steady R&D expenditure and leads to patent applications, may justify the need for training that would allow more efficient adaptation of workers. In any case, the innovative activities described above do not seem to rely on FDI.

If we consider the correlation matrix for MLTS (Table A6), the situation is very similar to that of LTS in terms of non-existent significant relationships between FDI and innovative inputs and outputs. However, in this case, sector specialisation is no longer alternative to high innovative efforts and performances (correlation coefficients are no longer significant). Rather, specialisation seems beneficial to productivity. Thus, in the case of MLT sectors, specialisation does not simply signal structural features associated with productive and economic backwardness, but probably provides a specific productive environment which is favourable to efficiency gains, although not in relationship with other innovative and productivity sources.

In MHTS industries (Table A7), significant and positive correlations emerged between FDI and R&D_GDP on one hand and FDI and LLL on the other. In the second period, the positive relationship between FDI and SPEC also becomes significant. Moreover, strong innovative performances (IPC_HT, but also INN_ENT) are positively related to high levels of human capital, training and productivity, and growing specialisation is accompanied by increasing R&D efforts and intermediate human capital endowments. One may hypothesise that these co-existences of innovative inputs, outputs and productivity depend on the presence of FDI, which may sustain this complementarity. This possible effect can be simply verified using partial correlation analysis, which allows identification of spurious correlations between two variables, only induced by their correlation with a third one. In our case, if the co-existence of innovative inputs, outputs and productivity depends on the presence of FDI, the correlations should disappear when FDI are constant. However, the partial correlation coefficients between the variables "controlling" for FDI reveal that all the relationships persist, except

[8] As indicated in the Tables, for some correlations the number of observations is lower than 27, due to missing data.

[9] For example, due to the fact that its initial level is low, the change of R&D_GDP is very high for various CEE countries: +52% for Estonia (0.61 in 2000 and 0.93 in 2005); +30% for Lithuania (from 0.59 to 0.76); +27% for Latvia (0.44 to 0.57). Conversely, the change over the period is small for some countries (e.g., Scandinavian) which exhibit high starting levels of R&D expenditures on GDP: +9% for Denmark (2.24 to 2.45) and -6% for Sweden (4.16 to 3.89); and +4% for Finland (3.34 to 3.48). Similarly misleading results are obtained, for example, in the case of human capital: EDU_LAU rises sharply in Italy, Portugal, Poland, Romania and Slovakia (where the indicator remains at around 5% in the two periods), and is substantially stable in Finland, Sweden and the UK, where its levels are, however, at about 15%. The relatively low informative potential of the outcomes does not change if simple differences (instead of % changes) or average annual changes are used. These tables of correlation are of course available upon request.

for the link between specialisation and R&D expenditures, which loses its significance[10]. This suggests that the presence of FDI is not crucial in determining the described contemporaneous presence of the innovative inputs and outputs, and so that a general (i.e., holding for all the countries considered) complementarity pattern between FDI and other factors cannot be hypothesised.

The results for HTS reveal first of all a significant and positive correlation (0.60 and 0.67 in the two periods) between FDI and specialisation levels. However, no other significant relationship exists for FDI. Thus, to some extent surprisingly, FDI in medium-high and high-tech sectors seem more attracted, in general terms, by specific productive environments (possibly generating some kind of external economies) than by the presence of intangibles, in particular R&D activities, or human capital. Instead, good innovation performances are associated, beyond R&D efforts, with increasing human capital endowment and training, and all these intangibles are positively and significantly related to productivity. However, FDI seem substantially extraneous to this mix of factors typically operating in high-tech sectors.

Overall, these findings highlight different and complex relationships in the four technological manufacturing intensity macro-sectors, and do not allow us to determine clear generalised patterns. This only means that clear and unique relationships do not apply in general to all the contexts considered; this was at least partly expected, due to the structural and economic heterogeneity of the contexts considered which, also according to theory, suggest a complexity (rather than a homogeneity) of possible relationships between the factors. However, the hypothesised co-existence of FDI and intangibles in subsets of countries with specific features cannot be excluded. For these reasons, we carried out the multivariate analyses of the next section.

3.4 Position of CEE Countries within the European Picture: Cluster and Discriminant Analyses

Our main objective here is to identify possible subgroups of countries which are relatively similar with respect to the features of interest; this also allows us to discuss the position of the CEE countries within the more general framework of the whole European area. For this aim, we use two methods of multivariate analysis: for each of the four technology intensity sectors we carried out a cluster analysis (CA) using the variables referring to the first period (average 2000-2002) in order to obtain groups of similar countries[11]. Then, moving from the resulting configuration, we tested its stability in the second period by means of canonical linear discriminant analysis (CLDA), which assigns a probability to each unit of analysis to persist in its group or to move to another one. We again emphasise that the aim of our research is purely explorative, and we do not intend to verify the existence of cause-effect relationships. Nonetheless, the results may highlight the co-existence (and persistence) of economic conditions, more or less consistent with our interpretative framework, which may help to characterise the phenomena examined or to render our research hypotheses explicit, to be tested in future studies.

The correlation for some of the variables available suggested limiting the number of indicators to those providing the least redundant information. When choosing the “active variables” of the cluster and the discriminant analysis, we obviously privileged the indicators that provided the most complete information, thus trying to maximise the number of countries included in each analysis. As the strength of the correlation among the initial set of variables changes across the four technology intensity sectors, the set of “active variables” is different in implementation. However, given the centrality of our interpretative and descriptive scheme of FDI, we always included this variable in the set of the active ones. Prior to their implementation, each variable was standardised on the average of the available EU-27 countries and this allows the characters of the groups to be compared directly with a benchmark of EU-27 = 1. Obviously, once the outcomes of the analyses were considered satisfactory, the “non-active variables” could be re-introduced, in order to characterise the groups in the two periods.

The classification of the 20 countries considered in the first cluster analysis (low-tech sector, variables are averages for 2000-2002) is articulated into the six clusters shown in Table 2, which also lists the group averages. Table 3 illustrates the results of the CLDA, and indicate a strong persistence in the second period (2003-2005) of the configuration obtained in the CA for the first one (200-2002). The CLDA does classify with a very high

[10] The partial correlation coefficients between IPC_HT and LLL, EDU_LAU and PROD are all significant at 99% and are 0.62, 0.60 and 0.72, respectively. The corresponding coefficients and significance levels for INN_ENT are 0.55 (95%), 0.55 (95%) and 0.76 (99%). Lastly, the partial correlations (and corresponding p_values) between SPEC_MHT and R&D_GDP, R&D_P_MHT and EDU_DIP are 0.23 (0.31), 0.68 (0.02) and 0.52 (0.02).

[11] Among the various methods of cluster analysis available in STATA, we chose a two-step approach, first carrying out a CA with the hierarchic *Ward’s linkage* method, and then testing stability of the resulting configuration by the *K-means* method, using the centres of the clusters previously obtained as “seeds”.

probability all the units considered in the same cluster where they fell after CA. Table 4 simply lists the characterisation of the clusters in the second period.

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Table 2. Clusters of Countries for the Low Tech Sector (averages 2000-2002)

	1	2	3	4	5	6
	Germany France Cyprus Austria Italy	Lithuania Estonia	Ireland	Bulgaria Romania	Denmark Finland U. K. Netherlands Sweden	Czech Republic Poland Slovakia Latvia Slovenia
	Cluster means					
FDI_LT*	0.20	1.63	3.27	1.07	1.07	0.94
R&D_GDP	0.86	0.35	0.59	0.23	1.44	0.46
R&D_P_LT	0.54	0.87	1.06	1.58	1.21	1.03
INN ENT*	0.81	0.99	0.84	0.64	0.90	1.09
IPC_LT	1.23	0.03	0.50	0.01	1.62	0.09
SPEC_LT*	0.85	1.56	0.62	1.30	0.74	1.23
LLL*	0.68	0.62	0.68	0.16	2.57	0.92
EDU_DIP*	1.04	1.17	0.89	1.16	1.14	1.50
EDU_LAU*	1.00	1.46	1.25	0.72	1.45	0.70
PROD	1.24	0.15	1.24	0.08	1.27	0.28

(*) Active variable in the cluster analysis

Table 3. Discriminant Analysis for the Low Tech Sector (averages 2003-2005)

	Cluster 00-02	Class. (03-05)	p		Cluster 00-02	Class. (03-05)	p
Germany	1	1	1.00	Denmark	5	5	1.00
France	1	1	1.00	Finland	5	5	1.00
Cyprus	1	1	1.00	U.K.	5	5	1.00
Austria	1	1	1.00	Netherlands	5	5	1.00
Italy	1	1	1.00	Sweden	5	5	1.00
Lithuania	2	2	0.80	Czech Republic	6	6	0.96
Estonia	2	2	1.00	Poland	6	6	0.88
Ireland	3	3	1.00	Slovakia	6	6	1.00
Bulgaria	4	4	0.96	Latvia	6	6	0.95
Romania	4	4	0.95	Slovenia	6	6	1.00

Table 4. Cluster means for the LTS after discriminant analysis (averages 2003-2005)

	1	2	3	4	5	6
FDI_LT*	0.22	1.70	2.36	1.16	1.27	0.95
R&D_GDP	0.91	0.43	0.66	0.24	1.44	0.46
R&D_P_LT	0.55	1.12	0.75	1.34	1.47	0.75
INN ENT*	1.24	0.95	1.47	0.48	1.20	0.71
IPC_LT	1.22	0.05	0.51	0.02	1.63	0.15
SPEC_LT*	0.85	1.67	0.55	1.50	0.71	1.21
LLL*	0.80	0.60	0.67	0.14	2.60	0.78
EDU_DIP*	1.04	1.26	0.87	1.15	1.11	1.49
EDU_LAU*	0.99	1.32	1.37	0.71	1.43	0.76
PROD	1.21	0.18	1.29	0.09	1.29	0.30

In LTS, in the two periods the Central and Eastern European countries are completely separate from the Western countries and fall into three clusters, which however show similar features. The first one contains two Baltic countries (Lithuania and Estonia) and is characterised by high intensity of FDI, accompanied by below average R&D efforts, especially in terms of expenditure on GDP, low training, above- average human capital endowments and high sector specialisation. As regards innovative outputs, the group shows very low levels of patents and on-average shares of innovative enterprises (this indicator refers to the whole manufacturing sector). This mix also corresponds to very poor productivity performance. The other two groups of CEECs (numbers 4 and 6) highlight similar features: although the FDI attractive capacity is lower, the two clusters have strong sector specialisation, very weak innovative output and productivity performance, and poor endowments of highly skilled labour. Although the situation of Lithuania and Estonia seems to some extent to evolve towards an increase in codified knowledge assets, these findings suggest that in these sectors FDI orientation in CEEC mainly tends towards an *asset exploiting* model, in which the productive conditions are probably characterised by relative cost advantages (which are also at the basis of strong specialisation) and thus gains in terms of production processes (or their segments) with low value added. This is also apparent if we consider cluster 5 (all the Scandinavian countries and the UK), where the FDI attraction capacity is above average and is accompanied by an innovative input/output mix and productivity performance which is clearly compatible with the complementarity of intangibles associated to a *asset seeking* model of FDI. The remaining clusters complete the picture: Ireland (cluster 3) shows a relatively high attractive capacity, only accompanied by strong education levels and productivity performance; cluster 1 is characterised by very poor FDI, but this does not prevent good innovative and productivity performance. Lastly, the overall clusters characterisation clearly shows that good productivity performance is associated with low specialisation, and *vice-versa*. This confirms one of the few general outcomes obtained in the correlations, and may reveal that, at least at country level and for the LT industries, this indicator is better able to measure a stage of structural development than the existence of internal or external conditions which may attract foreign investments or help efficiency.

In order to emphasise the main differences between LTS and HTS, we now consider the results carried out on the high-technology sectors: we comment later on MLT and MHLT.

The configuration into six clusters for HTS obtained in the first period (Table 5) is again confirmed in the second one by discriminant analysis (Tables 6 and 7).

Table 5. Clusters of Countries for the High Tech Sector

	1	2	3	4	5	6
	Bulgaria Estonia Cyprus Lithuania Romania	Latvia Poland Slovenia Slovakia	Denmark Finland U. K.	Germany France Austria	Ireland Netherlands	Czech Republic Hungary
			Cluster means			
FDI_HT *	0.49	0.23	0.72	0.77	4.26	1.79
R&S_GDP*	0.26	0.42	1.34	1.19	0.77	0.56
R&S_HT_P	0.76	1.18	0.91	1.69	1.59	0.71
INN ENT*	0.75	1.07	0.98	0.77	1.05	0.80
IPC_HT	0.05	0.05	2.99	1.39	2.26	0.06
SPEC_HT*	0.53	0.81	1.27	1.24	1.56	1.35
LLL*	0.41	0.95	2.66	0.75	1.44	0.58
EDU_DIP*	1.10	1.42	1.09	1.20	1.01	1.53
EDU_LAU*	1.16	0.72	1.51	1.02	1.29	0.68
PROD*	0.23	0.29	1.25	1.46	1.23	0.26

(*) Active variable in the cluster analysis

Table 6. Discriminant Analysis for the High Tech Sector (average 2003-2005)

	Cluster 00-02	Class. (03-05)	p		Cluster 00-02	Class. (03-05)	p
Bulgaria	1	1	1.00	Denmark	3	3	1.00
Estonia	1	1	1.00	Finland	3	3	1.00
Cyprus	1	1	1.00	U.K.	3	3	1.00
Lithuania	1	1	0.99	Germany	4	4	1.00
Romania	1	1	0.91	France	4	4	1.00
Latvia	2	2	0.90	Austria	4	4	1.00
Poland	2	2	0.78	Ireland	5	5	1.00
Slovenia	2	2	0.69	Netherlands	5	5	1.00
Slovakia	2	2	0.94	Czech Republic	6	6	0.91
				Hungary	6	6	0.99

Table 7. Cluster means for the HTS after discriminant analysis (average 2003-2005)

	1	2	3	4	5	6
FDI_HT *	0.36	0.39	0.44	0.70	3.90	2.66
R&S_GDP*	0.31	0.40	1.39	1.25	0.81	0.60
R&S_HT_P	0.66	1.49	1.13	1.94	1.19	0.89
INN ENT*	0.83	0.64	1.22	1.34	1.23	0.75
IPC_HT	0.11	0.05	2.91	1.57	1.58	0.10
SPEC_HT*	0.57	0.83	1.27	1.29	1.61	1.62
LLL*	0.46	0.83	2.66	0.87	1.19	0.50
EDU_DIP*	1.13	1.41	1.07	1.17	0.96	1.52
EDU_LAU*	1.10	0.79	1.48	1.00	1.39	0.70
PROD*	0.24	0.31	1.28	1.44	1.25	0.28

For HTS, cluster composition immediately provides evidence of marked differences compared with LTS. Apart from The Netherlands and Ireland, which clearly correspond to the *strategic asset seeking* behaviour of FDI in high-tech intensity sectors, and from the third cluster (which again proposes the similarity between Denmark, Finland and the UK), the CEE countries plot in three quite different groups. This, first of all, suggests that the situation of the CEE countries in the HTS is far less homogeneous than in LTS. Two Baltic countries (Estonia, Lithuania), Bulgaria and Romania are set apart, with very low levels of both potential innovative inputs (including FDI) and outputs, but on-average levels of human capital. This characterisation is not far from that of the second cluster where, however, the sector-specific innovative effort is higher, but does not translate into better innovative or productive performance. Instead, two CEECs (Czech Republic and Hungary) do provide evidence of high FDI attractive capacity which is, however, only associated with high sector specialisation and high endowments of intermediate human capital. Since the picture is completed by low productivity and innovative performance, this evidence may be compatible with FDI localisation strategies, which are again oriented towards the exploitation of cost advantages, but which also search for local conditions able to sustain production processes or, probably, the low value added segments of them, which do not need particularly high inflows of codified knowledge (Srholec, 2006). Apart from the FDI attraction capacity, the distinctive feature of cluster 6 compared with groups 1 and 2 is the high level of sector specialisation, which is now associated - unlike the case of LT sectors, and as emerged in the correlation analysis - to the presence of other intangibles. This may suggest that high-tech FDI in the Czech Republic and Hungary not only reward low labour costs, but also the presence of external economies deriving from agglomeration.

The outcomes (Tables 8-10) for the Medium-Low Tech sector (MLTS) again suggest a repartition into six clusters in the first period; discriminant analysis carried out using the same variables in the second period provides the interesting result that Poland, placed in cluster 4 in the first period is, with a very high probability (0.91), associated with the other CEE countries of group 1 in period 2. This means that the Polish situation has evolved in a relatively different direction with respect to the remaining countries of cluster 4, approaching the characteristics of Romania, Hungary and Bulgaria. In any case, the clearcut diversification between the CEE countries and the remaining Western countries is also confirmed for the MLT industries.

Table 8. Clusters of Countries for the Medium-Low Tech Sector (averages 2000-2002)

	1	2	3	4	5	6
	Romania Hungary Bulgaria	Czech Republic Slovenia Slovakia	Germany France Austria	Estonia Cyprus Latvia Lithuania Poland	Netherlands	U.K. Sweden
			Cluster means			
FDI_MLT *	1.52	1.60	0.33	0.46	3.74	0.40
R&S_GDP*	0.32	0.59	1.19	0.28	0.95	1.59
R&S_MLT_P	2.56	1.43	0.89	0.38	0.65	0.42
INN ENT*	0.58	1.17	0.77	0.88	1.26	0.37
IPC_LT	0.04	0.14	1.77	0.04	1.79	1.52
SPEC_MLT*	0.87	1.55	1.04	0.67	0.63	0.85
LLL*	0.24	0.97	0.75	0.68	2.21	2.81
EDU_DIP*	1.19	1.62	1.20	1.16	1.13	1.08
EDU_LAU*	0.72	0.66	1.02	1.18	1.32	1.39
PROD*	0.14	0.34	1.46	0.28	1.22	1.15

(*) Active variable in the cluster analysis

Table 9. Discriminant Analysis for the MLT (average 2003-2005)

	Cluster 00-02	Class. (03-05)	p		Cluster 00-02	Class. (03-05)	p
Bulgaria	1	1	0.99	Estonia	4	4	1.00
Hungary	1	1	0.94	Cyprus	4	4	1.00
Romania	1	1	1.00	Latvia	4	4	1.00
Czech Republic	2	2	1.00	Lithuania	4	4	0.97
Slovenia	2	2	1.00	***Poland***	***4***	***1****	***0.91***
Slovakia	2	2	1.00	Netherlands	5	5	1.00
Germany	3	3	1.00	Sweden	6	6	1.00
France	3	3	1.00	U.K	6	6	1.00
Austria	3	3	1.00				

** indicates misclassified observations*

Table 10. Cluster means for the MLT after discriminant analysis (average 2003-2005)

	1 *(includes Poland)*	2	3	4 *(now excludes Poland)*	5	6
FDI_MLT *	1.14	1.96	0.31	0.55	3.17	0.40
R&S_GDP*	0.32	0.58	1.25	0.33	0.95	1.52
R&S_MLT_P	1.45	1.73	1.17	0.03	0.57	0.46
INN ENT*	0.52	0.83	1.34	0.90	1.00	1.19
IPC_LT	0.05	0.22	1.76	0.04	2.02	1.43
SPEC_MLT*	0.92	1.54	1.03	0.69	0.57	0.82
LLL*	0.30	0.86	0.87	0.71	1.70	3.13
EDU_DIP*	1.19	1.61	1.17	1.18	1.06	1.14
EDU_LAU*	0.72	0.72	1.00	1.25	1.41	1.34
PROD*	0.19	0.36	1.44	0.30	1.21	1.18

The collocation of the CEECs in the case of MLT industries is quite complex. While the fourth cluster (which in the second period does not include Poland) does not show any particular attractive capacity for FDI, the first and second groups highlight mainly common features (in particular, above-average FDI inflows associated with R&D specific to the industries, high levels of intermediate human capital, low patent production and productivity), but also differ in terms of specialisation, training, and share of innovative manufacturing enterprises. This may mean that, in the case of Romania, Hungary and Bulgaria (and Poland in the second period), the FDI model is close to that identified as *asset exploiting*, the high R&D personnel probably depending on the activity performed by foreign firms. Instead, the situation for the Czech Republic, Slovenia and Slovakia may envisage the co-presence of *asset exploiting* and *asset seeking* models, the latter due to the possible beneficial effects of specialisation and training activities which may complement the innovative inputs provided by foreign firms in the provision of diffused innovation outcomes (above average INN_ENT). Again, the Netherlands provides a very important example of compatibility with the complementarity effects described in the *asset seeking* scheme.

The fourth cluster analysis (MHTS) reveals a classification into seven clusters, the stability of which over the two periods is confirmed by discriminant analysis (Tables 11-13). The specificities of Denmark, Finland and the UK (group 5) and The Netherlands (cluster 6) again emerge clearly, but the analysis also highlights the outstanding performance of Sweden, where the synergy hypothesised for the *asset seeking* model again seems clearly exemplified. Moreover, findings also reiterate how good innovative and productive performance can be achieved in the absence of remarkable FDI inflows by relying on domestic factors of tacit and codified knowledge (cluster 4, i.e., remaining Western countries).

Table 11. Clusters of Countries for the Medium-High Tech Sector

	1	2	3	4	5	6	7
	Bulgaria Poland Romania Slovakia	Estonia Cyprus Latvia Lithuania	C. Republic Hungary	Germany France Italy Austria	Denmark Finland U.K	Netherlands	Sweden
				Cluster means			
FDI_MLT*	0.58	0.25	1.99	0.49	0.60	2.38	5.45
R&S_GDP*	0.28	0.27	0.64	1.04	1.34	0.95	2.19
R&S_MHT_P	1.85	0.17	1.39	1.08	1.11	0.64	n.a.
INN ENT	0.92	0.80	0.92	0.89	0.98	1.26	0.29
IPC_HT	0.01	0.07	0.09	1.13	2.99	3.67	2.63
SPEC_MHT*	1.04	0.40	1.66	1.35	0.98	0.63	1.43
LLL*	0.51	0.70	0.73	0.73	2.66	2.21	2.69
EDU_DIP*	1.31	1.12	1.50	1.09	1.09	1.13	1.29
EDU_LAU*	0.65	1.33	0.71	0.90	1.51	1.32	1.42
PROD*	0.15	0.29	0.36	1.38	1.25	1.22	1.35

(*) Active variable in the cluster analysis

Table 12. Discriminant Analysis for the MHT (average 2003-2005)

	Cluster 00-02	Class. (03-05)	p		Cluster 00-02	Class. (03-05)	p
Bulgaria	1	1	0.99	Germany	4	4	1.00
Poland	1	1	1.00	France	4	4	1.00
Romania	1	1	1.00	Italy	4	4	1.00
Slovakia	1	1	1.00	Austria	4	4	1.00
Estonia	2	2	1.00	Denmark	5	5	1.00
Cyprus	2	2	1.00	Finland	5	5	1.00
Latvia	2	2	1.00	U.K.	5	5	1.00
Lithuania	2	2	1.00	Netherlands	6	6	1.00
C. Republic	3	3	1.00	Sweden	7	7	1.00
Hungary	3	3	1.00				
Slovenia	3	3	1.00				

Table 13. Cluster means for the MHT after discriminant analysis (average 2003-2005)

	1	2	3	4	5	6	7
FDI_MLT*	0.83	0.24	1.88	0.54	0.60	2.42	4.52
R&S_GDP*	0.27	0.33	0.65	1.09	1.39	0.95	2.08
R&S_MHT_P	1.29	0.24	1.43	1.28	1.17	0.81	n.a.
INN ENT	0.56	0.90	0.78	1.23	1.22	1.00	1.32
IPC_HT	0.02	0.14	0.10	1.28	2.91	2.58	2.48
SPEC_MHT*	1.09	0.44	1.77	1.38	0.94	0.59	1.53
LLL*	0.30	0.71	0.86	0.80	2.66	1.70	3.35
EDU_DIP*	1.27	1.18	1.49	1.09	1.07	1.06	1.31
EDU_LAU*	0.68	1.25	0.77	0.88	1.48	1.41	1.32
PROD*	0.17	0.30	0.38	1.34	1.28	1.21	1.39

As regards the CEE countries, their articulation resembles that already discussed for HTS. The Czech Republic and Hungary again highlight good FDI attractive capacities accompanied by sector-specific R&D efforts, specialisation and intermediate levels of human capital; this mix corresponds to intermediate levels of diffused innovative activity (INN_ENT). Again, this situation seems intermediate between the two polar schemes (*asset seeking* / *exploiting*). The characters of the remaining clusters 1 and 2 reinforce the interpretation provided for clusters 1 and 2 in the HT sector.

4. Summary and Final Remarks

Using a simplified theoretical framework, this paper explores empirically the relationships between FDI, some innovative inputs (R&D, human capital, training, specialisation levels of labour), innovative outputs (innovation propensity, number of patent applications) and productivity in the European countries (EU-27), with particular attention to the CEE countries.

The aim was to focus on the latent relationships among innovative inputs, in order to study the intensity with which they correlate to innovative outcomes (patents and number of innovations) and productivity, and also to highlight the role played in this context by FDI which, in certain conditions, may support key complementarities among inputs and boost good productivity performance. Our attempt was to provide empirical evidence for the fact that host countries may derive advantages from inward FDI not only (and simply) where they are coupled with higher levels of R&D investments and human capital, but also (and especially) where they co-exist with rich flows of innovative outputs and satisfactory productivity levels. In this second case, it cannot be excluded that FDI contribute to generating a knowledge base for a sustainable growth path. We also conjecture that these processes are sensitive to specific technological contexts, and therefore assigned crucial importance to a manufacturing sectoral breakdown by technological intensity classes. In order to provide clear theoretical references to measure empirical findings, we adopted a polar distinction of FDI-related strategies, available in the recent literature, into *asset exploiting* versus *asset seeking* targets, the latter highlighting the role of complementarities. In our essentially descriptive empirical approach, our interest is to place EU-27 countries, and in particular the CEECs, within this framework, assessing their eventual aspects of heterogeneity or homogeneity.

Preliminary descriptive analysis stressed that FDI are an important component for the development of CEE economies, and that their industry breakdown reveals not only the primacy of total services, but also the importance in manufacturing especially in some CEE (e.g., Hungary, Slovakia, Czech Republic) and old EU-15 (e.g., Ireland, Netherlands, Sweden) countries. The picture of FDI specialisation within manufacturing is complex, in the sense that a clear dichotomy between Western and Eastern countries does not emerge. Although the majority of CEE countries is persistently specialised on low and medium tech FDI, important exceptions are represented by Hungary, Slovenia (and the Czech Republic in the second period, 2003-2005), which show above-average specialisation in high and medium-high tech FDI. Moreover, also the important FDI specialisation in LT sectors of many Eastern countries cannot simply be interpreted in the sense that these FDI are exclusively or prevalently export-seeking, due to the fact that the LT aggregate sector includes, beyond labour-intensive, also resource (e.g., wood, pulp and paper) or capital (e.g., textile) intensive industries, or productions compatible with a market seeking strategy (e.g., food, beverages).

The correlation analysis revealed that, with few exceptions, generalised and univocal relationships between the variables considered do not emerge. This is consistent with our *ex-ante* expectations built on the theoretical background, which suggested a variety of models rather than univocal patterns, and on the high economic and structural heterogeneity of the units considered.

The evidence provided by multivariate statistical analysis contributed to discern the variety of situations in which FDI may or may not play key roles. First evidence common to the four sectoral cluster and discriminant analyses is that the Central and Eastern European countries are, in the two periods, completely separate from the Western ones, confirming their persisting structural diversity.

In the LT sectors, the CEECs fall into three clusters, which however show similar features. Although the situation of Lithuania and Estonia seems to some extent to evolve towards an increase in codified knowledge intensity, findings indicate that in LT sectors FDI orientation in CEEC mainly tends towards an *asset exploiting* model. Conversely, the case of the Scandinavian countries and the UK provides an example of compatibility with the *asset seeking* model of FDI.

The case of MLT industries is more complex. While the Baltic countries do not show any particular attractive capacity for FDI, the remaining CEECs highlight mainly common features in terms of R&D specific to industries, high levels of intermediate human capital, low patent production and productivity; however, they also differ in specialisation and training levels, and in the share of innovative manufacturing enterprises. In the case of Romania, Hungary, Bulgaria and (in the most recent period) Poland, the FDI model is close to that identified as *asset exploiting*, the high R&D personnel probably depending on the activity performed by foreign firms. Conversely, the Czech Republic, Slovenia and Slovakia may envisage the co-presence of *asset exploiting* and *asset seeking* targets, the latter due to possible beneficial effects of specialisation and training activities which may complement the innovative inputs provided by foreign firms in the provision of diffused innovation outcomes.

Lastly, the results for the MHT and HT sectors are quite similar. While the Scandinavian countries, The Netherlands, the UK and Ireland provide important and clear examples of the *asset seeking* strategy, the situation of the CEE countries again highlights remarkable heterogeneity. In particular, the Czech Republic and Hungary are set apart and characterised by remarkable FDI attractive capacity which is, however, associated with sector specialisation and high endowments of intermediate human capital, but low productivity and innovative performance. Again, this evidence may be compatible with FDI localisation strategies oriented towards the exploitation of cost advantages, but which also search for local conditions able to sustain production processes (or, probably, the low value added segments of them, which do not need particularly high inflows of codified knowledge). As had already emerged in the correlation analysis, and unlike the case of LTS, high specialisation in MHT and HT sectors is associated in general with the presence of other intangibles. This may suggest that external economies deriving from agglomeration are at work, and attract FDI in the Czech Republic and Hungary, coupling other cost-based attractive factors.

Although further research is needed in order to provide more robust evidence of the results obtained descriptively, they generally highlight some key characteristics of the many persisting differences between CEE countries, and also the complexity governing the possible combinations of various inputs and outputs which can contribute to productivity and economic performance. In our opinion, future research efforts should be devoted to investigating the dynamics of the possible models: in particular, a crucial point will be to understand whether the conditions of some CEECs identified with the co-existence of *asset exploiting* and *asset seeking* factors will further evolve towards the second model and, in this case, in which time horizon. Similarly, dynamic analysis may reveal if other countries will follow this path and when, or will persist in a position in the new international division of labour which may ensure capital injections but not necessarily the setting up of sustainable growth conditions.

APPENDIX

Table A1. Inward FDI in absolute values , as a % of GDP and importance of the EU-15 and US FDI

	Total inward FDI (Millions Euro) 2005		FDI W /GDP		FDI (EU-15)/FDI W		FDI (US)/FDI W	
			Average 2003-2005					
	stock	flows	stock	flows	stock	flows	stock	flows
Belgium	n.a.	27640	n.a.	10.69	n.a.	83.2	n.a.	8.4
Denmark	98292	10373	42.68	4.99	62.72	46.86	14.57	-4.00
Germany	526536	28841	24.25	0.76	72.59	90.41	14.90	-5.49
Ireland	138620	-25482	105.02	-2.35	73.86	44.53	9.69	22.58
Greece	n.a.	n.a.	10.38	n.a.	80.14	n.a.	6.18	n.a.
Spain	314415	20119	34.51	2.50	72.81	82.56	17.06	8.94
France	560263	65177	29.51	2.58	73.14	81.18	12.12	11.81
Italy	189934	16020	11.91	1.06	72.27	86.63	10.42	5.25
Luxembourg	37061	93578	128.40	284.44	81.33	64.73	12.79	6.80
Netherlands	382367	38354	72.43	4.07	58.54	123.14	19.78	-58.27
Austria	58874	8981	21.42	2.60	70.88	72.62	11.25	10.66
Portugal	55606	3188	36.02	2.98	71.98	41.60	2.72	-1.88
Finland	46272	3820	28.12	1.98	89.75	87.62	2.79	10.84
Sweden	145422	8210	48.46	2.55	67.49	42.58	17.94	41.18
United Kingdom	704529	155793	32.80	4.04	45.21	69.25	34.32	7.30
Cyprus	7338	954	49.50	6.86	44.56	57.63	1.96	4.64
Malta	3476	534	65.67	12.50	81.91	37.86	1.32	-1.70
Czech Republic	51433	9374	47.47	5.40	84.94	65.85	5.04	6.14
Estonia	9539	2254	75.33	12.55	84.36	84.74	4.71	-0.05
Latvia	4199	573	29.55	3.92	55.72	40.71	7.00	6.10
Lithuania	6921	826	27.82	2.80	60.24	71.26	5.88	-3.01
Hungary	52341	6203	53.02	4.64	69.23	97.65	3.71	1.93
Poland	76533	8284	28.75	3.52	83.30	80.94	7.75	6.56
Slovenia	6132	662	20.75	2.71	70.19	72.44	1.45	1.58
Slovakia	19951	1952	47.32	6.25	78.96	78.34	3.64	-0.07
Bulgaria	10731	3103	38.07	12.80	68.28	64.30	6.25	3.92
Romania	21884	5211	23.53	6.25	70.88	76.92	3.42	1.54

Source:Eurostat
Note: Luxemburg is an outlier due to transhipping

Table A2. Inward FDI stock by macro-sectors as a % GDP (average 2003-2005)

	Agriculture and fishing 595	Mining and quarrying 1495	Manufacturing 3995	Electricity, gas and water 4195	Construction 4500	Total services 5095
Belgium	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Denmark	0.00	1.38	4.79	0.34	0.12	37.40
Germany	0.01	0.03	3.04	0.04	0.03	21.10
Ireland	0.00	n.a.	47.83	n.a.	0.00	57.05
Greece	0.00	0.18	3.65	n.a.	0.27	6.28
Spain	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
France	0.03	0.04	5.25	0.22	0.07	23.24
Italy	0.05	0.28	4.54	0.30	0.00	6.60
Luxembourg	0.00	n.a.	14.99	n.a.	n.a.	113.08
Netherlands	0.01	2.69	25.55	1.43	0.07	42.59
Austria	0.01	0.15	4.56	0.09	0.04	16.56
Portugal	n.a.	n.a.	3.99	0.28	0.29	28.68
Finland	n.a.	0.29	8.80	0.67	0.26	17.95
Sweden	n.a.	-0.40	25.12	2.46	0.14	5.24
United Kingdom	0.02	3.66	8.03	1.75	0.27	19.07
Cyprus	0.01	0.44	1.17	0.00	0.89	46.39
Malta	n.a.	n.a.	13.18	n.a.	n.a.	55.31
Czech Republic	0.06	0.44	18.95	3.07	0.84	24.10
Estonia	0.38	0.31	12.14	1.50	1.20	52.87
Latvia	0.47	0.16	3.94	2.22	0.44	20.01
Lithuania	0.21	0.22	9.85	2.39	0.33	14.82
Hungary	0.23	0.08	21.25	1.98	0.43	23.88
Poland	0.13	0.06	10.58	0.98	0.53	16.40
Slovenia	0.01	-0.01	9.59	1.00	0.02	10.15
Slovakia	0.15	0.26	20.59	3.83	0.48	21.99
Bulgaria	0.25	0.31	8.32	2.12	0.86	26.61
Romania	0.15	1.36	10.30	0.47	0.30	10.94

Source: Eurostat

Table A3. Inward FDI stock by manufacturing sub-sectors as a % of GDP (averages 00-02 and 03-05)

	LT		MLT		MHT		HT	
	00-02	*03-05*	*00-02*	*03-05*	*00-02*	*03-05*	*00-02*	*03-05*
Belgium	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Denmark	1.44	1.85	n.a.	n.a.	0.91	1.88	0.08	0.06
Germany	0.16	0.31	0.26	0.56	1.29	1.44	0.41	0.42
Ireland	9.19	7.22	n.a.	n.a.	n.a.	n.a.	3.98	4.69
Greece	1.85	1.56	1.35	1.01	0.46	0.54	0.04	0.06
Spain	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
France	0.76	0.81	0.63	0.70	1.86	2.80	0.36	0.38
Italy	0.63	0.92	n.a.	n.a.	1.92	2.36	n.a.	n.a.
Luxembourg	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Netherlands	5.22	7.71	6.14	7.30	8.07	9.19	2.31	0.78
Austria	0.92	0.89	0.74	0.91	1.51	1.61	0.94	0.67
Portugal	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Finland	1.86	2.55	n.a.	n.a.	2.00	2.43	0.79	0.34
Sweden	4.39	4.68	0.67	1.30	18.44	17.09	n.a.	n.a.
United Kingdom	2.17	2.74	0.65	0.56	3.22	2.54	0.71	0.52
Cyprus	0.32	0.36	0.60	0.71	0.18	0.23	0.05	0.04
Malta	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Czech Republic	3.80	3.82	2.88	3.86	4.81	6.59	0.70	0.97
Estonia	5.22	6.61	0.64	0.99	1.68	1.61	0.34	0.49
Latvia	2.68	2.43	0.47	0.27	0.67	0.36	0.02	0.04
Lithuania	3.91	3.84	1.16	3.35	0.80	1.52	0.30	0.27
Hungary	4.58	3.73	2.30	2.94	9.67	9.51	1.94	2.74
Poland	2.67	3.09	0.92	1.58	2.27	3.43	0.28	0.33
Slovenia	1.64	1.57	1.43	1.51	5.70	5.30	0.18	0.22
Slovakia	2.42	3.69	3.66	8.31	1.39	5.07	0.19	0.49
Bulgaria	3.92	3.98	3.05	3.40	2.00	1.84	0.86	0.35
Romania	2.07	3.12	2.23	2.86	2.23	2.36	0.27	0.13

Source: Eurostat

Table A4. Specialisation of inward FDI stock within the manufacturing sectors (average of all available countries = 1; averages 00-02 and 03-05)

	00-02				**03-05**			
	LT	MLT	MHT	HT	LT	MLT	MHT	HT
Belgium	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Denmark	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Germany	0.24	0.63	1.54	2.26	0.37	0.88	1.37	2.18
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Greece	1.53	1.89	0.32	0.12	1.59	1.36	0.45	0.29
Spain	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
France	0.65	0.91	1.30	1.16	0.56	0.65	1.55	1.14
Italy	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Luxembourg	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Netherlands	0.73	1.47	0.95	1.23	0.99	1.25	0.96	0.44
Austria	0.69	0.93	0.93	2.69	0.71	0.95	1.03	2.31
Portugal	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Finland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sweden	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
United Kingdom	0.98	0.50	1.21	1.23	1.38	0.38	1.04	1.17
Cyprus	0.84	2.73	0.40	0.48	0.87	2.26	0.44	0.42
Malta	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Czech Republic	0.95	1.23	1.00	0.65	0.81	1.08	1.13	0.90
Estonia	2.03	0.43	0.54	0.51	2.19	0.44	0.44	0.71
Latvia	2.13	0.64	0.44	0.06	2.53	0.37	0.29	0.22
Lithuania	1.94	0.97	0.33	0.56	1.49	1.42	0.42	0.47
Hungary	0.76	0.65	1.33	1.22	0.64	0.66	1.31	2.07
Poland	1.33	0.78	0.94	0.53	1.19	0.78	1.06	0.56
Slovenia	0.56	0.83	1.62	0.24	0.59	0.75	1.61	0.36
Slovakia	0.97	2.45	0.46	0.29	0.65	2.07	0.75	0.40
Bulgaria	1.35	1.43	0.54	0.80	1.37	1.41	0.52	0.52
Romania	0.92	1.71	0.84	0.47	1.19	1.43	0.73	0.21

Source: Eurostat

Table A5. Correlations for LT

	Levels (average 2000-2002)									Levels (average 2003-2005)								
	FDI_ LT	R&D _GDP	R&D_ P_LT	SPEC_ LT	EDU_ DIP	EDU_ LAU	LLL	IPC_ LT	INN_ ENT	FDI_ LT	R&D _GDP	R&D_ P_LT	SPEC_ LT	EDU_ DIP	EDU_ LAU	LLL	IPC_ LT	INN_ ENT
R&D_GDP	-0.11									-0.07								
Sig.	*0.63*									*0.75*								
N.	*22*									*22*								
R&D_P_LT	-0.02	0.17								0.11	0.39							
Sig.	*0.93*	*0.43*								*0.65*	*0.07*							
N.	*20*	*24*								*19*	*22*							
SPEC_LT	0.04	-0.56	-0.06							0.08	-0.50	-0.11						
Sig.	*0.88*	*0.00*	*0.79*							*0.72*	*0.01*	*0.63*						
N.	*20*	*24*	*21*							*21*	*25*	*21*						
EDU_DIP	0.03	0.19	0.29	0.18						0.10	0.14	0.14	0.28					
Sig.	*0.90*	*0.34*	*0.18*	*0.41*						*0.65*	*0.47*	*0.53*	*0.18*					
N.	*22*	*27*	*24*	*24*						*22*	*27*	*22*	*25*					
EDU_LAU	0.18	0.52	0.07	-0.27	-0.04					0.26	0.51	0.31	-0.31	-0.08				
Sig.	*0.43*	*0.01*	*0.74*	*0.20*	*0.83*					*0.23*	*0.01*	*0.16*	*0.13*	*0.70*				
N.	*22*	*27*	*24*	*24*	*27*					*22*	*27*	*22*	*25*	*27*				
LLL	0.02	0.71	0.09	-0.42	0.22	0.53				0.04	0.78	0.36	-0.38	0.15	0.60			
Sig.	*0.94*	*0.00*	*0.68*	*0.04*	*0.28*	*0.00*				*0.85*	*0.00*	*0.10*	*0.06*	*0.45*	*0.00*			
N.	*22*	*27*	*24*	*24*	*27*	*27*				*22*	*27*	*22*	*25*	*27*	*27*			
IPC_LT	-0.20	0.87	0.05	-0.70	0.07	0.43	0.58			-0.10	0.83	0.29	-0.61	-0.01	0.41	0.57		
Sig.	*0.37*	*0.00*	*0.83*	*0.00*	*0.75*	*0.03*	*0.00*			*0.65*	*0.00*	*0.19*	*0.00*	*0.98*	*0.04*	*0.00*		
N.	*22*	*26*	*23*	*24*	*26*	*26*	*26*			*22*	*26*	*22*	*25*	*26*	*26*	*26*		
INN_ENT	-0.07	-0.11	0.08	0.01	-0.09	0.03	-0.04	-0.06		-0.08	0.66	0.16	-0.55	-0.05	0.59	0.44	0.69	
Sig.	*0.74*	*0.59*	*0.73*	*0.95*	*0.66*	*0.87*	*0.85*	*0.78*		*0.74*	*0.00*	*0.49*	*0.00*	*0.82*	*0.00*	*0.02*	*0.00*	
N.	*22*	*27*	*24*	*24*	*27*	*27*	*27*	*26*		*22*	*27*	*22*	*25*	*27*	*27*	*27*	*26*	
PROD	-0.20	0.64	0.06	-0.75	-0.19	0.35	0.35	0.80	-0.02	-0.19	0.64	0.23	-0.69	-0.24	0.38	0.40	0.83	0.66
Sig.	*0.38*	*0.00*	*0.78*	*0.00*	*0.34*	*0.08*	*0.07*	*0.00*	*0.90*	*0.40*	*0.00*	*0.30*	*0.00*	*0.23*	*0.05*	*0.04*	*0.00*	*0.00*
N.	*22*	*27*	*24*	*24*	*27*	*27*	*27*	*26*	*27*	*22*	*27*	*22*	*25*	*27*	*27*	*27*	*26*	*27*

Legend: FDI_LT = FDI in LT sector/GDP; R&D_GDP = R&D expenditure/ GDP; R&D_P_LT = LT sector R&D personnel / population; SPEC_LT = LT sectoral employment / total employment; EDU_DIP = secondary school / population; EDU_LAU = tertiary school / population; LLL = participants to life long learning / population; IPC_LT = LT sector patents / population; INN _ENT = innovative enterprises / population; PROD = manufacturing VA / manufacturing employment.

Table A6. Correlations for MLT

	Levels (average 2000-2002)									Levels (average 2003-2005)								
	FDI_ MLT	R&D _GDP	R&D_ P_MLT	SPEC_ MLT	EDU_ DIP	EDU_ LAU	LLL	IPC_ LT	INN_ ENT	FDI_ MLT	R&D _GDP	R&D_ P_MLT	SPEC_ MLT	EDU_ DIP	EDU_ LAU	LLL	IPC_ LT	INN_ ENT
R&D_GDP	-0.15									-0.19								
Sig.	*0.55*									*0.44*								
N.	*18*									*18*								
R&D_P_MLT	0.11	-0.07								0.14	0.05							
Sig.	*0.75*	*0.80*								*0.68*	*0.86*							
N.	*11*	*15*								*11*	*15*							
SPEC_MLT	0.08	0.18	0.12							0.11	0.14	0.34						
Sig.	*0.76*	*0.39*	*0.70*							*0.67*	*0.49*	*0.21*						
N.	*17*	*25*	*13*							*18*	*26*	*15*						
EDU_DIP	0.22	0.19	0.42	0.19						0.33	0.14	0.42	0.22					
Sig.	*0.39*	*0.34*	*0.12*	*0.37*						*0.18*	*0.47*	*0.12*	*0.28*					
N.	*18*	*27*	*15*	*25*						*18*	*27*	*15*	*26*					
EDU_LAU	-0.23	0.52	-0.38	-0.36	-0.04					-0.24	0.51	-0.39	-0.34	-0.08				
Sig.	*0.35*	*0.01*	*0.16*	*0.07*	*0.83*					*0.33*	*0.01*	*0.15*	*0.09*	*0.70*				
N.	*18*	*27*	*15*	*25*	*27*					*18*	*27*	*15*	*26*	*27*				
LLL	0.10	0.71	-0.23	-0.09	0.22	0.53				-0.16	0.78	-0.19	-0.06	0.15	0.60			
Sig.	*0.69*	*0.00*	*0.40*	*0.68*	*0.28*	*0.00*				*0.53*	*0.00*	*0.49*	*0.77*	*0.45*	*0.00*			
N.	*18*	*27*	*15*	*25*	*27*	*27*				*18*	*27*	*15*	*26*	*27*	*27*			
IPC_LT	-0.05	0.87	-0.16	0.18	0.07	0.43	0.58			-0.06	0.83	-0.04	0.25	-0.01	0.41	0.57		
Sig.	*0.84*	*0.00*	*0.59*	*0.38*	*0.75*	*0.03*	*0.00*			*0.80*	*0.00*	*0.89*	*0.22*	*0.98*	*0.04*	*0.00*		
N.	*18*	*26*	*14*	*25*	*26*	*26*	*26*			*18*	*26*	*15*	*26*	*26*	*26*	*26*		
INN_ENT	0.42	-0.11	-0.18	0.14	-0.09	0.03	-0.04	-0.06		-0.30	0.66	-0.21	0.07	-0.05	0.59	0.44	0.69	
Sig.	*0.08*	*0.59*	*0.53*	*0.51*	*0.66*	*0.87*	*0.85*	*0.78*		*0.23*	*0.00*	*0.46*	*0.74*	*0.82*	*0.00*	*0.02*	*0.00*	
N.	*18*	*27*	*15*	*25*	*27*	*27*	*27*	*26*		*18*	*27*	*15*	*26*	*27*	*27*	*27*	*26*	
PROD	-0.16	0.64	-0.35	0.39	-0.19	0.35	0.35	0.80	-0.02	-0.24	0.64	-0.27	0.39	-0.24	0.38	0.40	0.83	0.66
Sig.	*0.53*	*0.00*	*0.21*	*0.05*	*0.34*	*0.08*	*0.07*	*0.00*	*0.90*	*0.33*	*0.00*	*0.33*	*0.05*	*0.23*	*0.05*	*0.04*	*0.00*	*0.00*
N.	*18*	*27*	*15*	*25*	*27*	*27*	*27*	*26*	*27*	*18*	*27*	*15*	*26*	*27*	*27*	*27*	*26*	*27*

Legend: FDI_MLT = FDI in MLT sector/GDP; R&D_GDP = R&D expenditure/ GDP; R&D_P_MLT = MLT sector R&D personnel / population; SPEC_MLT = MLT sectoral employment / total employment; EDU_DIP = secondary school / population; EDU_LAU = tertiary school / population; LLL = participants to life long learning / population; IPC_LT = LT sector patents / population; INN _ENT = innovative enterprises / population; PROD = manufacturing VA / manufacturing employment.

Table A7. Correlations for MHT

	Levels (average 2000-2002)									Levels (average 2003-2005)								
	FDI_ MHT	R&D _GDP	R&D_ P_MHT	SPEC_ MHT	EDU_ DIP	EDU_ LAU	LLL	IPC_ HT	INN_ ENT	FDI_ MHT	R&D _GDP	R&D_ P_MHT	SPEC_ MHT	EDU_ DIP	EDU_ LAU	LLL	IPC_ HT	INN_ ENT
R&D_GDP	0.52									0.44								
Sig.	*0.01*									*0.05*								
N.	*21*									*21*								
R&D_P_MHT	0.12	0.15								0.18	0.38							
Sig.	*0.67*	*0.55*								*0.51*	*0.12*							
N.	*15*	*19*								*15*	*18*							
SPEC_MHT	0.30	0.38	0.37							0.42	0.38	0.67						
Sig.	*0.19*	*0.06*	*0.14*							*0.06*	*0.06*	*0.00*						
N.	*20*	*25*	*17*							*21*	*26*	*18*						
EDU_DIP	0.20	0.19	0.49	0.47						0.30	0.14	0.48	0.55					
Sig.	*0.38*	*0.34*	*0.03*	*0.02*						*0.19*	*0.47*	*0.04*	*0.00*					
N.	*21*	*27*	*19*	*25*						*21*	*27*	*18*	*26*					
EDU_LAU	0.08	0.52	-0.33	-0.31	-0.04					0.03	0.51	-0.38	-0.32	-0.08				
Sig.	*0.73*	*0.01*	*0.17*	*0.13*	*0.83*					*0.91*	*0.01*	*0.12*	*0.12*	*0.70*				
N.	*21*	*27*	*19*	*25*	*27*					*21*	*27*	*18*	*26*	*27*				
LLL	0.40	0.71	-0.07	0.07	0.22	0.53				0.43	0.78	0.07	0.11	0.15	0.60			
Sig.	*0.07*	*0.00*	*0.79*	*0.74*	*0.28*	*0.00*				*0.05*	*0.00*	*0.79*	*0.58*	*0.45*	*0.00*			
N.	*21*	*27*	*19*	*25*	*27*	*27*				*21*	*27*	*18*	*26*	*27*	*27*			
IPC_HT	0.27	0.78	-0.05	0.09	0.01	0.57	0.68			0.21	0.84	0.19	0.13	-0.04	0.56	0.64		
Sig.	*0.24*	*0.00*	*0.84*	*0.66*	*0.96*	*0.00*	*0.00*			*0.36*	*0.00*	*0.46*	*0.52*	*0.83*	*0.00*	*0.00*		
N.	*21*	*26*	*18*	*25*	*26*	*26*	*26*			*21*	*26*	*18*	*26*	*26*	*26*	*26*		
INN_ENT	-0.34	-0.11	-0.32	0.15	-0.09	0.03	-0.04	0.02		0.03	0.66	0.02	0.15	-0.05	0.59	0.44	0.49	
Sig.	*0.13*	*0.59*	*0.19*	*0.47*	*0.66*	*0.87*	*0.85*	*0.93*		*0.89*	*0.00*	*0.93*	*0.48*	*0.82*	*0.00*	*0.02*	*0.01*	
N.	*21*	*27*	*19*	*25*	*27*	*27*	*27*	*26*		*21*	*27*	*18*	*26*	*27*	*27*	*27*	*26*	
PROD	0.17	0.64	-0.19	0.03	-0.19	0.35	0.35	0.47	-0.02	0.15	0.64	-0.01	-0.02	-0.24	0.38	0.40	0.51	0.66
Sig.	*0.46*	*0.00*	*0.43*	*0.89*	*0.34*	*0.08*	*0.07*	*0.02*	*0.90*	*0.50*	*0.00*	*0.97*	*0.93*	*0.23*	*0.05*	*0.04*	*0.01*	*0.00*
N.	*21*	*27*	*19*	*25*	*27*	*27*	*27*	*26*	*27*	*21*	*27*	*18*	*26*	*27*	*27*	*27*	*26*	*27*

Legend: FDI_MHT = FDI in MHT sector/GDP; R&D_GDP = R&D expenditure/ GDP; R&D_P_MHT = MHT sector R&D personnel / population; SPEC_MHT = MHT sectoral employment / total employment; EDU_DIP = secondary school / population; EDU_LAU = tertiary school / population; LLL = participants to life long learning / population; IPC_HT = HT sector patents / population; INN _ENT = innovative enterprises / population; PROD = manufacturing VA / manufacturing employment.

Table A8. Correlations for HT

	Levels (average 2000-2002)									Levels (average 2003-2005)								
	FDI_ HT	R&D _GDP	R&D_ P_HT	SPEC_ HT	EDU_ DIP	EDU_ LAU	LLL	IPC_ HT	INN_ ENT	FDI_ HT	R&D _GDP	R&D_ P_HT	SPEC_ HT	EDU_ DIP	EDU_ LAU	LLL	IPC_ HT	INN_ ENT
R&D_GDP	0.11									-0.01								
Sig.	*0.64*									*0.97*								
N.	*20*									*20*								
R&D_P_HT	0.21	0.82								-0.14	0.74							
Sig.	*0.45*	*0.00*								*0.61*	*0.00*							
N.	*15*	*21*								*15*	*19*							
SPEC_HT	0.60	0.42	0.41							0.67	0.60	0.51						
Sig.	*0.01*	*0.03*	*0.07*							*0.00*	*0.00*	*0.02*						
N.	*19*	*26*	*20*							*20*	*26*	*19*						
EDU_DIP	-0.19	0.19	0.41	-0.01						-0.13	0.14	0.46	0.28					
Sig.	*0.43*	*0.34*	*0.06*	*0.97*						*0.59*	*0.47*	*0.05*	*0.16*					
N.	*20*	*27*	*21*	*26*						*20*	*27*	*19*	*26*					
EDU_LAU	0.12	0.52	0.46	0.09	-0.04					0.07	0.51	0.26	0.26	-0.08				
Sig.	*0.60*	*0.01*	*0.04*	*0.67*	*0.83*					*0.77*	*0.01*	*0.29*	*0.20*	*0.70*				
N.	*20*	*27*	*21*	*26*	*27*					*20*	*27*	*19*	*26*	*27*				
LLL	0.07	0.71	0.49	0.26	0.22	0.53				-0.14	0.78	0.40	0.39	0.15	0.60			
Sig.	*0.77*	*0.00*	*0.02*	*0.19*	*0.28*	*0.00*				*0.56*	*0.00*	*0.09*	*0.05*	*0.45*	*0.00*			
N.	*20*	*27*	*21*	*26*	*27*	*27*				*20*	*27*	*19*	*26*	*27*	*27*			
IPC_HT	0.23	0.78	0.64	0.41	0.01	0.57	0.68			-0.07	0.84	0.53	0.45	-0.04	0.56	0.64		
Sig.	*0.33*	*0.00*	*0.00*	*0.04*	*0.96*	*0.00*	*0.00*			*0.76*	*0.00*	*0.02*	*0.02*	*0.83*	*0.00*	*0.00*		
N.	*20*	*26*	*20*	*25*	*26*	*26*	*26*			*20*	*26*	*19*	*26*	*26*	*26*	*26*		
INN_ENT	-0.13	-0.11	-0.29	0.02	-0.09	0.03	-0.04	0.02		0.19	0.66	0.52	0.42	-0.05	0.59	0.44	0.49	
Sig.	*0.60*	*0.59*	*0.20*	*0.93*	*0.66*	*0.87*	*0.85*	*0.93*		*0.43*	*0.00*	*0.02*	*0.03*	*0.82*	*0.00*	*0.02*	*0.01*	
N.	*20*	*27*	*21*	*26*	*27*	*27*	*27*	*26*		*20*	*27*	*19*	*26*	*27*	*27*	*27*	*26*	
PROD	0.28	0.64	0.57	0.23	-0.19	0.35	0.35	0.47	-0.02	0.16	0.64	0.52	0.30	-0.24	0.38	0.40	0.51	0.66
Sig.	*0.24*	*0.00*	*0.01*	*0.25*	*0.34*	*0.08*	*0.07*	*0.02*	*0.90*	*0.51*	*0.00*	*0.02*	*0.14*	*0.23*	*0.05*	*0.04*	*0.01*	*0.00*
N.	*20*	*27*	*21*	*26*	*27*	*27*	*27*	*26*	*27*	*20*	*27*	*19*	*26*	*27*	*27*	*27*	*26*	*27*

Legend: FDI_HT = FDI in HT sector/GDP; R&D_GDP = R&D expenditure/ GDP; R&D_P_HT = HT sector R&D personnel / population; SPEC_HT = HT sectoral employment / total employment; EDU_DIP = secondary school / population; EDU_LAU = tertiary school / population; LLL = participants to life long learning / population; IPC_HT = HT sector patents / population; INN _ENT = innovative enterprises / population; PROD = manufacturing VA / manufacturing employment.

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