ISSN 1825-0211

# HOMOGENEOUS, URBAN HETEROGENEOUS, OR BOTH? EXTERNAL ECONOMIES AND REGIONAL MANUFACTURING PRODUCTIVITY IN EUROPE

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Quaderno n. 51 — Aprile 2008

## QUADERNI DEL DIPARTIMENTO DI ECONOMIA, FINANZA E STATISTICA

# Homogeneous, Urban Heterogeneous, or Both?

# External Economies and Regional Manufacturing Productivity in Europe

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**Abstract**

*The objective of this paper is to analyse theoretically and empirically the effects of sectoral homogeneity and urban heterogeneity on regional manufacturing "pure" productivity differentials. Hypotheses of the existence and co-existence of the two types of external effects are formulated and tested for the regions of 13 Western EU countries by means of panel data spatial econometric techniques. The outcomes clearly support our conjectures and also reveal how a simply strong manufacturing sector, i.e., not accounting for internal specialisation, may be harmful to productivity. This result, and the existence of heterogeneous externalities, are confirmed for a sample of regions extended to Eastern European countries.*

JEL classification: J.24, O.14, O.18

Keywords: homogeneous and urban heterogeneous external economies, manufacturing productivity, EU regions

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* We thank participants in the XVI AISSEC (Italian Association of Comparative Economic Studies) Conference, Parma, Italy, June 21-23, 2007, for their helpful comments.

## 1. AIMS AND SCOPE OF THE PAPER

Aspects related to competitiveness and productivity at regional level have increasingly been a focus for scholars, as evidenced by the large theoretical and empirical literature available. In Europe, this interest has been significantly stimulated by the policy concern on productivity growth in general, but also on the reduction of huge spatial differences in competitiveness. This persisting feature of European economy directly and remarkably affects not only development disparities and thus cohesion objectives, but also the sustainability of various crucial achievements (e.g., the monetary union) and future developments (e.g., enlargements) of the Union.

The aim of this paper is to shed light on the effects produced on productivity levels and dynamics by various factors which are external to firms but which characterise the economic, social and institutional environments to which they belong. These aspects have been widely debated in the literature, which has in some cases opposed external economies stemming from industry agglomeration to those deriving from industry diversification, typical of urban settings. We intend to contribute to this debate first of all by highlighting the ambiguity of identifying the variety of economic activity with urbanisation economies, very common in an important quota of the literature. We contend that diversity of economic activity (i) is not an attribute exclusive to urban settings; (ii) is only one among various other urban sources of external economies; and (iii) is not necessarily alternative to specialisation. We then distinguish and define the two groups of *homogeneous* and *urban heterogeneous* external economies and test empirically their existence, co-existence and impact on the levels and dynamics of regional manufacturing labour productivity in 13 countries of the old EU in the period 1995-2003. On empirical grounds, a distinctive feature of this paper is the use of a panel spatial econometric approach, which allows the role of geographical interactions to be taken into account explicitly. Particular attention is devoted to defining dependent and explicative variables. In particular, as productivity indicator we use a "pure" productivity differential measure, devoid of the industry mix effect, which is more suitable for the aims of our analysis; consistently with the theoretical approach, we also define a composite indicator of urban heterogeneous external effects, able to take into account the different features which qualify urban diversity. The empirical analysis is also extended to the whole set of regions of the EU countries (EU-25, excluding Cyprus and Malta), but the constraints posed by data availability only allowed us to consider the impact of urban heterogeneous effects on productivity. However, they did allow us to highlight the differences emerging for the "old" EU-15 states and the 2004 new members of central and eastern Europe.

Since the existing theoretical background on these topics is very rich and diversified, section 2 limits discussion to the most important streams of literature related to the aims and scope of this paper. Section 3 presents the empirical part of the paper, first describing its general objectives and the constraints posed by data availability, and then rendering explicit the hypotheses we intend to test econometrically (3.1). Sections 3.2 and 3.3 describe the indicators used and provide and comment on some descriptive statistics, respectively. Section 3.4 presents the empirical model, econometric estimation approaches, and the results obtained. In section 3.5, analysis is extended to the wider set of EU-23 regions. Section 4 provides a short summary of the outcomes, discussion of their policy implications, and some final remarks.

## 2. THEORETICAL FRAMEWORK

Our starting point is that features of regional contexts may exist which affect the productivity and thus the competitiveness of the firms located in them. This is a well-established idea in important streams of regional economic studies, and is widely debated and illustrated both theoretically and empirically. We only aim here at emphasising some aspects of this literature which are more functional to and consistent with our approach which, in line with the classical works by Hoover (1937, 1948) [1], distinguishes between *homogeneous* and *urban heterogeneous* external economies, and their relationships.

### 2.1. Homogeneous External Economies

The level and dynamics of labour productivity in a region may depend on many material and immaterial factors: its economic structure, innovative activity taking place in it, its accessibility, skills endowment, presence and quality of decision centres, and specific environmental, social and cultural features (Gardiner, Martin, and Tyler 2004). Many of these factors are explicitly considered because of their dynamic implications (i.e., evolution of productivity over time), which are also the bases for alternative explanations of convergence, divergence or persistence of productivity disparities. In the standard neo-classical model, the focus is on capital endowment per worker and on the rate of technical change. Thus, when observed at a given point in time, regional differences in output per worker depend on these two factors, the second of which is assumed to be determined exogenously. As

[1] These works may be considered the first attempt of classification of external agglomeration economies, distinguished into: (a) economies external to firms but internal to the sector (localisation economies); and (b) economies external to firms and to the sector but internal to the urban area (urbanisation economies).

is well known, this point is the essential difference with respect to endogenous growth models, in which the rate of technological progress depends on the growth process itself, by means of various channels which introduce the crucial importance of agglomeration factors (e.g., number of workers in knowledge-creation activities, size of the knowledge and technology base, etc.). In this case, regional productivity disparities are determined by the localisation of these technology/knowledge factors, whereas their persistence or fading depends on whether they scatter or not, and how rapidly, across regions. These dynamic knowledge spillover effects may typically derive from (and take place in) the agglomeration of similar or related production activities, and they have been introduced into a wider set of localisation external effects, called MAR externalities by Glaeser et al. (1992), which do include both static (Marshall 1920) and dynamic (Arrow 1962; Romer 1986) agglomeration effects. The role of static marshallian agglomeration effects has been developed in various directions, especially due to developments in localisation theory in the last fifteen years within the framework of the "new economic geography" (NEG) approach (Krugmann 1991a; 1991b), which emphasised the role of accumulation of specialised labour pools and the agglomeration of suppliers of services and inputs specific to the main industry, beyond focusing on the effectiveness of the circulation of specific knowledge. Recent empirical evidence about patterns of regional specialisation in Europe is provided, among various others, by Stirboeck (2006) and Ezcurra, Pascual, and Rapùn (2006). In particular, the specific point of static and dynamic knowledge and innovation effects on the performances of closely located firms has been the object of very extensive literature from various theoretical perspectives (well-known examples include Audretsch 1998; Jaffe, Trajtenberg, and Henderson 1993; Audretsch and Feldman 2004; Boschma 2004).

Within this broad theoretical framework, there is no room for hopes of regional convergence, since these agglomeration factors induce further localisation and specialisation, and poor peripheral regions are doomed to remain so.

This simplified theoretical basis may be enriched from several points of view. For example, as stressed by Glaeser et al. (1992), the MAR externality framework predicts that, when an industry is significantly spatially concentrated, local monopoly is better than local competition, since it restricts the leakage of ideas from the innovator, thus allowing full internalisation of the externalities created. Conversely, Porter (1990) highlights how local competition may be good for productivity growth, since it fosters the search for and rapid adoption of innovations. So, industry specialisation is crucial for productivity growth, but in the sense of firms clustering within a limited space. Enlargement of the sources of external economies operated by the NEG and Porter may be further widened recalling what can be called the neo-marshallian approach which, historically moving from the evidence supplied by industrial districts, built the articulated field of theoretical and empirical material which lies at the base of the "local development" approach (e.g., Becattini 2000 and 2004; Cossentino, Pyke, and Sengerberger 1996). With respect to the topics of interest here, the fundamental step forward of this theoretical framework is that external economies are produced not only by the clustering of firms in a single place (a "local production system", Bellandi 2004), but also by the features of the local society. This means that, beyond the simple existence of the cluster, it is the mix between it and the social, cultural and institutional features of the local society (which, in turn, interacts with and influences the clusters) which are crucial to the competitiveness of local firms, especially by means of facilitated social interactions which can lower the costs of using the market, favour knowledge flows, and address solutions to common questions (Guiso and Schivardi 2007). In this perspective, the agglomeration of firms has also been interpreted as an alternative to hierarchical organisation in economising transaction costs (e.g., Wood and Parr 2005), or in the social capital theoretical framework (Molina-Morales 2005). So, as proposed by Becattini and Musotti (2003) for the specific case of the industrial district, the sources of competitive advantage external to firms may be distinguished into two groups: those dependent on the presence of a cluster, and those emerging from its interactions with the local context. The former may contain external economies of (i) *organisation*, (ii) *knowledge (contextual) and learning*, and (iii) *concentration.* The latter may be of (i) *training,* (ii) *transaction*, or (iii) *adaptation*.

We call these forms of external economies, usually referred to as *localisation externalities*, as "homogeneous economies", in order to mean that, in certain conditions, they stem from the presence of one or more manufacturing branch specialisation. "In certain conditions" means that they do not necessarily emerge, or have the same strength, when there is simply a relatively strong manufacturing sector which is not sufficiently specialised into one or more sub-sectors in which external economies take place (typically, light industry and production with a decomposable production process).

### 2.2. Urban Heterogeneous External Economies

A contrasting view to possible positive impacts of sectoral agglomeration is often identified (e.g., Feldman and Audretsch 1999) in Jacobs' conceptualisation. Jacobs (1969 and 1984) argues that the variety and diversity of geographically close industries promote innovation and growth, since the most important knowledge and ideas flows spill over across industries (rather than within them). The focus here is exclusively on knowledge and innovation, and supports the view that the most important inputs of knowledge come from outside the core industry. Since the precondition for cross-fertilisation of *sticky* knowledge (Von Hipple 1994) to arise is social interaction, this typically happens in cities, where the economy is diversified and person-to-person contacts are easier and more frequent. From the perspective of growth theories, Lucas (1988) emphasises the fact that increasing returns to resource agglomeration are related to the geographically compact nature of cities, which facilitates communications and makes these locations more competitive. Identification of product diversity with urban settings has led a number of researchers to define Jacobs' diversity externalities as "urbanisation externalities", with consequent measurement approaches on empirical grounds. Jacob's urbanisation externalities are indeed usually measured by means of various kinds of industry diversity/concentration indexes (e.g., Glaeser et al. 1992; Henderson, Kuncoro, and Turner 1995; Harrison, Maryellen, and Kelley 1996; Eaton and Eckstein 1997; Feldman and Audretsch 1999; Kelley and Helper 1999, Duranton and Puga 2001; Paci and Usai 1999; Cingano and Schivardi 2004). However, this identification has introduced some ambiguity, for at least three reasons: (a) diversity of economic activities is not, in the post-fordist era, an attribute exclusive to urban settings; (b) the diversity of economic activities is only one among various other characters of urban areas, which may be the sources of other external economies, as emphasised by extensive urban literature; and (c) diversity is not necessarily alternative to specialisation.

*(a) Diversity is not only urban*

From the first point of view, structural dynamics provide evidence of the evolution of rural (non-urban) systems from a prevalence of farming and farming-related activities towards diversified settings, in which agricultural-based activities only play a minor role. This evolution may be reinforced when urban congestion costs induce productive activities to locate outside urban areas (see also point *b* below). Moreover, the idea of a diversified small business-based rural economy may be connected to that a viable density of social networks (Fuà 1988) governed by specific, shared, historically rooted institutional settings (e.g., prevalence of informal relationship, crucial role of the household, attitude of cooperation inherited from the farming tradition, etc.), able to promote effective circulation of information and knowledge (Martino and Perugini 2007; Murdoch 2000). However, the lower density of economic activities and the qualitative differences of information and knowledge flows compared with those of urban settings (see point *c*) weaken the possible impact of the cross-fertilisation idea at the basis of variety external economies. In any case, variety is not an exclusive attribute of urban areas, so a simple diversity measure cannot identify a situation in which spillovers of heterogeneous knowledge and information take place. In other terms, variety needs to be "qualified", in the sense that only the co-existence of some interrelated activities (e.g., productive activities, R&D structures, business services) is able to generate beneficial information and knowledge exchanges.

*(b) Diversity is one among various other sources of urban external economies*

The centrality of knowledge and information flows due to diversity of economic activities is also largely emphasised by the urban economics literature, but within a more complex framework of "urban assets" (e.g., Hoover 1937; Glaeser et al. 1992; Kresl 1995; Turok 2004; Budd and Hirmis 2004; Begg 1999 and 2002; Henderson 2007), such as skilled labour pools (e.g., Wheeler 2005; Rauch 1991), sustained and diversified local demand (e.g., Henderson 1986; Tabuchi and Yoshida 2000), presence of public and private research and education centres, institutional networks (Turok 2004), proximity to decision centres (Ades and Glaeser 1995), proximity to advanced, not sector-specific, business services (Kolko 1999), and the availability and efficiency of hard and soft infrastructures (Davis and Henderson 2003). Thus, the set of "urbanisation" externalities is wider than that deriving from diversity of economic activities, which may be considered an intrinsic attribute of urban areas, due to the high density of economic activities and to demand-side effects. So a simple sector concentration/diversity measure may not be satisfactory, not only because it does not discriminate between "diversities" (point *a*), but also because it is not able to include other external features, typical of urban areas, which affect economic performance.

However, not all cities (or urban areas) contain the same urban assets. Depending on various factors (e.g., developmental stage and model), the prevalence of tertiary activities, for example, may depend upon a strong presence of public administration rather than on advanced business services; the abundance of human capital may be more (science and technology) or less (arts, humanities) functional to the development of firms and their performance. This means that a satisfactory measure of urban externalities cannot be a simple urbanisation indicator (i.e., population density as a proxy for density of economic activity, and thus diversity), but this measure must be adequately integrated with others directly representing the existence and strength of other significant features.

*(c) Diversity and specialisation may co-exist*

As mentioned above, Jacobs' diversity externalities have been interpreted in opposition to specialisation externalities (e.g., Feldman and Audretsch 1999), in the sense that "diversity increases as the measure of specialisation decreases" (Ejermo 2005, p.171). However, a number of theoretical and empirical contributions do consider the possible co-existence of specialisation and diversity. Within the modern theory of localisation (NEG framework), this co-existence is explained starting from the consumption side of the market (Fujita and Thisse 2002). The diversity of available products enters the consumers' utility function in a basic two-region (core-periphery) model, in which the concentration of labour (and hence consumers) into the core region corresponds to a strong local demand for diversified products. So the typical agglomeration effects of firms of the various sectors take place in the core region, giving rise to the co-existence of different clusters of specialised activities in the same geographical area. The same outcome may occur if production processes can be decomposed into different phases and carried out within a system of sub-contractors. Consumers' demand for diversity increases the diversity of requests to subcontractors by final firms. Given the strong demand for each specific product, this generates clusters of specialised (phase) producers via typical agglomeration processes, which together give rise to a great variety of products. In this sense, "specialisation implies diversity" (Ejermo 2005, p.170). The same outcome may be explained by considering product life-cycle theories in relation to the size of cities, and moving from the idea of cities as nurseries of new products, as formalised by Duranton and Puga (2001). In larger cities, congestion costs may be remarkable and induce firms to keep only the tasks which most benefit, directly or indirectly, by the contact with final demand or strategic flows of information (e.g., R&D, new product development and launch, etc.), while decentralising other productive (or mass) activities to peripheral areas. As a consequence, large cities are characterised by a marked diversity of economic activities, which correspond to initial phases of product life-cycles, while peripheries tend to specialise. In small and medium-sized cities, congestion costs are lower, so firms may also keep mass production phases and, depending on the size of the sectors, originate co-existence of diversity and specialisation. The relationship between urban specialisation/diversification and product life-cycles are also the core of the paper by Henderson, Kuncoro, and Turner (1995). The possibility of the co-existence of diversity and specialisation has been acknowledged empirically in many contributions, as witnessed by the widespread contemporaneous use of sector specialisation (localisation) and diversity (usually concentration) indexes to explain, for example, employment growth (e.g., Glaeser et al. 1992; Henderson, Kuncoro, and Turner 1995), innovation activities (e.g., Harrison, Maryellen, and Kelley 1996; Kelley and Helper 1999; Paci and Usai 1999; Van Ort 2002; Cingano and Schivardi 2004), productivity (e.g., Cingano and Schivardi 2004).

Points *a*, *b* and *c*, taken together, support the idea that the *homogeneous* and *urban heterogeneous* externalities are not mutually exclusive, since they basically emerge from different and potentially co-existing circumstances. The former are sector-specific or sector-related (homogeneous) and take place within a single sector; the latter (urban heterogeneous) are not sector-specific and take place within a variety of interconnected sectors located in urban areas able to enrich the set of favourable productive situations. In certain conditions (i.e., absence of high congestion costs), agglomerations of firms may be part of urban areas, and this does not conflict with variety. This is especially true if the agglomeration, as often happens, is of manufacturing firms, taking into account the structural decline of this sector in absolute and relative terms which, even in areas of manufacturing specialisation, renders more space available to other activities[2]. Evidence of this may be found in the present conditions of the textbook cases of Italian industrial districts which were the main sources of the recovery of the originally marshallian conceptualisation. For instance, in the textiles and clothing district of Prato, Tuscany, the strong agglomeration of firms is located in a urban area (the city of Prato, the metropolitan area of which is now indistinguishable from that of Florence). Similarly, in the Emilia Romagna region, many industrial districts and clusters co-exist with a dense network of medium and medium-large towns and cities.

## 3. EMPIRICAL ANALYSIS

This part of the paper presents the empirical analysis based on the theoretical framework discussed above. Section 3.1 specifies the main objective of the analysis, renders explicit the hypothesis we intend to test empirically, and illustrates the constraints posed by data. Section 3.2 defines the indicators used in the analysis. Then we present some descriptive statistics (§ 3.3) and discuss the econometric approach and results (§ 3.4). The econometric analysis is then extended geographically (§ 3.5), but with further important analytical constraints due to data availability.

### 3.1. Objectives, hypotheses and basic data constraints

The general objective of the empirical analysis is to estimate the impact of homogeneous and urban heterogeneous external economies on regional manufacturing productivity in Europe. On the basis of the theoretical arguments proposed in the previous sections, we test the following hypotheses:

*$H_1$: a growing concentration into one or a few manufacturing subsections increases the manufacturing productivity of the region (homogeneous external economies);*

[2] Similarly, Malizia and Ke (1993) argue that the idea of diversity does not reflect that of absence of specialisation, but may reveal the existence of multiple specialisations.

*$H_2$: growing urbanisation features increase the manufacturing productivity of the region (urban heterogeneous external economies) and these effects may co-exist with those deriving from sectoral agglomeration.*

The constraints posed by data availability significantly influence the geographical scope of our analysis and must be taken into account in the interpretation of results. A crucial aspect regards the choice of the territorial unit of analysis, since the objective of considering regions of different EU countries necessarily indicates the use of NUTS2 regions. Apart from remarkable differences in terms of the relative size of these regions, they are clearly too large to allow certain types of external economies to be correctly captured. Some kinds of the homogeneous type usually take place in the territories where the local production system is located, which is normally part of a NUTS2 region. So a smaller spatial unit, able to account for systemic features which may characterise specific local societies and local production systems, would have been preferable; unfortunately, functional regions identified as travel-to-work areas (TTWA) are available only for a limited set of Western EU countries, for which few data are available (examples of papers which consider these optimal territorial levels in studying agglomerations are Paci and Usai (1999 and 2006) and Perugini and Daddi (2005). Similarly, only a few data are available at regional NUTS3 level. Conversely, the choice of NUTS2 level allows us to consider the widest coverage of European regions with the acceptable availability of data needed to define dependent and explicative variables. In interpreting the results, we must bear in mind that we are considering proxies of average regional level of homogeneous and heterogeneous externalities as determinants of average levels of labour productivity of the firms in the region. The use of this “large” unit of analysis also reinforces the possibility of verifying the hypothesis of the co-existence of the various forms of external economies, since the regions considered are on average sufficiently large to contain both core (diversified cities with urban assets) and peripheral areas (in which manufacturing activities may locate and agglomerate).

The geographical coverage of the analysis is strongly limited by the sectoral breakdown of the variables considered. Data on value added, employment and investments are drawn from the Cambridge Econometrics (CE) dataset, which provides a breakdown of manufacturing subsectors only for the 151 regions of 13 members of the EU before 2004 (all the old EU-15 countries, excluding Germany and Austria)[3]. This constraints not only the measure of labour productivity and investments, but also the construction of localisation / concentration measures. At the same time, Eurostat Regio data measuring explicative variables important to our aims (i.e., patents for innovation activity) were largely missing at detailed sectoral level and had to be considered in aggregated form. So $H_1$ and $H_2$ were tested for the subset of regions belonging to 13 old EU members (sample EU-13).

### 3.2. Definition of indicators

*3.2.1. Dependent variable*

We move here from the standard classical concept of *labour* productivity, which is consistent with the theoretical perspective adopted, which also places productivity differentials in the framework of productivity growth/convergence patterns. We do not discuss here the problem of identifying or distinguishing the concepts of competitiveness and productivity, which are discussed in depth in many other contributions (Begg 1999 and 2002; Camagni 2002; Gardiner, Martin, and Tyler 2004; Krugman 1990; Porter 2001 and 2003). Similarly, we do not debate the differences with respect to or the desirability of adopting other measures of productivity (i.e., total factor productivity). For a discussion of these aspects, see, for example, Sargent and Rodriguez (2000) or Hulten (2000).

W move from the classical indicator of aggregate manufacturing labour productivity:

$$(1) \qquad \mathrm{PROD_r} = \frac{\mathrm{V_r}}{\mathrm{L_r}}$$

where $V_r$ is the value added in manufacturing (at 1995 constant prices) for region *r*, and $L_r$ is employment in manufacturing (number of employees) in the same region. To compare productivity between countries correctly, value added in euros at constant prices was converted into Purchasing Power Parities (PPPs) by applying the 1995 conversion factor derived from GDP[4]. Unfortunately, the available data did not allow us to consider productivity per hour worked which, for various reasons, is a preferable measure.

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[3] Due to missing data on economic accounts, the following regions had to be excluded from the sample: two Spanish regions, ES63 – Ciudad Autonoma de Ceuta and ES64 – Ciudad Autonoma de Melilla; two Portuguese, PT2 - Região Autónoma dos Açores and PT - 3 Região Autónoma da Madeira; and four French overseas regions (FR91, 92, 93, 94). Four other regions (GR41 – Voreio Aigaio; UKd1 – Cumbria; UKf3 – Lincolnshire; UKm2 - Eastern Scotland) were excluded due to missing data on patents. A few other missing data for other regions were estimated by means of linear interpolation.

[4] As regards sectoral productivity comparisons, in theory the sector-specific conversion factor should be applied (see Pilat 1996; Sørensen 2001; Van Biesebroeck 2004). However, since sectoral PPPs are not available, the same conversion factor was used for each industry.

However, as already mentioned, for the EU-13 sample the CE dataset provides the composition of manufacturing employment and value added disaggregated into six industries[5], thus a measure of "pure" manufacturing productivity differentials may be obtained by deflating aggregate labour productivity by its industry mix component. The approach for this purpose (a kind of shift–share analysis applied to regional levels) is discussed in depth within a more complex methodological and empirical framework in Bracalente and Perugini (2006). Again, for a given region, let $V_r$ be value added (at PPPs), $L_r$ regional employment (independently of workers' place of residence); also let $v_{rh}$ ($V_{rh} / L_{rh}$) be regional labour productivity in manufacturing subsector *h* and $\bar{v}_h$ the corresponding average labour productivity at the aggregate level (i.e., the EU-13 sub-set of European regions).

We then define the following fictitious aggregate:

$$(2) \qquad V_r^* = \sum_h \bar{v}_h L_{rh}$$

$V_r^*$ is the value added of the region if the productivities per worker are, sector by sector, equal to the average productivities at EU-13 level. By means of fictitious value added $V_r^*$, we can break down the aggregate measure of labour productivity ($V_r / L_r$) into two multiplicative factors:

$$(3) \qquad \frac{V_r}{L_r} = \frac{V_r^*}{L_r} \cdot \frac{V_r}{V_r^*} = \left( \sum_h \bar{v}_h \frac{L_{rh}}{L_r} \right) \cdot \left( \frac{\sum_h v_{rh} \cdot L_{rh}}{\sum_h \bar{v}_h \cdot L_{rh}} \right) = \text{INDMIX}_r \cdot \text{PRODIF}_r$$

$\text{INDMIX}_r$ is the component of aggregate regional productivity attributable to the industry mix: it is greater than the European mean if the regional industry mix is oriented in the direction of sectors with higher productivity per worker at EU level, and *vice versa*. This component may be considered as expressing the structural characteristics of the regions related to historical factors, which can only be changed in the long term.

$\text{PRODIF}_r$ is the component of aggregate productivity attributable to the difference, sector by sector, between productivity per worker at regional and EU-13 level (*productivity differential component*)[6]. This component expresses intrinsic differences in competitiveness between regions, without industry mix effects, i.e., the influence on aggregate manufacturing productivity of the specialisation in high or low productivity sub-sectors. This "pure" productivity indicator is particularly suitable for the aims of this paper - in particular, to the objective of measuring the effects of the sector concentration of manufacturing (homogeneous effects) on its aggregate productivity, since it ensures that high/low manufacturing productivity does not depend on the fact that manufacturing is concentrated into high/low productivity sub-sections[7].

In the second empirical analysis (EU-23), in which the breakdown of employment and value added into manufacturing subsectors is not available, the basic labour productivity measure (1) was adopted.

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[5] The sections are: DA *(Food, beverages and tobacco)*; DB+DC *(Textiles and leather etc.)*; DF+DG+DH *(Coke, refined petroleum, nuclear fuel and chemicals etc.)*; DL *(Electrical and optical equipment)*; DM *(Transport equipment)*; and DD+DE+DN+DI+DJ+DK *(Other manufacturing)*.

[6] This decomposition of aggregate productivity is a multiplicative version of the original shift-share analysis applied to levels, in which the allocative component is integrated into the productivity differential effect.

[7] For descriptive purposes, given multiplicative decomposition, we can measure, the contribution of each factor to the interregional inequality of labour productivity. For this, we use the Theil entropy index (T):

$$T = \sum_r y_r \ln \frac{\text{PROD}_r}{\text{PROD}_{eu}} = \sum_r y_r \ln \frac{\text{INDMIX}_r \cdot \text{PRODIF}_r}{\text{INDMIX}_{eu} \cdot \text{PRODIF}_{eu}} = \sum_r y_r \ln \frac{\text{INDMIX}_r}{\text{INDMIX}_{eu}} + \sum_r y_r \ln \frac{\text{PRODIF}_r}{\text{PRODIF}_{eu}}.$$

where $y_r$ is the share of region *r* of European manufacturing value added ($y_r = V_r / V_{eu}$), $\text{PROD}_r$ is manufacturing labour productivity in region *r* ($\text{PROD}_r = V_r / L_r$), and $\text{PROD}_{eu}$ is the average manufacturing labour productivity at EU level ($\text{PROD}_{eu} = V_{eu} / L_{eu}$). Both $\text{PROD}_r$ and $\text{PROD}_{eu}$ can be broken down as in (3) (with $\text{PRODIF}_{eu}$, $\text{INDMIX}_{eu}$ as the corresponding components at aggregate level). It is noteworthy that the outcomes of this decomposition could be different using the so-called "second" Theil measure (i.e., weighting by the regional share of employment). Moreover, in this breakdown, we did not consider explicitly the role of interaction effects between the two components.

*3.2.2. Homogeneous external effects*

In order to account for the importance of the whole manufacturing sector, we use the following Balassa specialisation index in manufacturing:

(4) $$SPEC_r = \frac{L_r / L_{r,T}}{L_{eu} / L_{eu,T}}$$

where $L_r$ is again employment in manufacturing in region *r*, $L_{r,T}$ is total employment in region *r*, and $L_{eu}$ and $L_{eu,T}$ are the corresponding measures at European level.

This indicator is not, alone, a correct measure of homogeneous externalities since we have no information about the internal composition of manufacturing employment (if it is diversified into many different sub-sectors, or specialised in one or a few of them). The previous specialization index only measures the strength of the manufacturing sector in one region; but a larger manufacturing sector may not be necessarily good for productivity, if it conflicts with heterogeneous externalities (i.e., those related to diversity).

So, in order to measure homogeneous economies, we computed an index aimed at measuring how much the manufacturing sector is concentrated (specialised) or diversified into its subsectors. This concentration index (also known as Krugman's index) is:

(5) $$CONC_r = \frac{1}{2} \cdot \sum_h \left| q_{r,h} - q_{eu,h} \right|$$

where $q_{r,h}$ is the share of employment in subsector *h* on total manufacturing employment in region *r* ($q_{r,h} = L_{r,h} / L_r$), and $q_{eu,h}$ is the corresponding share at European Level ($q_{eu,h} = L_{eu,h} / L_{eu}$). The index is zero when the observed composition of manufacturing employment by subsectors is the same at both regional and European levels (absence of regional specialisation) and rises as the regional sectoral composition becomes more and more concentrated into a few (or only one) subsectors. The low number of manufacturing subsections did not allow us to take into account the fact, stressed by Ejermo (2005), that activities grouped into different headings may be more or less similar (e.g., the chemical and pharmaceutical sectors are technologically closer to each other than the wood processing and food processing sectors), and so a concentration/diversification index which does not take this into account may be misleading. Moreover, no information about the average size of manufacturing firms, or distribution of firms according to size classes, is available. Eurostat data on the number of local units are in fact largely incomplete at regional level. Manufacturing specialisation being equal, this information would be important in order to distinguish between regions characterised by the presence of the manufacturing concentration of medium and small firms (local productive systems and local competition) and those characterised by only one or a few large firms (local monopoly).

*3.2.3. Urban heterogeneous effects*

As regards measurement of urban heterogeneous external economies, we initially considered three different indicators which, as explained below and consistently with their definition, we subsequently transformed into a single summary index. The first basic indicator is residential density, a commonly employed general indicator of urbanisation (OECD 1994). However, given the size of some of our territorial units of reference (NUTS2 regions), a simple indicator of population density (regional population over regional area) seemed somewhat inappropriate since, for example, the average regional density is equal for two regions, one of them with a very highly urbanised area and large rural spaces, and the other with a plurality of medium-sized towns. Nevertheless, in the second case the advantages associated with the urban effect are gained by a larger share of manufacturing firms, whereas diseconomies of congestion are less important. To capture this "diffused" urban effect, we propose here the weighted geometric average of NUTS3 population density to compute the corresponding NUTS2 urbanisation index:

(6) $$DENS_r = \left[ \prod_{j \in r} \left( \frac{P_{j,r}}{A_{j,r}} \right)^{A_{j,r}} \right]^{\frac{1}{A_r}}$$

where $P_{j,r}$ and $A_{j,r}$ are population and area (in square kilometres), respectively, of the *j* NUTS3 regions making up the *r* NUTS2 region. Compared with the arithmetic average (the classical NUTS2 density of the population), the geometric average of NUTS3 densities is always smaller, and the difference with respect to the former increases as the concentration of the population in a few NUTS3 areas increases, thus fulfilling the properties required by our indicator of urbanisation of the NUTS2 region. This urbanisation index represents a growing density of agents (on both sides of the market) and so is able to measure a growing diversity of economic activities. As discussed in section 2, this diversity needs to be "qualified" in order to represent the kind of diversity which actually promotes knowledge and information spillovers. Given the constraints on data availability, on one hand we considered the presence and importance in the regional productive system of suppliers of financial and business services (identified as those belonging to the J - financial intermediation - and K - real estate, renting and business activities sections of the NACE classification). The measure is again a Balassa index:

(7) $$\mathrm{SERV_r} = \frac{\mathrm{L_{r,JK}} / \mathrm{L_{r,T}}}{\mathrm{L_{eu,JK}} / \mathrm{L_{eu,T}}}$$

On the other hand, we considered the total human capital endowment of the regional system (in the whole economy, since sectoral data were not available at regional level), as a proxy of which we used recent statistics released by Eurostat concerning Human Resources in Science and Technology (HRST) (Eurostat, on-line statistics). The "occupation" subset of HRST, used here, includes the following categories of workers:

- *professionals*, i.e., workers whose main tasks require a high level of professional knowledge and experience in the fields of physical and life sciences, or social sciences and humanities;
- *technicians and associated professionals*, i.e., workers whose main tasks require technical knowledge and experience in one or more fields of physical and life sciences, or social sciences and humanities.

These types of occupations typically require successfully completed education at the third level, corresponding to the International Standard Classification Education (ISCED) levels 6, 5a and 5b. However, whether the people involved have or do not have this formal education (e.g., they have formal education below ISCED class 5b) is irrelevant, as those in these occupations are automatically considered as belonging to HRST. Therefore, the advantage of using this Eurostat classification consists of capturing the tacit knowledge of highly qualified and experienced blue-collar workers occupied in complex tasks, and of considering them as provided with informal education as skilled labour. The indicator used is simply the ratio of Human Resources in Science and Technology "occupied" (HRSTO) on total employment:

(8) $$\mathrm{HRST_r} = \frac{\mathrm{HRSTO_r}}{\mathrm{L_{r,T}}}$$

As a measure of heterogeneous external economies, we should also take into account the role of physical infrastructure endowment, but unfortunately pertinent regional-level data were not available at an acceptable level of completeness.

In order to measure urban heterogeneous external effects, the last three indicators were summarised into a single measure (URB_HET) by means of principal component analysis, as illustrated in the following section.

*3.2.4. Control Variables*

As regards other control variables, a first major question is posed by the absence of a measure of the private capital stock in manufacturing at regional level. The CE dataset supplies data on aggregate investments by sector since 1980, but with no further qualitative distinction; at the same time, capital stock estimates at a given point in time are available only for a limited number of regions considered. So, as a second-best choice, we used regional investments in manufacturing at PPPs and 1995 constant prices ($\mathrm{INVEST_r}$) per employed person ($\mathrm{L_r}$):

(9) $$\mathrm{INV_r} = \frac{\mathrm{INVEST_r}}{\mathrm{L_r}}$$

We also considered a proxy of innovation activity as a control variable. Data on R&D expenditures and personnel were largely missing at regional level. Consequently, rather than measuring regional innovation activity by means of an input indicator, we used the output indicator, i.e., the number of patents ($\mathrm{PAT_r}$) registered at the European Patent Office (EPO) out of (every thousand) persons employed in manufacturing ($\mathrm{L_r}$):

(10) $$INN_r = \frac{PAT_r}{L_r}$$

The mechanisms and costs associated with a patent registration with the EPO ensure that innovations measured are actually important from the economic point of view. Unfortunately, no sectoral breakdown is available at regional level, so we considered total patents. However, this is not a major problem, since the large majority of innovations are developed in the manufacturing sector. The indicator may also be considered as a measure of high-level formalised knowledge endowment (typically employed in R&D activities), i.e., able to generate important innovations, as opposed to the incremental innovations which are "invisible" to statistics and frequently emerge in specialised contexts, rich in tacit knowledge and *learning by doing* processes.

### 3.3. Descriptive Analysis

Overall statistics concerning the reduced sample (151 regions belonging to 13 old EU members) are shown in table 1. In the period 1995-2004, for these 151 European regions average labour productivity and per worker investments of manufacturing sectors recorded an average of 46,382 and 7,256 Euro respectively (at PPPs and 1995 prices). The total human resources employed in the science and technology fields (HRST) were about 24% of total employment, and innovative activities totalled 1.29 patents per thousand workers.

TABLE 1

Descriptive statistics of variables used in regions of 13 old EU members (pooled sample 1995-2004)

| Stats | Labour productivity (000, 1995 prices, PPP) | INV (000, 1995 prices, PPP) | SPEC | CONC | HRST | URB (000 inhab. per sq. km) | SERV | INN* (patents per 000 workers) |
|---|---|---|---|---|---|---|---|---|
| mean | 46.382 | 7.256 | 0.945 | 0.187 | 0.244 | 0. 342 | 0.899 | 1.294 |
| median | 44.778 | 6.795 | 0.911 | 0.168 | 0.236 | 0.110 | 0. 818 | 0.862 |
| cv | 0.150 | 0.260 | 0.141 | 0.248 | 0.085 | 7.299 | 0.216 | 1.388 |
| min | 5.517 | 0.519 | 0.148 | 0.020 | 0.060 | 0.003 | 0.184 | 0.003 |
| max | 277.320 | 36.080 | 1.972 | 0.815 | 0.505 | 8.792 | 2.413 | 12.486 |

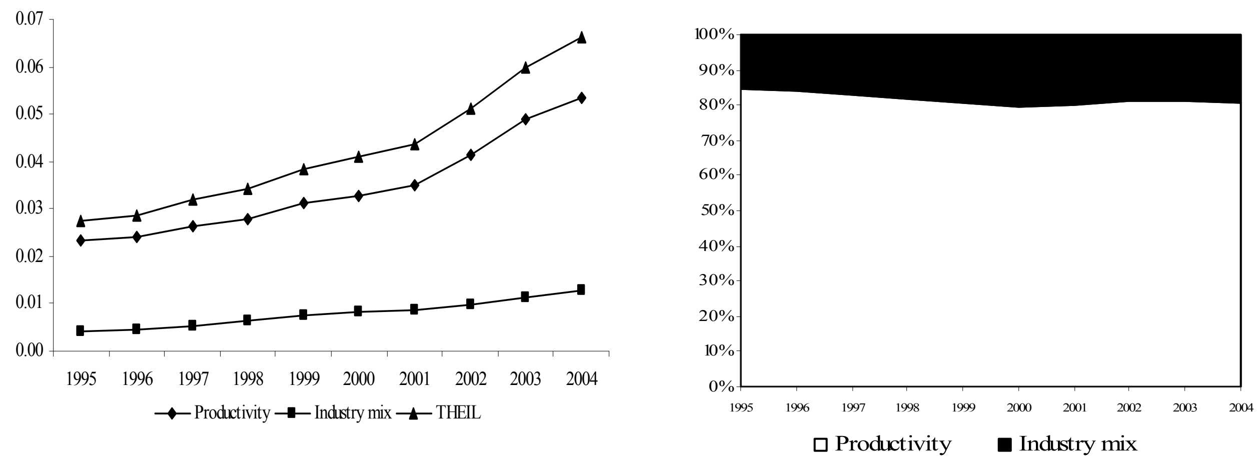
** average 1995-2003*

In this pooled sample, the differences between mean and median values stress that the skewedness of the distributions is not particularly remarkable and that the coefficients of variation are not high. Only in the cases of patents (INN) and population density (DENS) are the median values much lower than the respective means and the coefficients of variation are above 1. This last result emphasises that the diffusion of innovative activities and concentrations of population among European regions are strongly polarised.

Other useful information is provided by the decomposition of labour productivity into the industry mix and the "pure" productivity differentials components, as discussed in the previous section (see footnote 7). Figure 1 shows that more than 80% of the inequality in aggregate productivity derives from "pure" productivity differentials, and its share is slowly increasing in the period considered.

FIGURE 1

Trend of Theil index on labour productivity in manufacturing and its components



In other terms, differences in manufacturing productivity among Western European regions over time do not depend on increasing divergences in specialisation patterns (industry mix), but must be attributed to an enlarging gap related to the general conditions in which manufacturing works.

Preliminary information about the link of these variables is provided by a simple correlation analysis. The first result worthy of comment is that most of the variables are positively correlated: patents, investments and human capital, consistent with theoretical and empirical literature, are all positively and significantly correlated to labour productivity (coefficients of 0.45, 0.46 and 0.43, respectively). Population density (URB) and specialisation in advanced services (SERV) also positively influence the latter. Conversely, no correlation (-0.05) emerges between manufacturing specialisation and the productivity differential component (PRODIF). This evidence helps us specify the hypothesis $H_1$ (homogeneous external economies): according to Glaeser et al. (1992), a simple over-representation of the whole manufacturing industry may not be good for labour productivity if it does not show remarkable levels, where the division of labour starts to provide advantages. Instead, the negative effect of the over-representation of the manufacturing sector on productivity may also simply indicate the presence of many regions at a stage of development behind that of the most highly developed regional economies, in which the structural shift from manufacturing to services has just occurred, or is still occurring (Paci and Usai 2006).

Needless to say, considerable localisation of financial intermediation, real estate and business services (SERV) occurs in urban regions provided with advanced tertiary activities. These two variables SERV and URB are indeed positively and notably correlated (0.48). Moreover, most European countries show a very high share of HRST to total employment in financial and other market service sectors (Calzoni, Perugini, and Pompei 2007). This fact also explains a very similar correlation between HRST and SERV (0.48). As described in section 3.2, variables URB, SERV and HRST were summarised into a single indicator by means of Principal Component Analysis (PCA), in order to represent urban heterogeneous externalities (URB_HET). The results may be considered satisfactory, partly due to the high levels of correlation of the three variables[8].

### 3.4. Empirical Models, Econometric Approach and Results

The empirical analysis aimed at testing the existence, direction and significance of the relationships between labour productivity and the set of explicative variables, as defined above.

The baseline model, estimated for the EU-13 sample, has the following panel structure:

$$(11) \qquad PRODIF_{r,t} = \alpha + \beta(SPEC)_{rt} + \vartheta(CONC)_{r,t} + \nu(URB\_HET)_{r,t} + \delta(INV)_{rt} + \varphi(INN)_{rt} + \mu_r + \tau_t + \varepsilon_{r,t}$$

where subscripts *r* and *t* are the 151 regions and the 9 (1995-2003) years, respectively; $PRODIF_{r,t}$, SPEC, CONC, URB_HET, INV and INN are the variables defined in section 3.2, and $\alpha, \beta, \nu, \delta$ and $\varphi$ are the coefficients associated with the explicative variables; $\mu_r$ and $\tau_t$ are region and time specific effects, respectively, and $\varepsilon_{r,t}$ are the error terms.

The empirical relationship was estimated by means of panel econometric techniques with four different specifications. Before starting panel estimation procedures, we ran a pooled Ordinary Least Square estimate in order to identify the presence and significance of space and time effects. Their significance indicated that they should be included in the models, whereas the Hausman test unequivocally suggested the use of fixed effects models (see table 2, 3 and 4). This was consistent with previous panel analyses carried out at regional level in this field. For all (fixed effects) models, the standard diagnostic test showed residual autocorrelation (Wooldridge test), heteroschedasticity (modified Wald test) and contemporaneous correlation (Breusch Pagan LM test). This suggested the use of a Prais-Winsten regression, correlated panels corrected standard error (PCSEs) estimators[9].

The presence of contemporaneous correlation of residuals (two or more units have correlated errors at the same time) indicated the probable existence of unobservable features in some regions, related to unobservable features in other regions. In the case of spatial data, this may reveal the existence of spatial autocorrelation, i.e., the behaviour (or performances) of neighbouring regions is somehow (positively or negatively) connected. This may be basically due to: (a) measurement errors for observations referring to contiguous geographic units; (b) actual spatial interaction patterns. The spatial correlation of the dependent and exogenous variables were calculated

[8] Statistics concerning PCA were carried out on the EU-13 (151 regions) and EU-23 (240 regions) samples. In both cases, adopting the eigenvalue-one criterion, which suggests retaining and interpreting any component with an eigenvalue greater than 1, we only used the first component, which explains 56% of variance of the three variables. Detailed tables of results are available upon request.

[9] Since the corresponding STATA commands do not automatically provide fixed effects estimates, it was necessary to introduce (n-1) regional dummy variables (not reported in the tables for the sake of brevity).

descriptively by means of the Moran spatial autocorrelation index[10] which, consistently with other existing empirical evidence, shows that all variables considered are spatially autocorrelated, although at different levels and with different dynamics (data available upon request). These outcomes suggested that spatial interaction should be carefully considered in econometric analysis by means of the existing specific techniques, in order to avoid inefficient and biased estimates (Anselin and Griffith 1988). The use of spatial econometric tools has been growing in recent years in all the fields of empirical regional analysis, including those considered here (e.g., Lim 2004; Ezcurra, Pascual, and Rapùn 2006; Paci and Usai 1999; Van Ort 2002). As the econometric literature shows (starting from Anselin 1988), traditional spatial autoregressive models may present: (a) the dependent variable correlated with its spatial lag (spatial LAG model); (b) the error term affected by spatial autocorrelation (spatial ERROR model); or (c) both spatial LAG and ERROR correlations. In our empirical analysis, we used the available MATLAB spatial econometric tools to run ML estimates for fixed effects autoregressive spatial LAG and spatial ERROR models for manufacturing labour productivity differentials[11]. In the case of the model described in equation 11, the two specifications are, respectively:

(12)

$$PRODIF_{r,t} = \alpha + \rho W(PRODIF)_{r,t} + \beta(SPEC)_{rt} + \vartheta(CONC)_{r,t} + \nu(URB\_HET)_{r,t} + \delta(INV)_{rt} + \varphi(INN)_{rt} + \mu_r + \tau_t + \varepsilon_{r,t}$$

where $\rho$ is the coefficient of the spatially lagged dependent variable; W is the weight - or spatial lag – matrix; and the remaining notations assume the same meanings as in equations 11. Also:

(13)

$$PRODIF_{r,t} = \alpha + \beta(SPEC)_{rt} + \vartheta(CONC)_{r,t} + \nu(URB\_HET)_{r,t} + \delta(INV)_{rt} + \varphi(INN)_{rt} + \mu_r + \tau_t + \lambda W\varepsilon_{r,t} + \eta_{r,t}$$

where $\lambda$ is the coefficient of a spatial autoregressive structure for disturbance $\varepsilon_{r,t}$.

Table 2 shows the outcomes of the specifications of equations 11, 12 and 13 concerning the EU-13 sample (151 regions). First, it is worth noting that, besides the significance of all the variables considered, strong consistency in the sign and magnitude of coefficients holds for the four estimations, with the spatial autoregressive coefficients which turn out to be positive and significant. As expected, per-worker patents (INN) and investments (INV) positively influence the level of labour productivity. With reference to the focus of the paper, both indexes of homogeneous (CONC) and urban heterogeneous externalities (URB_HET) are positive and significant, corroborating the hypothesis of the existence of homogeneous and heterogeneous external economies on labour productivity differentials, and the possibility of their contemporaneous action.

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[10] The technical precondition for the inclusion of spatial effects in the analysis is the availability of a weights (or spatial lags) matrix able to express the connections between the geographic units in question. Depending on the nature of the phenomenon studied, the weight may be represented in different ways. In our case, we considered the matrix of the inverse geographical distance between the capital city (or most highly populated city) of each region.

[11] In the simplest formal terms, if W is the weight - or spatial lag - matrix, the starting point is:

$$y = \rho W y + X \beta + \varepsilon$$

where:

$\varepsilon = \lambda W \varepsilon + \eta$; $\eta \sim N(0, O)$, and the diagonal elements of the O covariance matrix of errors $O_{ij} = h_i(z\varpi)$; $\beta$ is a vector Kx1 of parameters associated with explicative variables X (matrix N x K); $\rho$ is the coefficient of the spatially lagged dependent variable; $\lambda$ is the coefficient of a spatial autoregressive structure for disturbance $\varepsilon$.

We have a spatial LAG model if $\lambda = \varpi = 0$ and $y = \rho W y + X \beta + \varepsilon$. We have a spatial ERROR model if $\rho = \varpi = 0$ and $y = X \beta + (I - \lambda W)^{-1} \eta$. In the first case, a typical omitted-variable problem arises, which could not be faced by means of OLS estimation (due to simultaneity/endogeneity) and may be addressed using Maximum Likelihood (ML), Instrumental Variables and Robust approach estimates. It is also possible that correcting for the spatial lag of the dependent variable makes the error spatial autocorrelation disappear. Methods of estimation alternative to OLS are also recommended in the case of spatial ERROR correlation.

TABLE 2

Econometric estimates of determinants of "pure" labour productivity differentials (1995-2003, EU-13)

| | ***Fixed effects*** | | ***Correlated PCSE (fe)**** | | ***ML (fe) (spatial lag-ρ)*** | | ***ML (fe) (spatial error-λ)*** | |
|---|---|---|---|---|---|---|---|---|
| | *Coeff.* | *p-values* | *Coeff.* | *p-values* | *Coeff.* | *p-values* | *Coeff.* | *p-values* |
| SPEC | -1.574 | *0.000* | -1.766 | *0.000* | -1.590 | *0.000* | -1.644 | *0.000* |
| $SPEC^2$ | 0.474 | *0.000* | 0.547 | *0.002* | 0.495 | *0.000* | 0.509 | *0.000* |
| CONC | 0.658 | *0.000* | 0.646 | *0.021* | 0.691 | *0.000* | 0.718 | *0.000* |
| log_INV | 0.290 | *0.000* | 0.217 | *0.000* | 0.291 | *0.000* | 0.277 | *0.000* |
| URB_HET | 0.038 | *0.044* | 0.045 | *0.033* | 0.037 | *0.034* | 0.039 | *0.030* |
| INN | 0.023 | *0.000* | 0.009 | *0.201* | 0.023 | *0.000* | 0.026 | *0.000* |
| D_1996 | -0.014 | *0.214* | -0.010 | *0.142* | -0.014 | *0.186* | -0.015 | *0.270* |
| D_1997 | -0.033 | *0.006* | -0.024 | *0.007* | -0.032 | *0.003* | -0.033 | *0.014* |
| D_1998 | -0.039 | *0.001* | -0.029 | *0.005* | -0.039 | *0.000* | -0.040 | *0.003* |
| D_1999 | -0.043 | *0.001* | -0.029 | *0.008* | -0.045 | *0.000* | -0.045 | *0.001* |
| D_2000 | -0.050 | *0.000* | -0.032 | *0.003* | -0.053 | *0.000* | -0.052 | *0.000* |
| D_2001 | -0.044 | *0.001* | -0.029 | *0.008* | -0.048 | *0.000* | -0.047 | *0.001* |
| D_2002 | -0.037 | *0.004* | -0.022 | *0.035* | -0.041 | *0.001* | -0.039 | *0.005* |
| D_2003 | -0.018 | *0.144* | -0.014 | *0.186* | -0.025 | *0.038* | -0.019 | *0.179* |
| constant | 1.640 | *0.000* | 1.257 | *0.000* | - | - | - | - |
| *n. of observations* | 1359 | | 1359 | | 1359 | | 1359 | |
| *n. of groups* | 151 | | 151 | | 151 | | 151 | |
| *F (14, 1906)* | 26.160 | *0.000* | | | | | | |
| *R-sq within* | 0.2347 | | | | | | | |
| *R sq between* | 0.0274 | | | | | | | |
| *R sq overall* | 0.0336 | | | | | | | |
| *R squared* | | | 0.891 | | 0.915 | | 0.916 | |
| *Hausman Test* | 99.270 | *0.000* | | | | | | |
| *Wooldridge test* | 99.641 | *0.000* | | | | | | |
| *Modified Wald (heteroskedasticity)* | 5.1e+05 | *0.000* | | | | | | |
| *Breusch-Pagan LM (contem. correlation)* | 34862.130 | *0.000* | | | | | | |
| *ρ (AR 1 term)* | | | 0.523 | | | | | |
| *ρ / λλ* (spatial effects terms) | | | | | 0.138 | *0.001* | 0.192 | *0.000* |

** coefficients and p_values of regional fixed effects omitted forsake of brevity*

So, once the size of the manufacturing sector is controlled for, growing specialisation within the manufacturing sector affects the levels and dynamics of regional manufacturing productivity positively. The estimates of table 2 also confirm a preliminary result which had already emerged in the descriptive analysis, and partially answer a question that arose in that context: does the strong presence of the manufacturing sector (SPEC) in regional economic systems negatively affect its labour productivity differentials? Actually, if we introduce a quadratic term ($SPEC^2$), we see that the above mentioned result holds as far as a given threshold. When SPEC is small, manufacturing sector specialisation affects negatively labour productivity, whereas the opposite occurs when SPEC is very large[12].

### 3.5 An extended analysis for the regions of EU-23

We also extended the empirical analysis to the whole sample of 240 European regions (sample EU-23, which includes regions of all member countries, except Cyprus and Malta, due to many missing data) but, as the manufacturing sector breakdown was unavailable for the regions of the ten countries added to the sample, we were only able to test the impact on simple labour productivity (PROD) of urban heterogeneous effects and of the

[12] If we consider the quadratic function $Y = \alpha X^2 + \beta X$ and set its derivative at zero, we can calculate the minimizing value of the X, which is $X=-\beta/2\alpha$..

strength of manufacturing. So equations 11, 12 and 13 were also estimated for this larger sample, but replacing the dependent variable with the simple labour manufacturing productivity indicator ( $PROD_r$ ) and omitting the explicative CONC. This EU-23 sample includes 39 regions of Central and Eastern European Countries (CEEC) , and this offered the opportunity to identify and discuss interesting structural differences in productivity levels and determinants between the regions of Western and Central and Eastern European countries.

Some preliminary descriptive statistics on this extended sample are shown in table 3. Of course, the inclusion of CEEC regions in the total pooled sample causes lower values of mean and medians for labour productivity and investments with respect to those observed in table 1 ( 41,198 and 7,089 Euro, respectively, at PPPs and 1995 prices).

Indeed, when we distinguish between the 201 regions belonging to the old EU-15 members (including Germany and Austria) and the 39 CEEC regions, notable differences emerge. The level of labour productivity of EU-15 regions is twice that of the CEEC. Despite the different measurement approach (in our case, it is simply the manufacturing value added per worker), the result is perfectly consistent with the estimation of Gardiner, Martin, and Tyler (2004).

TABLE 3

Descriptive statistics of variables used in empirical analysis (pooled sample 1995-2004)

| Stats | Labour Productivity (000, 1995 prices, PPP) | INV (000, 1995 prices, PPP) | SPEC | HRST | URB (000 inhab. per sq. km) | SERV | INN* (paternts per 000 workers) |
|---|---|---|---|---|---|---|---|
| | | | *Total pooled sample* | | | | |
| mean | 41.198 | 7.089 | 0.974 | 0.253 | 0.325 | 0.909 | 1.228 |
| median | 41.238 | 6.326 | 0.953 | 0.248 | 0.116 | 0.866 | 0.830 |
| cv | 0.189 | 0.273 | 0.132 | 0.070 | 6.580 | 0.212 | 1.384 |
| min | 5.517 | 0.000 | 0.133 | 0.060 | 0.003 | 0.207 | 0.001 |
| max | 277.320 | 36.080 | 2.176 | 0.505 | 8.792 | 2.703 | 12.486 |
| | | | *Old EU-15 regions* | | | | |
| mean | 45.235 | 7.521 | 0.926 | 0.257 | 0.355 | 0.977 | 1.454 |
| median | 43.617 | 6.759 | 0.902 | 0.252 | 0.131 | 0.905 | 1.032 |
| cv | 0.135 | 0.279 | 0.131 | 0.073 | 6.340 | 0.176 | 1.030 |
| min | 5.517 | 0.000 | 0.133 | 0.060 | 0.003 | 0.207 | 0.003 |
| max | 277.320 | 36.080 | 1.783 | 0.504 | 8.792 | 2.703 | 12.486 |
| | | | *CEEC regions* | | | | |
| mean | 20.386 | 4.864 | 1.220 | 0.237 | 0.170 | 0.559 | 0.064 |
| median | 19.725 | 4.472 | 1.182 | 0.237 | 0.098 | 0.508 | 0.034 |
| cv | 0.081 | 0.148 | 0.081 | 0.049 | 4.593 | 0.211 | 2.486 |
| min | 7.581 | 1.501 | 0.531 | 0.084 | 0.023 | 0.259 | 0.001 |
| max | 51.567 | 12.697 | 2.176 | 0.388 | 2.434 | 1.681 | 0.721 |

** average 1995-2003*

The correlation matrix for these variables shows results very similar to those discussed for the EU-13 sample. However, in this case, a detailed comparative description allows us to shed light on CEEC regional specificities and provides insights for a specific econometric analysis. Thus, we carried out a descriptive dynamic framework which maintains the information about the distributions of variables and shows it in the time dimension. The box plot analysis of figure A1 in the appendix responds to this need.

As regards labour productivity levels, we observe that the huge gap between EU-15 and CEEC regions tends to close very slowly over time. In 1995, the median labour productivity in Western regions was above 39,600 Euro but was only 15,900 Euro in the Eastern ones (i.e., 40% of the former). Ten years later, these medians had increased up to respectively 52,600 and 25,400 Euro (the latter is now 48% of the former).

The empirical literature identifies several reasons for the slow catching-up process between CEEC and EU-15, most of them concerning the difficulties of the early transition period (Svejnar 2002). In particular, some authors have focused on national-level factors such as tight macroeconomic policies (Bhaduri, Kasko, and Levcik

1993; Rosati 1994); lack of organisation among suppliers, producers and consumers, associated with the collapse of central planning (Blanchard and Kremer 1997; Roland and Verdier 1999); and the switch from a controlled to an uncontrolled monopolistic structure in these economies (Li 1999; Blanchard 1997).

Instead, regional studies have concentrated on the role of geographically localised externalities and increasing returns (Martin and Sunley 1998). Where the sources of these externalities are embedded in socio-cultural and institutional differences across regions, productivity differentials may not diminish over time (Martin 2000) and a "core-periphery" equilibrium pattern of productivity may emerge (Davis and Weinstein 2001). Therefore, if we put together both national- and regional-level explanations for the persistent productivity differentials, we can conclude, like Gardiner, Martin, and Tyler (2004), that the CEEC regions are completing their transition period by becoming a large periphery of the most advanced Western regions. Moreover, the larger variability of productivity within EU-15 regions, which increases over time, may be explained by the emergence of peripheral Western regions, mainly located in Greece, Portugal and Spain (Prokopijevic 2004).

Indeed, the different trends of the distributions of manufacturing specialisation *versus* service sectors specialisation (see box plots in figure A1) support this core-periphery view, and indicate that significant processes of relocation of economic activities may take place between EU-15 and CEEC regions, as stressed in the literature on international outsourcing, trade flows and FDI localisation (Graziani 1998 and 2001; Kaminski and Ng 2001; Perugini, Pompei, and Signorelli 2005). After the increasing trend of the median, in 2004 about 75% of CEEC regions were specialised in the manufacturing sector (SPEC), while the opposite had occurred in the EU-15 ones. Conversely, almost 50% of EU-15 regions were now specialised, throughout the period, in financial and business activities (SERV), whereas no Eastern regions were.

The dynamic framework of per-worker investments (INV) and patents (INN) also reveals significant findings. In particular, the median of investment in Eastern regions seems to be growing faster than in the EU-15, but the whole distribution always remains at very low levels: in 2004, the upper adjacent value of the CEEC box plot (that is, the Eastern region with maximum per-worker investment level) slightly exceeded the median value of the EU-15 regions. The widest gap is observed for patents. On one hand, this outcome emphasises important differences in endogenous technological capabilities; on the other, it may also signal an important institutional bias, concerning national differences in the propensity to register patents wih the European Patent Office. It must also be noted that the increasing skewedness in the distribution of Western patents confirms results in the recent literature on the geography of innovation, which has highlighted the very uneven location of innovative outputs throughout the European regions in the last few years (Longhi and Keeble 2000).

The econometric estimates of the restricted version (without CONC and with PROD as dependent variable) of equation 11 provides the following results.

TABLE 4

Econometric estimates of determinants of aggregate labour productivity (1995-2003, EU-23)

| | **Fixed effects** | | **Correlated PCSE (fe)*** | | **ML (fe) (spatial lag-ρ)** | | **ML (fe) (spatial error-λ)** | |
|---|---|---|---|---|---|---|---|---|
| | *Coeff.* | *p-values* | *Coeff.* | *p-values* | *Coeff.* | *p-values* | *Coeff.* | *p-values* |
| SPEC | -1.670 | *0.000* | -1.813 | *0.000* | -2.114 | *0.000* | -1.776 | *0.000* |
| $SPEC^2$ | 0.542 | *0.000* | 0.589 | *0.000* | 0.657 | *0.000* | 0.579 | *0.000* |
| log_INV | 0.044 | *0.000* | 0.030 | *0.001* | 1.091 | *0.000* | 0.048 | *0.000* |
| URB_HET | 0.062 | *0.000* | 0.058 | *0.002* | 0.066 | *0.000* | 0.057 | *0.000* |
| INN | 0.023 | *0.000* | 0.012 | *0.078* | 0.024 | *0.000* | 0.028 | *0.000* |
| D_1996 | -0.002 | *0.794* | 0.001 | *0.898* | -0.001 | *0.901* | -0.003 | *0.778* |
| D_1997 | -0.011 | *0.215* | -0.005 | *0.402* | -0.007 | *0.403* | -0.012 | *0.240* |
| D_1998 | -0.014 | *0.116* | -0.007 | *0.385* | -0.009 | *0.276* | -0.017 | *0.118* |
| D_1999 | -0.010 | *0.297* | 0.001 | *0.941* | -0.006 | *0.484* | -0.013 | *0.223* |
| D_2000 | -0.008 | *0.441* | 0.005 | *0.546* | -0.005 | *0.577* | -0.011 | *0.318* |
| D_2001 | -0.005 | *0.586* | 0.007 | *0.442* | -0.005 | *0.552* | -0.009 | *0.425* |
| D_2002 | 0.002 | *0.835* | 0.013 | *0.118* | -0.002 | *0.803* | -0.001 | *0.915* |
| D_2003 | 0.025 | *0.008* | 0.028 | *0.001* | 0.017 | *0.056* | 0.026 | *0.019* |
| constant | 1.856 | *0.000* | 1.478 | *0.000* | - | - | - | - |
| *n. of observations* | 2160 | | 2160 | | 2160 | | 2160 | |
| *n. of groups* | 240 | | 240 | | 240 | | 240 | |
| *F (14, 1906)* | 28.260 | *0.000* | | | | | | |
| *R-sq within* | 0.1632 | | | | | | | |
| *R sq between* | 0.1525 | | | | | | | |
| *R sq overall* | 0.1508 | | | | | | | |
| *R squared* | | | 0.907 | | 0.940 | | 0.943 | |
| *Hausman Test* | 79.560 | *0.000* | | | | | | |
| *Wooldridge test* | 144.334 | *0.000* | | | | | | |
| *Modified Wald (heteroskedasticity)* | 1.8e+05 | *0.000* | | | | | | |
| *Breusch-Pagan LM (contem. correlation)* | 1.08e+05 | *0.000* | | | | | | |
| *ρ (AR 1 term)* | | | 0.581 | | | | | |
| *ρ / λ* (spatial effects terms) | | | | | 0.152 | *0.000* | 0.259 | *0.000* |

** coefficients and p_values of regional fixed effects omitted for sake of brevity*

As regards the focus of this paper, the outcomes confirm the positive effects and significance of URB_HET, corroborating the hypothesis of better productivity performance associated with urban assets. The sign and significance of the remaining control variables are consistent with those of the previous estimates. This is also true for the SPEC indicator, which again provides evidence of a quadratic relationship; the threshold of SPEC at which the direction of the relationship is inverted is again high (1.53). From 1995 to 2003, the regions exceeding this value rose from 13 to 25. From a geographical point of view, in 2003 56% of these regions belonged to CEEC (10 regions) and Spain and Portugal (4 regions), i.e, to the area defined by some authors as the periphery of the European Union (Prokopijevic 2004).

This U-shaped relationship needs further comment. The strong presence of manufacturing in the regional economy may simply correspond to a rearward stage of development, when compared with more advanced tertiary regional productive systems. Although we currently have no information about the composition of manufacturing, beyond certain (high) levels of manufacturing specialisation, some form of homogeneous external economies, which are not strictly specific to a section of manufacturing, probably emerge (advantages of the division of labour, concentration of input suppliers, local competition goods created by favourable governance and policy setting).

The final group of econometric estimates (table 5) refers to the same model presented in table 4, but the explicative variables have also been interacted with a dummy variable which identifies regions of the CEEC[13].

[13] The coefficient of the variable therefore gives the effect for the non-CEEC regions, whereas the coefficient of the interaction gives the sign and size of the differences recorded for the CEEC subsample. If the interaction is not significant, no statistically significant differences emerge between the two subsamples.

Some interesting results emerge. First of all, both urban heterogeneous externalities and patents do not exhibit significantly different coefficients between CEEC and EU-15 regions. Conversely, investments play a more important role in CEEC regions: the coefficient of log_inv_ceec is indeed significantly higher than log_inv. Similarly, SPEC_ceec and $SPEC^2$_ceec show signs opposite to those referring to EU-15 regions, disclosing a lowering of the threshold beyond which manufacturing specialisation positively influences labour productivity. If we put together the evidence of descriptive analysis concerning the remarkable gaps in labour productivity featuring CEEC regions, and the outcomes of the econometric analysis indicating that some determinants boost labour productivity with a different strength in these contexts (investments and manufacturing specialisation), we can conclude that quite different patterns have been characterising Western and Eastern regions over the last few years. This point needs to be further investigated in future research.

TABLE 5

Econometric estimates of determinants of labour productivity (1995-2003, EU-23 with interactions for CEEC regions)

| | ***Fixed effects*** | | ***Correlated PCSE (fe)**** | | ***ML (fe) (spatial lag-ρ)*** | | ***ML (fe) (spatial error-λ)*** | |
|---|---|---|---|---|---|---|---|---|
| | *Coeff.* | *p-values* | *Coeff.* | *p-values* | *Coeff.* | *p-values* | *Coeff.* | *p-values* |
| SPEC | -2.149 | *0.000* | -2.313 | *0.000* | -2.652 | *0.000* | -2.612 | *0.000* |
| SPEC_ceec | 1.625 | *0.000* | 1.838 | *0.001* | 1.859 | *0.000* | 1.857 | *0.000* |
| $SPEC^2$ | 0.800 | *0.000* | 0.861 | *0.000* | 0.944 | *0.000* | 0.919 | *0.000* |
| $SPEC^2$_ceec | -0.664 | *0.000* | -0.734 | *0.003* | -0.755 | *0.000* | -0.738 | *0.000* |
| log_INV | 0.033 | *0.000* | 0.022 | *0.012* | 1.148 | *0.000* | 1.095 | *0.000* |
| log_INV_ceec | 0.070 | *0.004* | 0.058 | *0.000* | 0.097 | *0.000* | 0.101 | *0.000* |
| URB_HET | 0.062 | *0.000* | 0.058 | *0.004* | 0.065 | *0.000* | 0.066 | *0.000* |
| URB_HET_ceec | 0.015 | *0.732* | -0.008 | *0.715* | 0.015 | *0.724* | 0.017 | *0.690* |
| INN | 0.025 | *0.000* | 0.012 | *0.062* | 0.026 | *0.000* | 0.026 | *0.000* |
| INN_ceec | 0.199 | *0.129* | 0.047 | *0.526* | 0.189 | *0.121* | 0.194 | *0.112* |
| D_ceec | - | - | -0.891 | *0.000* | - | - | - | - |
| D_1996 | -0.004 | *0.653* | -0.001 | *0.867* | -0.005 | *0.572* | -0.004 | *0.600* |
| D_1997 | -0.014 | *0.128* | -0.008 | *0.226* | -0.013 | *0.124* | -0.013 | *0.128* |
| D_1998 | -0.019 | *0.036* | -0.011 | *0.142* | -0.019 | *0.024* | -0.019 | *0.027* |
| D_1999 | -0.016 | *0.098* | -0.005 | *0.577* | -0.018 | *0.044* | -0.016 | *0.074* |
| D_2000 | -0.014 | *0.146* | 0.000 | *0.981* | -0.018 | *0.046* | -0.015 | *0.099* |
| D_2001 | -0.013 | *0.205* | 0.001 | *0.925* | -0.019 | *0.040* | -0.016 | *0.093* |
| D_2002 | -0.005 | *0.608* | 0.009 | *0.328* | -0.015 | *0.115* | -0.011 | *0.262* |
| D_2003 | 0.019 | *0.053* | 0.022 | *0.009* | 0.005 | *0.552* | 0.011 | *0.232* |
| constant | 1.904 | *0.000* | 1.650 | *0.000* | - | - | - | - |
| *n. of observations* | 2160 | | 2160 | | 2160 | | 2160 | |
| *n. of groups* | 240 | | 240 | | 240 | | 240 | |
| *F (14, 1906)* | 22.790 | *0.000* | | | | | | |
| *R-sq within* | 0.1774 | | | | | | | |
| *R sq between* | 0.1129 | | | | | | | |
| *R sq overall* | 0.0958 | | | | | | | |
| *R squared* | | | 0.910 | | 0.942 | | 0.941 | |
| *Hausman Test* | 137.410 | *0.000* | | | | | | |
| *Wooldridge test* | 132.972 | *0.000* | | | | | | |
| *Modified Wald (heteroskedasticity)* | 2.0e+05 | *0.000* | | | | | | |
| *Breusch-Pagan LM (contem. correlation)* | 1.03e+05 | *0.000* | | | | | | |
| *ρ (AR 1 term)* | | | 0.568 | | | | | |
| *ρ / λ* (spatial effects terms) | | | | | 0.145 | *0.000* | 0.034 | *0.321* |

## 4. SUMMARY AND FINAL REMARKS

This paper aimed at exploring labour productivity differentials in the manufacturing sector across European regions, focusing on the various factors characterising the context in which firms are located. As in various other contributions, besides the traditional determinants (i.e., per worker investment and innovation capacity measured by patents per worker), we examined two classes of external factors which, respectively, represent *homogeneous* external economies, stemming from high concentrations of firms in one or a few manufacturing specialisations within regions, and *urban heterogeneous* external economies, typical of urban settings. However, we discuss theoretically the definition of the latter in the light of the existing literature, providing a definition which, in our opinion, addresses the ambiguity of some previous approaches. In the empirical part of the paper, we test the hypothesis that the two kinds of external economies are beneficial to regional labour productivity levels and dynamics, and that they are not alternative but may co-exist. The outcomes, obtained by means of various panel econometric approaches, including spatial autoregressive models, clearly corroborate our conjectures. So, in general terms, these insights clearly support the well-established and empirically documented view of cumulative processes of development and growth, with consequent outcomes in the dynamics of regional disparities.

As regards the area of homogeneous economies, we were able to provide a satisfying measure only for a subset of regions (13 Western EU countries). For this reduced sample - for which we also calculated a more specific measure of productivity differentials (net of the industry mix component) - the econometric estimates support the view that manufacturing productivity may benefit from the significant presence of a specialised manufacturing sector. However, our analyses (both descriptive and econometric) also provide definite evidence that the growing importance of manufacturing (not taking its specialisation into account) may be harmful to productivity, at least as far as a certain (quite high) threshold. This indicates that a strong manufacturing sector does not mean, *per se*, good productivity performance, but may rather signal a rearward stage of development with respect to more advanced tertiary regional productive systems - even though, as discussed below, a specific specialisation pattern cannot be excluded. Also as regards heterogeneous external economies, the various estimates provide evidence of their steady and significant positive effects on manufacturing productivity.

Broadly speaking, these results allow us to provide an empirical contribution to the debate concerning the efficiency of European manufacturing industries in the tertiary era. They confirm the widely theoretically and empirically investigated idea that the sources of competitiveness are not to be sought only within firms, but also suggest that external sources of productivity gains may derive not exclusively from the agglomeration of specialised activities, but also from the location of manufacturing firms in urban areas, typically rich in important competitive factors. In other words, efficient production of goods may rely both on stability in a determined specialisation, favouring cumulative knowledge processes and exploitation of the learning curve, and on the possibility of accessing other important resources, such as skilled labour pools, sustained local demand, university and private research centres, institutional networks, proximity to decision centres, proximity to financial and business services, and the availability and efficiency of hard and soft infrastructures. The two sources are independent, since each of them can exist without the other, but they are not alternative, since a specialised production system may be located within an urban context, as witnessed by the locations of many industrial districts in urban areas across Europe. When the two kinds of external economies co-exist, manufacturing production is likely to benefit from the increased ability to react to exogenous shock or pressures, accessing multiple factors of competitive adaptation.

Coherent policy implications should entail, for homogeneous economies, the setting-up of traditional schemes fostering the clustering of sectorally similar or integrated firms, or the reinforcement of existing agglomeration patterns. This involves the inclusion, in industrial policy design and implementation, of a more clearcut regional dimension, able to accompany the already existing map of spatial division of labour emerging from historical, economic, social and cultural circumstances. In effect, if a significant part of the homogeneous external economies derives from the interplay of productive structures and features of the local society, their promotion will certainly not be a short-term, centrally-designed fact, but must encounter some specific and favourable local conditions.

As regards urban heterogeneous external economies, awareness of their importance suggests that the design and implementation of policies typically directed to improving urban quality may entail important “external” effects on the traditional productive sectors. In this respect, Malecki (1997) observed that public and recreational amenities and other high-quality personal services very often play a crucial role in attracting researchers and other skilled labour. More in general, similar considerations may be put forward with regard to the provision of non-sector-specific material and immaterial infrastructures: not only with the aim of increasing accessibility to transport and information networks, but also as factors able to attract and hold high-quality sources of innovation and adaptation capacities (human capital, private and public research laboratories, financial and business services, universities, etc.).

Another general concluding remark regards to the information supplied by our analysis on the geography of productivity levels and determinants in European regions. Different factors operate with different strength in the regions belonging to the CEEC (and also in some Spanish, Portuguese and Greek regions). Indeed, in these areas, where the convergence literature and also our descriptive analysis confirmed lower levels of labour productivity, we found that investment levels play a stronger role, whereas the negative impact of the presence of strong manufacturing sectors (not taking their internal specialisations into account) seems to be reduced. It is important to understand if this persistent productivity gap depends on not yet completed structural adjustment processes (convergence view) or if, alternatively, it may be explained by means of the core-periphery theoretical framework. This second option directly addresses the question of the existence of different kinds of externalities, which in turn support different patterns of specialisation embedded in a new international division of labour within the EU-27.

Thus, a future line of research may go into more in-depth study of these preliminary findings, such as the important role played by investments in tangible goods and manufacturing specialisations in CEEC regions, and may combine them with the interesting outcomes of international trade flow studies. Some authors have emphasised how the CEEC regions have been occupying specific positions in the segment of the value chains controlled by Western firms (e.g., Graziani 1998 and 2001). The Eastern regions have obviously improved the quality and value of their exports, but they have specialised in sectors concerned with outward processing traffic (electrical machinery, footwear and garment sectors) or other intermediate goods sectors. According to the above literature, these phenomena depict an interesting map of comparative advantages in the common European market, so that the eastward enlargement of the EU did not introduce conflicts with specialisation patterns in Western regions. However, this specialisation path would also mean strict dependence on decisions made outside (although within the Western area) and persistent gaps in labour productivity (due to the industry mix component), threatening social cohesion among EU regions.

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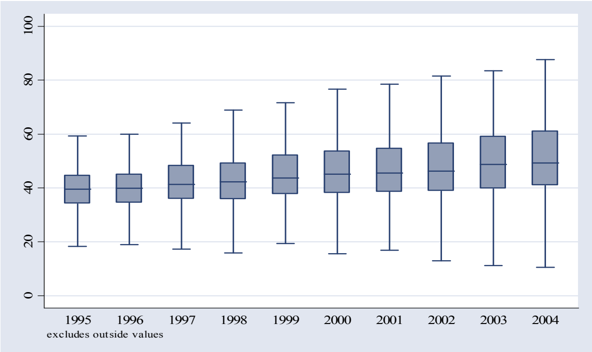
## APPENDIX

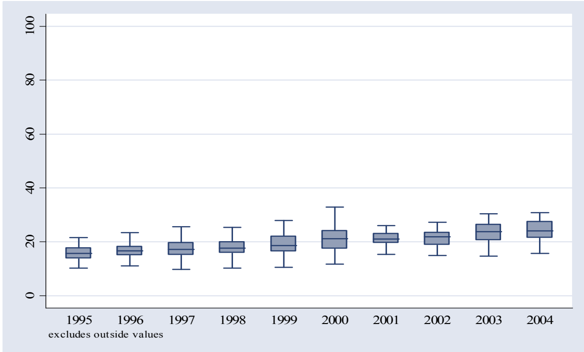
FIGURE A1

Variability over time of labour productivity and its explicative variables*

OLD EU | CEEC

*Labour productivity*

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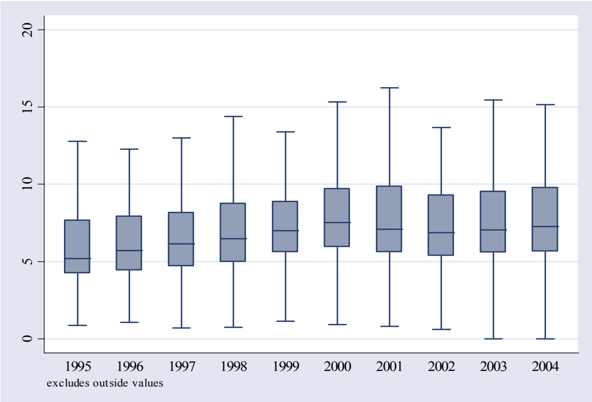


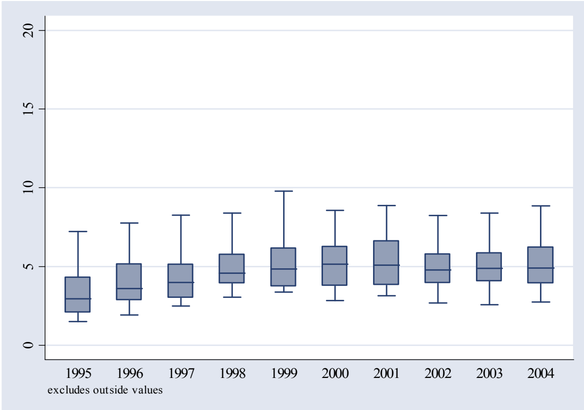


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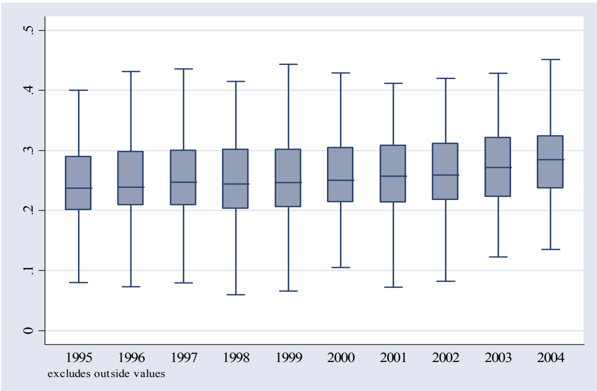


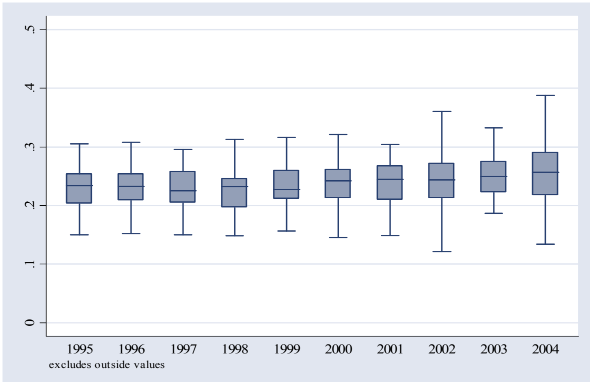


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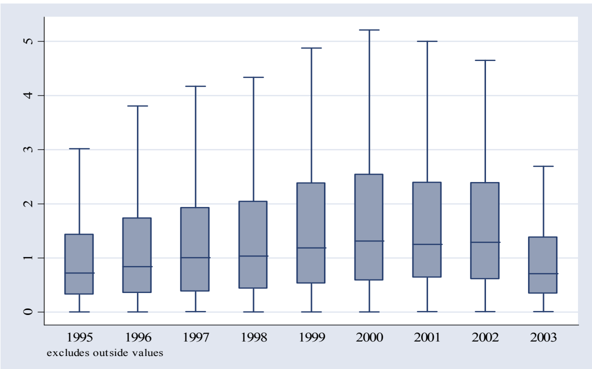


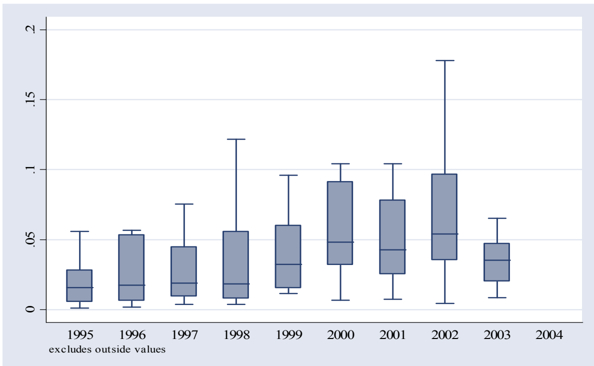
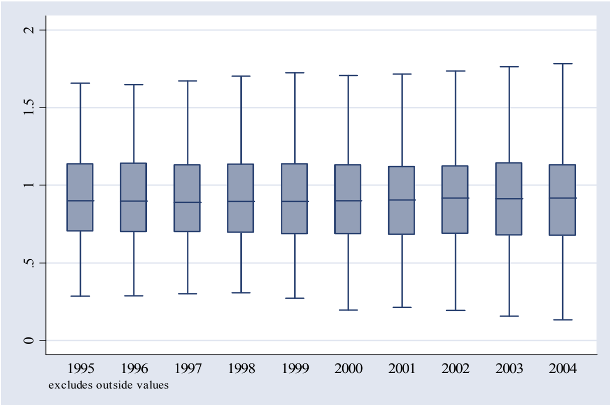
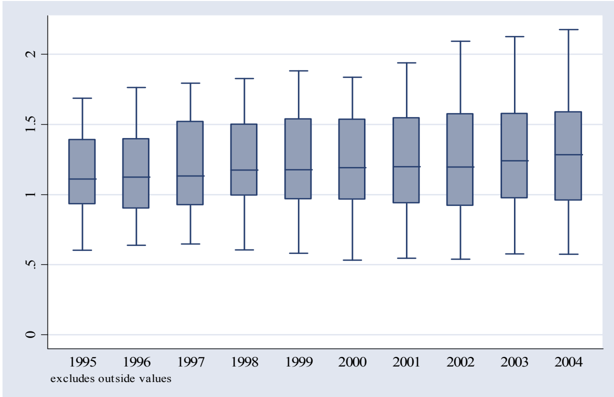



FIGURE A1 *(continued)*

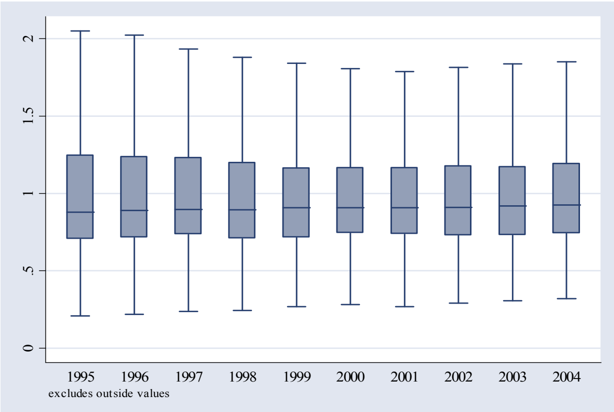
OLD EU | CEEC

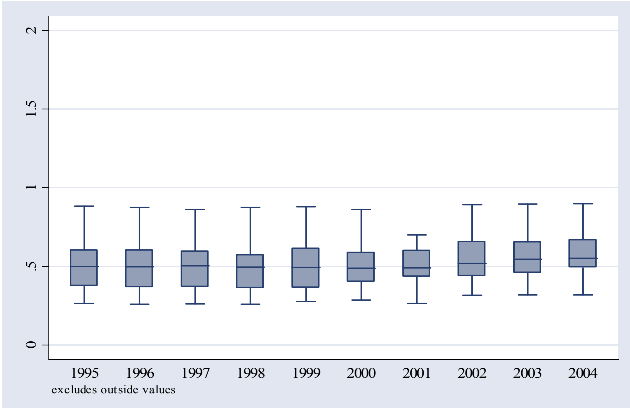
*SPEC*



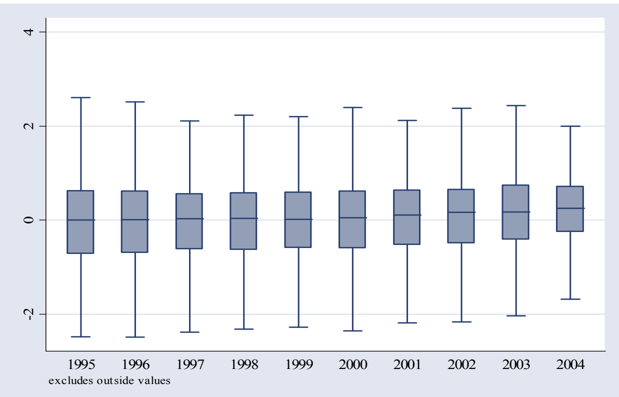



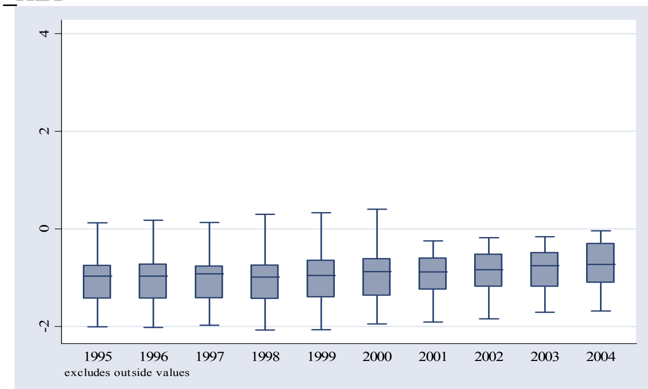

*SERV*




*URB_HET*




** Outside values are automatically excluded by software (STATA 8.2).*
*** Vertical axes have different scales in order to render CEECS graph readable.*

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