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"I want creative neighbours". Do creative service industries spillovers cross regional boundaries?

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Abstract: *The occurrence of creative service industries (CSI) is a strong determinant of differences in wealth amongst European regions. However, it is unknown if the strong effects are limited to occurring within regional boundaries or whether there are spillover effects into neighbouring regions. The purpose of this paper is to assess the existence of CSI spillover effects on the wealth of neighbouring regions. CSI and spillovers are integrated into both an empirical model and an endogenous growth model. Both models are estimated for a sample of 250 regions in the European Union in 2008. We find that most of the effects of CSI take place within regions, although there is also evidence that CSI has indirect spillovers across regions.*

Keywords: *creative industries; creative services; regional growth; spatial spillovers; spatial econometrics*

JEL: R11, R12, R58

1. INTRODUCTION

Are we bored by a conventional circus but captivated by the Cirque du Soleil? What is the difference between the shoes you are wearing and those of Manolo Blahnik for which Sarah Jessica Parker sighed and longed for in Sex and the City? The answer is *creativity*. Industries such as publishing, fashion, audiovisual, radio and TV, software, architecture and engineering, research and development, advertising, design, photography, and arts and entertainment, are generally considered to be “creative”. Taken together, creative industries (CI) can be defined as a set of knowledge-based activities focused on the generation of meaning, content and aesthetic attributes by means of creativity, skill and talent, and with the potential to create wealth from trade and intellectual property rights (DCMS 2001; UNCTAD 2010). CI have two key qualities: firstly, their knowledge base is neither synthetic (as in the industrial paradigm) nor analytic (as in the knowledge economy), but is based on the creation and use of symbols, and is thus representative of a post-knowledge economy. Secondly, CI have an extraordinary potential for regional development.

Several models have sought to explain the relationship between CI and the economic performance of countries and regions (e.g. Potts & Cunningham 2008, Sacco & Segre 2006, Rausell et al. 2011). Empirical research has provided evidence of the strong effects of CI on national and regional growth (DCMS 1998; Dolfman et al. 2007; Power & Nielsén 2010; Florida et al. 2008; Rausell et al. 2011). For the case of the European regions, De Miguel et al. (2012) and Boix et al. (2012) have reported on the presence of CI being associated with impressive gains in wealth, amounting to a rise of 4% for every 10% increase in the percentage of workers employed in CI, finding that the effect is due to services rather than to manufacturing. Since *creative service industries* (CSI) account for more than 6% of employment across the European regions, and in extreme cases such as Inner London for over 30% (Boix et al. 2012), CI have attracted attention as potential drivers of regional growth.

All these studies have been placed in static space, assuming implicitly that the effects of CI are limited to the regions in which they are located, without considering the possibility of cross-regional spillover effects. This assumption presents two problems: firstly, the theoretical models and measurements of impact used may be biased, unduly magnifying the impact of creative industries on wealth. Secondly, as

Boix et al. (2012) suggest, our ignorance of the nature and spatial extent of CI spillovers hampers our capability to design and evaluate effective policies. By focusing on CSI because of the positive differential impact on the wealth of regions, the research question we pose is: d*o spillovers of creative service industries go beyond regional boundaries and affect wealth creation in neighbouring regions?*

The purpose of this paper is to assess the existence of CSI spillovers and their effect on wealth creation in neighbouring regions. To do this, we integrate the notion of creativity into two kinds of regional wealth models, applied to 250 European regions in 2008. By doing this, the study proposes to make three contributions: firstly, it contributes to the building up of a more comprehensive framework for understanding the roles of CSI, and services based on a symbolic knowledge base, in the creation of wealth within and between regions; b) secondly, it addresses a widely neglected issue in the literature on CI, namely the use of formal theory-based modelling; it does this by contrasting an empirical model with a robust endogenous growth model; c) and, thirdly, it provides novel insights into the design of regional policy strategies based on CI, in the process enriching our core repository of possible actions and initiatives for fostering growth within and between regions.

The article is divided into six parts. After Section 1's introduction, Section 2 reviews the literature on CSI and spillovers, and arrives at four hypotheses. Section 3 then develops two regional growth models with spatial effects, covering the points of view of both policy-makers and economists. Section 4 introduces the data and variables. Section 5 presents the results of the econometric estimates and the main findings. Finally, Section 6 is devoted to a discussion of the results and their implications.

2. CREATIVE INDUSTRIES AND INTER-REGIONAL SPILLOVERS

The term *creative industries* originated in Australia (DCA 1994), and then its use expanded thanks to the actions of Tony Blair's British Labour government which needed to find new bases for growth for the UK's post-industrial economy (O'Connor 2007; DCMS 1998). The discourse had an attraction of changing the perception of certain activities such as arts and culture from being subsidized sectors (Baumol & Bowen 1965) to being generators of wealth (DCMS 1998; UNCTAD 2010) and as contributors to the so called new economy. The contemporary success of Richard

Florida's (2002) book *The Rise of the Creative Class* helped with the dissemination of the idea. However, whereas Florida's creative class perspective is human capital-based, the CI approach is industry-based.

The research agenda on CI has hitherto focused on four basic aspects: epistemological and taxonomical issues (DCMS 2001; O'Connor 2007; Flew & Cunningham 2010; Hesmondhalgh 2008); geographies (Cooke & Lazzeretti 2008; Lazzeretti et al. 2008; Capone 2008; De Propris et al. 2009; Lazzeretti 2012); policy-making (Garnham 2005; Mommaas 2004; Hesmondhalgh 2008; Raunig 2007); and economic and social impacts (UNCTAD 2010; Flew & Cunningham 2010; Potts & Cunningham 2008; DeMiguel et al. 2012; Boix et al. 2012; Rausell et al. 2011). So far, the literature has not paid attention to the existence of spillovers across regions.

To arrive at hypotheses about the existence, and types, of inter-regional CI spillovers we proceed in three steps. Firstly, we delimit the types of spillovers that could occur and the mechanisms through which they are transmitted. Secondly, we then seek evidence in the literature of the spatial range of spillovers. Thirdly, and finally, we introduce the particular character of symbolic knowledge, dominant in CI, and discuss how it might be expected to relate to spatial considerations.

2.1. Nature and types of spillovers: growth and knowledge spillovers through direct, indirect and induced mechanisms

Capello (2009, p.643) defines spillovers as "those growth enhancing elements of one region that, in their nature of public goods, exert positive (negative) effects on other regions, with visible distance-decay effects". She differentiates between knowledge spillovers, industry spillovers and growth spillovers. *Knowledge spillovers* happen when knowledge transfers as a public good between firms or regions without any compensation for the benefit generated. *Industry spillovers* apply to the effects generated by multinational or endogenous firms on the productivity of other vertical and horizontally related firms, without any compensation for the advantage generated - although this category is not directly applicable to spillovers between regions. *Growth spillovers* describe a situation in which at least a part of the growth (or wealth) of a region is due to the behaviour of neighbouring regions, usually due to market or trade linkages between regions.

Spillovers can be transmitted through either direct or indirect channels. This is similar to the notion of direct and indirect external effects described in Viner (1931) and Scitovsky (1954). *Direct spillovers* (also called "technological external economies" or "pure externalities") happen when a variable in a region is affected by a variable in another region without the intervention of other mediating mechanisms (e.g. when the percentage of jobs in CI in one region depends on the percentage of jobs in CI in other regions). *Indirect spillovers* (or "pecuniary external economies") happen when the effect is transmitted through indirect channels (e.g. when CI in a region *j* affects the growth of CI in another region, and then which in turn has an effect on the level of wealth in region *i*). Indirect spillovers can occur though one or more than one intermediate steps. We use the term *induced spillovers* to differentiate those than use more than one intermediate step.

2.2. The spatial range of spillovers: unclear for knowledge spillovers and supra-regional for growth spillovers

The literature on *knowledge spillovers* has been one of the most prolific when it comes to measuring the spatial range over which spillovers occur. This literature has proposed various spillover mechanisms, such as: through the mobility of individuals and/or the trade or transfer of goods; the direct transfer of production technologies; the existence of sharing mechanisms (such as patent licensing, collaborative research projects, and scientific exchange); and the role played by social networks (Döring & Schnellenbach 2006). Research has used in most cases knowledge production functions that show the direct effect of a variable of interest on an explained variable as a measure of a spillover, and which delimit the spatial distance over which a spillover occurs. Overall, the results are unclear, and vary among studies. Thus, Maurseth & Verspagen (2002), Fischer et al. (2006) and Greunz (2005) find evidence of direct industry-specific interregional knowledge flows in Europe, albeit that spillovers are more intense between regions located close together in technological spaces limited by country boundaries. Bottazzi & Peri (2000) suggest that the range of spillovers in Europe could extend up to an extreme value of 300 Km. A second group of works focused on the USA (Varga 2000; Adams & Jaffe 1996; Anselin et al. 2000) find that spillovers can occur over a range of between 50 and 75 miles (80 to 120 Km), or may be constrained within the same metropolitan area (Jaffe et al. 1993; Audrestch & Feldman 1996). Research for smaller countries also supports the idea that spillovers take place basically within regions (See, for example, Autant-Bernard, 2001, for France, and Funke & Niebuhr, 2005, for Germany).

In contrast, the literature on *regional endogenous growth* provides robust evidence that *growth or wealth spillovers* between regions occur (see Abreu et al. 2005 and Arbia 2006 for a synthesis of the abundant literature on this topic). The basic conclusion is that the economic performance of a region (such as its level of wealth, or its productivity) has a major impact on the production levels, productivity and wealth of neighbouring regions. This is due to the fact that: (a) an increase in local income in one region results in an increase in local demand, which is in part met by imports of commodities and factors from other neighbouring regions (resulting in more intense trade flows); and/or because of (b) the existence of processes of technological catch up (Arora & Vamvakidis 2005; Döring & Schnellenbach 2006). The coefficient for spatial spillover differs among studies due to differences in the dependent variables (such as whether it be GDP per capita, or GDP per worker), time periods, the particular sample of regions, the type of effect (such as spatial lag, spatial error or latent variables), and the estimation procedure, although in all cases it is robust and strong, within a range of 0.4 and 0.9.

2.3. Creativity is not liquid: barriers to spillovers, a lack of regional absorptive capacity, and the symbolic nature of knowledge in creative industries constrain the occurrence of creative spillovers

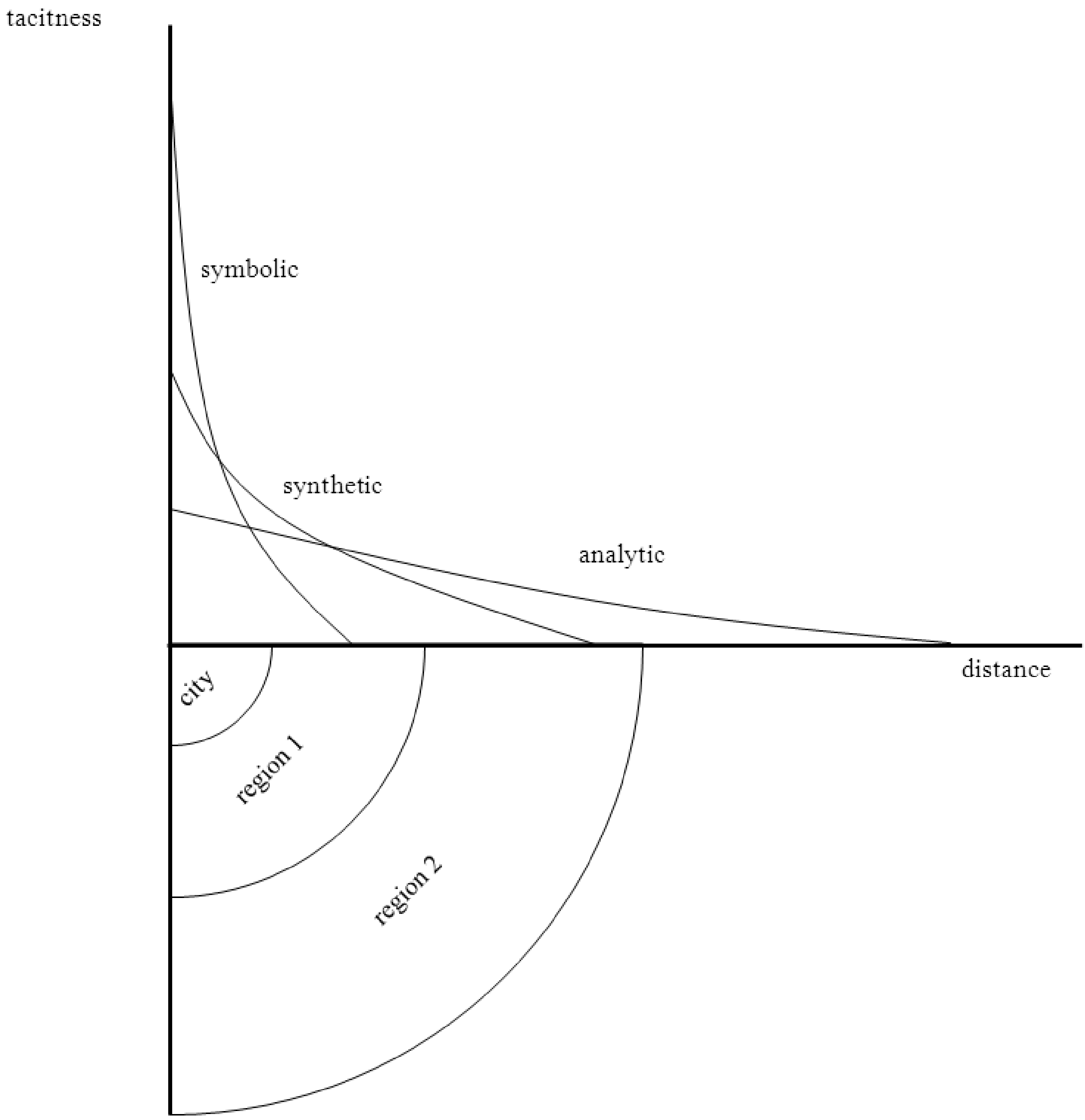
Explanations for differences between the occurrence of *knowledge* and *growth* spillovers, and for differences in the range (or distance) of spillovers, include the existence of barriers, such as: geographical distance, lack of learning capability, inadequate institutional frameworks, barriers pertaining to particular sectors or firm sizes (Caniëls & Verspagen 2001; Döring & Schnellenbach 2006), and the nature of different transmission channels (Capello 2009).

Using a *geographical*, *functional* and *cognifive* approaches to space, Capello explains that in the first one spillovers are bounded because information flows more easily in a limited geographical area, where transport costs are lower, where there are larger pools of skilled workers, where there is a facility for imitation, and where there are easier possibilities for commuting. In *functional* approaches, spillovers are said to be locally bounded because of the existence of an absorptive capacity possessed by a locally specialized productive structure, and because of the presence of a locally adaptive labour market. In the *cognitive* approach, spillovers are said to be bounded because channels of diffusion are highly embedded in the socio-cultural structure of the local system, the cooperative nature of traded dependencies, the existence of untraded interdependencies, and the occurrence of local non-replicable assets. In this perspective, the industrial and urban *atmosphere* associated with the cognitive mechanisms is important. The co-location of people and firms in a geographical space (e.g. in industrial districts or clusters) facilitates sharing and internalising knowledge in the local context. Local embeddedness facilitates the absorption and dissemination of tacit knowledge thanks to transmission through networks of practice, between individual through face-to-face communication, along supply chains, through the inter-firm mobility of workers, thanks to entrepreneurship mechanisms, and through participation in shared institutional infrastructures (Marshall 1920; Malecki 1997; Almeida & Kogut 1997; Audretsch & Feldman 2004; Jacobs 1961). This explains why in most studies the spatial scope of spillovers is analysed at the intra-regional level, even though spillovers could also occur on an inter-regional scale.

A different perspective suggests differences can be explained by the fact that spillovers are highly dependent on the nature and type of knowledge. Higher levels of codification and lower contextual embeddedness are associated with larger spillover distances. On the contrary, higher levels of tacitness and contextual embeddedness are related to shorter spillover distances (Almeida & Kogut 1997; Autant-Bernard 2001). To understand the nature of creative spillovers, it is crucial to determine the type of knowledge base found in creative industries. Conceptual distinctions between *knowledge bases* take into account the rationale for knowledge creation, its development and use, and the way the knowledge is transmitted and absorbed. Jensen et al. (2007) and Asheim & Parrilli (2012) differentiate three types of knowledge bases: analytical, synthetic and symbolic. The *analytical base*, linked to the Science, Technology and Innovation model of the knowledge economy, involves the production and use of explicit (codified) knowledge that originates from science and technology (e.g. the pharmaceutical industry). The *synthetic base* is linked to the Doing, Using, and Interacting model, where knowledge is created in a more inductive process of testing, experimentation, and practical work (e.g. as found in mechanical engineering). In the *symbolic base*, knowledge is related to the creation of content, desire, and aesthetic attributes of products (e.g. as found in the creative industries).

The creative industries provide services where the use of symbolic knowledge is dominant, but existing evidence about cross-regional spillovers mostly refers to basic manufacturing (which uses a synthetic knowledge base) and high-tech manufacturing and services industries (where analytical knowledge is prevalent). The dominance of particular knowledge bases (whether it be analytical, synthetic or symbolic) have different spatial implications and, as a consequence, different sensitivities to geographical distance. Analytical knowledge is highly codified and usually non-dependent on a local context. Synthetic knowledge is partially codified and embodied in technical solutions, although tacit knowledge is also relevant due to the importance of the experience at the workplace, learning by doing, and using and interacting processes. Symbolic knowledge associated with the creative industries - where a crucial share of work is dedicated to the creation of new ideas and images - is related to a deep understanding of the habits and norms of specific social groups, and so is highly embedded, tacit and context-specific. Consequently, analytical knowledge is less sensitive to distance-decay with the consequence that spatial spillovers can be local, intra-regional and inter-regional. Synthetic knowledge is much more sensitive to proximity effects, and so spillovers will be more frequent in local and intra-regional ambits. Symbolic knowledge tends to be extremely locally sensitive and so, in consequence, spillovers also should be highly local (Figure 1).

Figure 1. Propensity to knowledge spillovers over distance in relation to type of knowledge base (symbolic, synthetic or analytic).



2.4. Hypotheses

From our review of the literature, we conclude that CSI can affect wealth levels in neighbouring regions in three ways: directly; indirectly, through CSI in a neighbouring region; or indirectly, affecting first the wealth of the region where the CSI are located, and then the wealth of the neighbour region.

As we have seen, the literature on *knowledge spillovers* does not provide clear evidence about the spatial range of spillovers. However, in industries based on symbolic knowledge, both knowledge spillovers and trade effects must be local (within-region). Consequently, we can put forward the following hypotheses:

> Hypothesis 1: The direct impact on the wealth of a region from the occurrence of CSI in neighbouring regions is expected to be not significant. We name this hypothesis *direct wealth effect*.

> Hypothesis 2: The impact on CSI in a region from the occurrence of CSI in neighbouring regions is expected to be not significant. As a consequence, the occurrence of CSI in a region cannot affect the wealth of neighbouring regions through this type of indirect effect. We name this hypothesis *mimetic contagion*.

On the other hand, the literature supports the idea that CSI have a significant effect on the wealth of the regions where they are located, and the literature on endogenous regional growth supports the view that higher levels of wealth in a region have a positive effect on the wealth of neighbour regions. If we join the sequence, then we can offer the following hypothesis:

> Hypothesis 3: The presence of CSI in a region first increases the wealth of that region, which in turn then drives higher the wealth of neighbouring regions. We name this hypothesis *pecuniary contagion*.

In addition, we notice that some articles within the innovation literature, such as Adams & Jaffe (1996) or Audretsch & Keilbach (2002), suggest that the *indirect wealth effect* is not caused simply by a wealth-to-wealth process, but, rather, through the effects of additional mechanisms intermediating the process. Following this logic, a fourth hypothesis can be put forward, namely:

> Hypothesis 3b: The presence of CSI in a region increases the level of wealth in that region, which in turn induces an increase in the share of CSI in

neighbouring regions, which finally, in turn, induces increases of wealth in those neighbouring regions. We name this hypothesis *induced effect*.

3. TWO MODELS WITH SPATIAL SPILLOVERS

To investigate the existence of spillovers of CSI across regions we employ two models. A first one is based on the empirical model utilised by De Miguel et al. (2012) and Boix et al. (2012). A second is an endogenous growth model that seeks to address the lack of a theoretical base in the empirical model. A feature of these models is that they have a cross section specification, an advantage because in order to capture creative industries with precision in European regions it is necessary to use NACE Rev.2, which is only available for 2008 (and partially for 2009). This means the use of time-dynamic models are not yet possible. Both our models are enhanced to address spatial dynamics, which permits the testing for the existence of inter-regional spillovers of creative industries.

3.1. Two models relating creative industries and wealth

Our first, empirical, model is an improvement on that utilised by De Miguel et al. (2012) and Boix et al. (2012). By employing this model, we continue a line of incremental work that has successfully examined the effects of creative industries on regional wealth. The initial objective of De Miguel et al. (2012) was to compare and contrast the effects on regional wealth of the structure of employment and localization economies, specifically distinguishing the effect of creative industries as well as other knowledge intensive activities. To do this, they used a linear equation in which the variables were expressed in levels. Later on, Boix et al. (2012) argued that manufacturing sectors that are considered as creative are actually non-creative, and that urbanization and scale economies must be incorporated into the equation in order to consider a more complete range of agglomeration economies. This produced an additive production function in the form:

$$\frac{Y}{P} = \beta_0 + \beta_1 s_R + \beta_2 s_Y + \beta_3 \, Agglomeration + \varepsilon_i \qquad (1)$$

, where *Y* is the output of the economy, *P* the population, s_R is the percentage of jobs in CSI in the region, $s_Y=1-s_R$ the percentage of jobs in the rest of activities, and *Agglomeration* the agglomeration economies.

Additive production functions without interaction terms assume that inputs in the equation are technically independent ($(dy/dx1)/dx2 = 0$). As a consequence, there is deemed to be perfect substitution between inputs. Economists consider that this assumption is unrealistic, although it is true that in equation 1 substitution between productive structure and agglomeration economies is conceptually feasible. In contrast, policy makers feel comfortable with the possibility of focussing on factors separately. There are another two criticisms of equation 1. Firstly, the theory underlying the model is weak. Secondly, although the fit of the model for the European regions is good (R2=0.61), it could be biased as it does not consider the effect of other inputs, such as that of productive capital, the rate of people working in the economy, or spatial spillovers.

The assumption of additivity and, in particular, the theoretical weakness of the model, compels us to seek an alternative specification in the form of endogenous growth theory. Endogenous growth theory explains the occurrence of long-run growth as something which emanates from economic activities internal to an economic system creating new knowledge. It proposes channels through which the rate of technological progress, and hence the long-run rate of economic growth, can be influenced by economic factors. A second wave of endogenous growth theory, generally known as *innovation-based growth theory*, recognizes that intellectual capital, the source of technological progress, is distinct from physical and human capital. The key point is that whereas physical and human capital are accumulated through saving and schooling, intellectual capital grows through creativity, and this drives innovation.

Innovation-based growth is generally thought to develop in accordance with either of two main conceptual frameworks, namely *Schumpeterian theory* (Grossman & Helpman 1991; Aghion & Howitt 1992), which accommodates very well the notions of analytic and synthetic knowledge; or *endogenous technological change models* proposed by Romer (1990), which accord perfectly with the idea of symbolic knowledge. Romer-type models assume that aggregate productivity is an increasing function of the degree of product variety: innovation causes productivity growth by creating new, but not necessarily improved, varieties of products. Intuitively, an increase in product variety raises productivity by allowing society to spread its intermediate production more thinly across a larger number of activities, each of which is subject to diminishing returns and hence exhibits a higher average product when operated at a lower intensity. The implication is that the way to grow rapidly is not by saving, but by dedicating a large fraction of output to creative activities.

Our model is based on the Romer-Jones framework. We reproduce the solution of Jones (1995, 2001), assuming a multiplicative equation $Y = K^{\propto} \; AL_Y \;^{1-\propto}$. The key of the model is that working people (L), the source of creativity, can be dedicated to producing ideas (L_A) in the creative sector or, alternatively, producing goods and services in other sectors (L_Y): $L = L_A + L_y$, where $L_A = S_R L$ and s_Y=*1*-s_R. The solution of the simplest version of the model for a path of balanced growth is[1]:

$$y^* = \frac{s_K}{n+g_A+d}^{\propto/(1-\propto)} \quad 1 - s_R \quad \frac{\delta s_R}{g_A} L \qquad (2)$$

, where y^* is the output per worker (*Y/L*), s_K is the investment rate in capital, n the growth rate of the population, and d is the depreciation rate of capital. Following Glaeser et al. (1992) we assume that the growth rate of ideas is a function of MAR and Jacobs dynamic economies g_A. The equation can be linearized taking logarithms. Finally, we goes from productivity to wealth (GDP per capita) by taking into account that $\frac{Y}{P} = \frac{Y}{L}\frac{L}{P}$ (where P is the population), so that $lny = lny^* + ln \;\; L \;\; P$. The final equation is:

$$\ln y = ln\,\delta + lns_R + lns_y + \frac{\propto}{1-\propto}\ln s_k - \frac{\propto}{1-\propto}\ln \;\; n + g_A + d \;\; + lnL - lng_A + ln \;\; L \;\; P$$

(3)

[1] Jones provides this solution for the particular case where there are not duplicities in the creation of ideas and the current productivity of a creative is independent from past ideas. He considers this case more realistic than the introduced by Romer in the original model. The equation can be solved for a more general case, producing a log-linear solution with the same variables than the equation 3 although with ϕ and λ accompanying α.

The main differences from the additive model are: now the original functional form is multiplicative and so inputs are complementary; the equation includes terms related to input capital; and the equation includes a final term that takes into consideration that the wealth of a region depends not only on productivity but also on the rate of working people in the total population. Notice that these terms can also be incorporated in the additive equation 1, and we can estimate two models that include the same variables, with the only difference being that in one of them the variables will be in levels and in the other in logarithms.

3.2. Direct wealth effects

The *direct wealth effect* (Hypothesis 1) can be incorporated in the form of an additional variable *WX*, where *W* is the matrix of spatial weights incorporating the neighbours of each region *i* , and *X* is the percentage of jobs in CSI in the neighbouring regions *j≠i*. This form is known as a *spatial cross-regressive model* (Anselin 1988), where the coefficient γ of the spatial variable measures the existence of direct inter-regional spatial spillovers from CSI to wealth levels:

$$y = \beta_0 + \beta_1 s_R + \beta_2 s_Y + \beta_3 s_K - \beta_4 \; n + g_A + d \;\; + \beta_5 L - \beta_6 Agglomeration + \beta_7 \; \frac{L}{P} \;\; + \gamma W s_R \quad (4)$$

3.3. Mimetic contagion

The occurrence of CSI in neighbouring regions *j≠i* affects the share of CSI in a region *i*, and, through their presence, the GDP per capita of *i* (Hypothesis 2). Under the condition that the second part of the proposition is true (De Miguel et al. 2012; Boix et al. 2012), we must test the first part, that is, that the presence of CSI in a region is a function of the occurrence of creative industries in neighbouring regions, which can be done by including in the equation the share of jobs in CSI in neighbouring regions ($\rho W s_R$):

$$s_R = -\beta_0 + \beta_1 y - \beta_2 s_Y - \beta_3 s_K + \beta_4 \; n + g_A + d \; - \beta_5 L + \beta_6 Agglomeration - \beta_7 \; \frac{L}{P} \; + \rho W s_R \quad (5)$$

3.4. Pecuniary contagion

A second indirect effect is that which happens as a result of the occurrence, or growth, of wealth in neighbouring regions (Hypothesis 3). The literature on regional growth reports on the effects on the wealth of one region arising from inter-regional spillovers thanks to levels of wealth, or growth of wealth, in neighbouring regions. If the presence of CSI in neighbouring regions *j≠i* affects the levels of wealth in those regions *j≠i,* and that then impacts on the wealth of a region *i*, then an indirect effect is produced. This effect is usually introduced in an equation as a spatial lag of the dependent variable (ρWy) (Anselin 1988):

$$y = \beta_0 + \beta_1 s_R + \beta_2 s_Y + \beta_3 s_K - \beta_4 \; n + g_A + d \; + \beta_5 L - \beta_6 Agglomeration + \beta_7 \; \frac{L}{P} \; + \rho W y \quad (6)$$

, where $\rho W y$ reproduces the same equation for neighbouring regions, including the second-order spatial lag ($\rho W2$):

$$Wy = \beta_0 + \beta_1 W s_R + \beta_2 W s_Y + \beta_3 W s_K - \beta_4 W \; n + g_A + d \; + \beta_5 W L - \beta_6 W Agglomeration + \beta_7 W \; \frac{L}{P} \; + \rho_2 W_2 y \quad (7)$$

This impact can be also induced through a stochastic shock transmitted by means of a spatial component in the error term (spatial error model, Anselin 1988)[2]. However, we agree with Fingleton & López-Bazo (2006) that the spatial dependence in

[2] Other combinations are possible, for example a combination of the spatial lag and error models (Anselin 1988) or the Durbin model (spatial lag plus spatial cross-regressive model) (see Fischer 2009), or the inclusion of latent variables (Parent & LeSage 2008).

spatial growth models should be more of the substantive type (lag, cross-regressive) than due to stochastic shocks (error).

3.5. Induced effects

The *induced effect* (Hypothesis 3b) involves a longer sequence: the presence of CSI in neighbouring regions *j≠i* increases the wealth of those regions, which then impacts on some factor in region *i* (which in our case can be creative services), and then, finally, this factor increases the wealth of region *i*.

$$s_R = -\beta_0 + \beta_1 y - \beta_2 s_Y - \beta_3 s_K + \beta_4 \; n + g_A + d \; - \beta_5 L + \beta_6 Agglomeration - \beta_7 \; \frac{L}{P} \; + \rho W y \quad (8)$$

4. DATA AND VARIABLES

4.1. Data and variables

Our sample comprises data for 250 European NUTS 2 regions, drawn from Eurostat's Structural Business Statistics (SBS), Science and Technology Statistics (STS) and Regional Economic Accounts (ESA) databases for the year 2008. The countries for which data was not available, such as for Greece, Luxembourg and Malta, were not included. SBS, in combination with the new NACE, provides a good source of data for this research, since the information is disaggregated from two to four digits. The new NACE is particularly designed to deal with the requirements of the knowledge economy, with the consequence that CI are properly captured at the two digits level in most cases.

The dependent variable is regional GDP per capita. It is a mix of productive efficiency and income per capita, and is the indicator traditionally used as a proxy for regional wealth in cross-country and cross-region studies.

In the intra-regional model (equations 1 and 3), the variable of interest is the share of jobs in CI (s_R). The variable s_Y refers to the share of the rest of industries. The most comprehensive taxonomy of CI, particularly appropriate to cross-country comparisons, has been proposed by UNCTAD (2010). This classification has the advantage of being not only firmly founded but also of being less restrictive as it encompasses both cultural and technological dimensions of CI, whereas other taxonomies (e.g. DCMS, WIPO or KEA) are biased towards one of the two dimensions. It includes both manufacturing and service industries, although the majority of creative industries are in fact services, especially knowledge-intensive services (such as audiovisual, broadcasting, computer programming, R&D, publishing, architecture and engineering, advertising, design, and arts and entertainment services) (Table 1). Boix et al. (2012) suggest there should be an exclusive focus on creative services because they are the only CI that have a positive impact on wealth differentials.

In De Miguel et al. (2012), the share of jobs in the rest of industries, $s_{Y,}$ is divided amongst seven categories according to Eurostat's (2009) classification of activities by knowledge intensity, plus a residual group including non--classified activities (agriculture, mining, construction). In order to make for greater coherency with other parts of this article, we propose to aggregate knowledge intensities into two groups representing analytic and synthetic knowledge. Analytic knowledge includes high-tech manufacturing and service sectors (except those already classified as creative services). Synthetic knowledge groups the rest of manufacturing and service activities classified as non-creative[3]. In order to avoid perfect collinearity, in the estimates we will consider only symbolic, analytic and synthetic activities, excluding the residual group of non-classified activities.

Table 1- Classification of activities by knowledge base

Knowledge base	NACE Rev.2 codes
Symbolic (creative services)	4779 Retail sale of second-hand goods in stores 58 Publishing 59 Audiovisual 60 Programming and broadcasting 62 Computer programming 71 Architecture and engineering

[3] This elaboration is imperfect, although it provides a first proxy for exploring the idea of separating the three types of knowledge bases. The fact that analytic and synthetic knowledge bases do not create ideas could seem counterintuitive. A more realistic view is that the creative sector produces basically ideas and the rest produces basically goods and services. In any case, this does not affect the structure of the model.

	72 R&D 73 Advertising 74 Design, photography 90 to 93 Arts, entertainment and recreation (section R)
Analytic	21, 23 High tech manufacturing 61, 63 High tech knowledge intensive services (excluding creative services)
Synthetic	20, 27, 28, 29, 30 Medium-high tech manufacturing 19, 22, 23, 24, 25, 33 Medium-low tech manufacturing 10, 11, 12, 13, 14, 15, 16, 17, 18, 31, 32 Low tech manufacturing 50, 51, 64, 65, 66, 69, 70, 75, 78, 80, 84, 85, 86, 87, 88 Rest of knowledge intensive services (excluding creative services) 45, 46, 47 (excluding 4779), 49, 52, 53, 55, 56, 68, 77, 79, 81, 82, 94, 95, 96, 97, 98, 99 Less-knowledge-intensive services
Non classified	Rest of NACE codes

Source: Elaborated from UNCTAD (2010) and Eurostat (2009).

In line with Fischer (2009), the capital investment rate s_K is measured using gross fixed capital formation per worker; n is the annual growth rate of the working age population (15 to 64 years) between 1992 and 2008 (the largest series without significant problems of missing data); $g+d$ is considered to be 0.05 for every region, which is usual in this type of model due to the lack of regional data about depreciation rates; and L is the number of jobs in the region.

The indicators for dynamic agglomeration economies (specialization, diversity and competition) are quite similar to those used by Glaeser et al. (1992). Glaeser uses the location quotient of each industry as a proxy for MAR specialization economies. However, our models include the share of jobs by type of knowledge base, which is the numerator of the location quotient. The simple indicator and the location quotient are highly collinear so that only the simple coefficient is introduced because is requested by the model. Other proxies, such as the count of local specializations proposed by De Miguel et al. (2012), have been tested, although they generated strong collinearity problems. To capture Jacobs's variety of activities, Glaeser uses, for each industry in the panel, the fraction of the city's employment in the largest five industries other than the industry in question. Since our data are not panelled, we use the more usual inverse of Hirschman-Herfindahl index, calculated for the jobs in 60 sub-sectors in the economy:

$$IHHI_s = 1 \quad {}_i(Jobs_{i,s} \quad Jobs_i \;^2) \qquad (9)$$

The higher the IHHI ratio, the more diverse is the region, and this should affect positively its wealth. We add a second indicator of Jacobs's economies, the density of jobs per square kilometre, to take into account the fact that density fosters technological spillovers within regions (Ciccone & Hall 1996). Glaeser use the location quotient of number of firms per worker in city industry as a proxy for competition economies. We use the inverse, the number of workers per firm, which can be understood as an indicator of competition or, more usually, as a basic indicator of scale economies. Descriptive statistics for the variables are provided in Table 2.

Table 2. Descriptive statistics. Variables in levels.

Variable	Mean	Std. Dev.	Min	Max
GDP per capita in PPS	24,465	9,005	7,100	85,800
% jobs in creative services	6.88	3.83	0.01	32.86
% jobs in analytic knowledge	1.65	1.42	0.01	7.94
% jobs in synthetic knowledge	71.65	6.22	41.86	83.71
Average firm size	8.21	7.02	1.00	44.22
Productive diversity	16.73	5.62	3.43	26.23
Population density (population/Km2)	363.14	890.89	3.30	9,405.70
Total employment	863,878	675,619	14,924	5,300,000
Capital investment rate	11,371.32	5,863.28	1,000	33,858.58
n+g+d	5.32	0.5795	3.72	8.30
Rate jobs/population	45.31	5.36	29.31	67.30

4.2. Spatial weights matrices

Interaction between regions can take several forms and use diverse mechanisms. Basic differentiations can be made according to horizontal and vertical mechanisms (i.e. proximities and hierarchies), or according to spatial and non-spatial mechanisms (such as geographical distance, technological proximity, social proximity, institutional proximity, organizational proximity, and relational proximity) (Hägerstrand 1967; Döring & Schnellenbach 2006; Marrocu et al. 2011; Basile et al. 2012). The choice of one or several forms and mechanisms depends on the objectives of the research. In our case, the interest is on the existence of spillovers between regions that are very close in geographical space.

The literature on regional spillovers and regional endogenous growth describes three basic forms of a geographical spatial weights matrix (Abreu et al. 2005; Greunz 2005; Varga 2000; Anselin et al. 2000; Funke & Niebuhr 2005; Arbia 2006), which are well suited to the way CSI spillovers may transmit. A first form relates to *contiguity* between regions. This form assumes that spillovers occur between neighbouring regions because interaction is conceived as being based on a mix of cognitive, organizational, social, institutional and geographical proximities. A second matrix is based on *geographical distance* between regions. In this case spillovers are considered to occur by neighbourhood and that the probability of their occurrence linearly decays with geographical distance (Anselin 1988). It could also be suggested that spillovers might decay more than proportionally with distance, with the result that a third matrix could be considered, in this case including the inverse of the squared distance. These matrices are the most usual choices in spatial econometrics and are appropriate for this article's objectives of achieving scale in design and relevance for the application of policy strategies for CSI[4]. As Döring & Schnellenbach (2006) remark, the use of proximity or contiguity and distance decay implies that we are considering that diffusion between regions takes place horizontally, such as occurs in the second stage of Hägerstrand's (1967) epidemic model.

The most usual form of a weights matrix referred to in the regional growth literature is row normalization (see for example Abreu et al. 2005), since it is one of the ways to assure that (I-ρW) is non-singular, and it has produced excellent results for capturing spatial dependence. As argued by Kelejian & Prucha (2010) the form of the weights matrix should be justified, otherwise an eigenvalue normalization must be used. The economic effects that row normalization capture are: neighbour observations j influence observation I; each neighbour exerts the same influence regardless of its size; and the number of neighbours is not relevant[5].

5. FINDINGS

[4] However, the possibility of taking into account the effects of different types of proximities separately would be of clear interest in future extensions of the research.

[5] The assumption about the non-relevance of size is arguable. However, in our case trials incorporating the size of the region (total GDP) to the weights matrices did not produce significant results, and spatial dependence was not captured. Eigenvalues normalization such as in Kelejian & Prucha (2010) produced almost similar (but not better) results to row normalization.

5.1. Exploratory analysis of spatial data

An exploratory analysis of spatial data (ESDA) has been conducted in order to obtain preliminary information about the spatial processes occurring. ESDA has been carried out using: graphic information through the mapping of the variables, global Moran's I autocorrelation statistic, and multivariate local Moran's I. The ESDA analysis suggests there is no clear visual pattern of spatial correlation between the shares of creative industries in regions, or between these shares and the GDP per capita in neighbouring or close-by regions (Figure 2). However, in the latter case, the values of the Moran I are positive and statistically significant, suggesting that both variables are spatially correlated (Table 3).

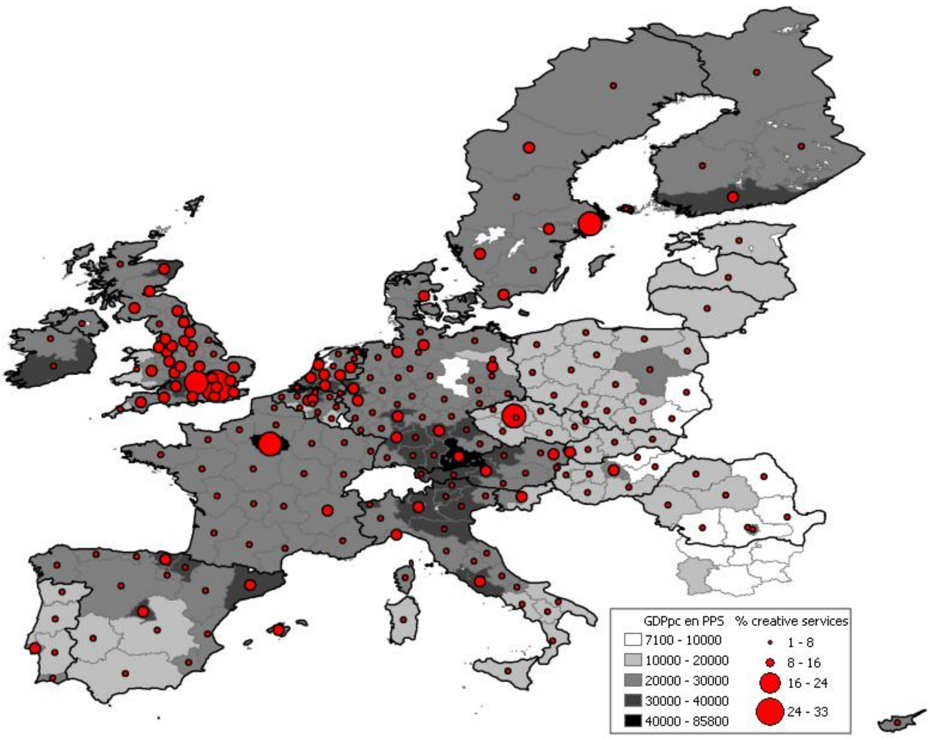
The multivariate local Moran index (Figure 3) looks at these results in further detail, and indicates that the correlation between GDP per capita and the presence of creative industries in neighbouring regions is statistically significant in only 25% of the regions. In 6% of the cases, high values of wealth are correlated with high shares of creative industries in neighbouring regions (for example for the south-east of the United Kingdom and for the centre of the Netherlands), and in another 15% there is a low-low correlation (for example, in regions in Poland, Romania, and Bulgaria, and the centre-west of France). Mixed patterns of high-low or low-high occur for another 4% of the regions. For the remaining 75% of regions the correlation is statistically non-significant.

ESDA provides fundamental evidence about another two facts. Firstly, regions with the same levels of GDP per capita tend to be located close in space, providing evidence that the wealth of regions is affected by the wealth of neighbouring regions (See Table 3). Secondly, the more robust evidence of spatial correlation is provided in all the cases by the matrix of contiguities, suggesting that neighbourhood is more relevant than distance-decay (See Table 3).

Table 3. Exploratory analysis of spatial data. Univariate and multivariate Moran I statistics for GDP per capita, percentage of jobs in creative services, and GDP per capita confronted with the spatial lag of the percentage of jobs in creative services

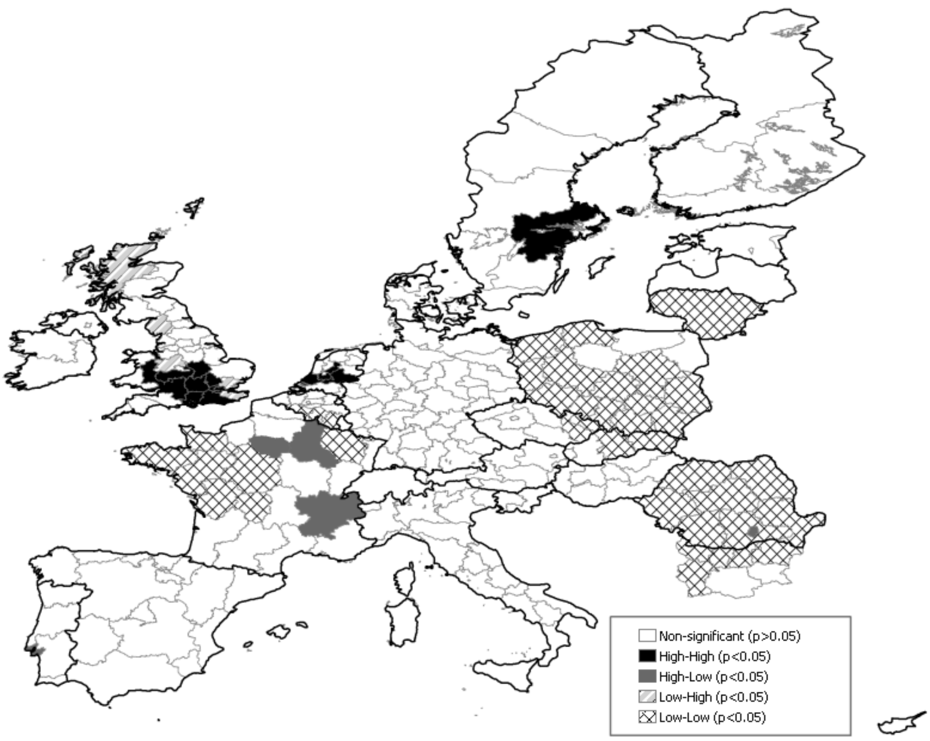
Variable	Matrix	Moran I	Probability (random)
GDP per capita in PPC	Contiguity	0.4478	0.000
	Inverse distance	0.1274	0.000
	Squared inverse distance	0.2487	0.000
Percentage of jobs in creative services	Contiguity	0.2982	0.000
	Inverse distance	0.0739	0.000
	Squared inverse distance	0.1960	0.000
GDP per capita in PPC versus spatial lag of the percentage of jobs in creative services	Contiguity	0.2589	0.001
	Inverse distance	-0.0030	0.990
	Squared inverse distance	-0.0030	0.990

Figure 2. Share of creative services in regional employment and relative specialisation of the region (location quotient) in creative services in 250 EU regions



Source: Elaboration from Eurostat.

Figure 3. Multivariate LISA map. GDP per capita in PPS correlated with the spatial lag of the percentage of jobs in creative services. Queen spatial weights matrix



5.2. Regression analysis

The estimation by Ordinary Least Squares (OLS) of equation 1 (the additive model) produces a parsimonious specification in which the explanatory variables are the percentage of jobs in CSI, the percentage of jobs in other knowledge-intensive services, the number of clusters of less-knowledge-intensive services, and the population density (Table 4, column 1). This is similar to those obtained by Boix et al. (2012).

The exogeneity of CSI is not rejected using a Durbin-Wu-Hausman test. This means that there is no effect on the consistency of the model. As a consequence, the estimated effect of CSI on wealth levels is causal, and OLS is more efficient than instrumental variables (IV).

As *WX* is exogenous by definition, equation 2 can also be estimated using OLS (Anselin 1988). The spatial lag and error in equations 5 to 7 are endogenous and they are estimated using spatial models by Maximum Likelihood or, when suffering from non-normality and heteroskedasticity, using robust Instrumental Variables (IV) (see Anselin 1988).

Tables 4 to 7 present the detailed results, and a synthesis relating to the hypotheses is presented in Figure 4.

Hypothesis 1 suggests that there is not a direct impact on the wealth of a region from the presence of CSI in neighbouring regions. We find that the coefficient of the spatial lag of the creative services *WX* is very small in both models (elasticities of -0.007 and 0.052) and statistically non-significant (p=0.43 and 0.14) (Figure 4; Table 5, regressions 1 and 3). Thus, Hypothesis 1 is supported and there is no evidence of a *direct wealth effect*.

Hypothesis 2 suggests that spillovers from CSI located in neighbouring regions $j \neq i$ on the CSI of a region *i* are not significant and they cannot cause an indirect spillover on the wealth of region *i*. The estimation of a spatial lag model including the spatial lag of the creative services (Figure 4; Table 6, regressions 3 and 6) indicates that in both models the spatial lag of the dependent variable is very small (elasticities of -0.034 and 0.052) and statistically non-significant (p=0.60 and 0.40). Thus, Hypothesis 2 is supported and there is no evidence of *mimetic contagion*.

Hypothesis 3 suggests that changes in the share of CSI in neighbouring regions $j \neq i$ increases the GDP per capita of these regions $j \neq i$, and this translates to an increase of wealth of the region *i*. We found that the growth of creative industries in neighbouring regions affect positively the GDP per capita of those regions (Figure 4; Table 7, elasticities of 0.269 with p=0.000, and 0.069 with p=0.001), and that then the wealth of neighbouring regions $j \neq i$ affects positively the wealth of region *i* (Figure 4; Table 5, column 2, ρ=0.216 with p=0.003; column 4, ρ=0.339 with p=0.000)[6]. The spillover effect resulting from the two steps, as well as its statistical significance, is calculated following LeSage and Pace (2009) "indirect effect". The effect is moderate: on average, an increase of 1% in the share of CSI in neighbouring regions increases by 0.058% the wealth of the region of interest in the additive model (208 euros) and by 0.024% in the endogenous growth model (87 euros). Thus, Hypothesis 3 is supported and there is evidence of *pecuniary contagion*, although the impact is small.

Hypothesis 3b proposes a three phased mechanism (*induced effect*). Firstly, the presence of CSI in neighbouring regions increases the wealth of those regions $j \neq i$. Then,

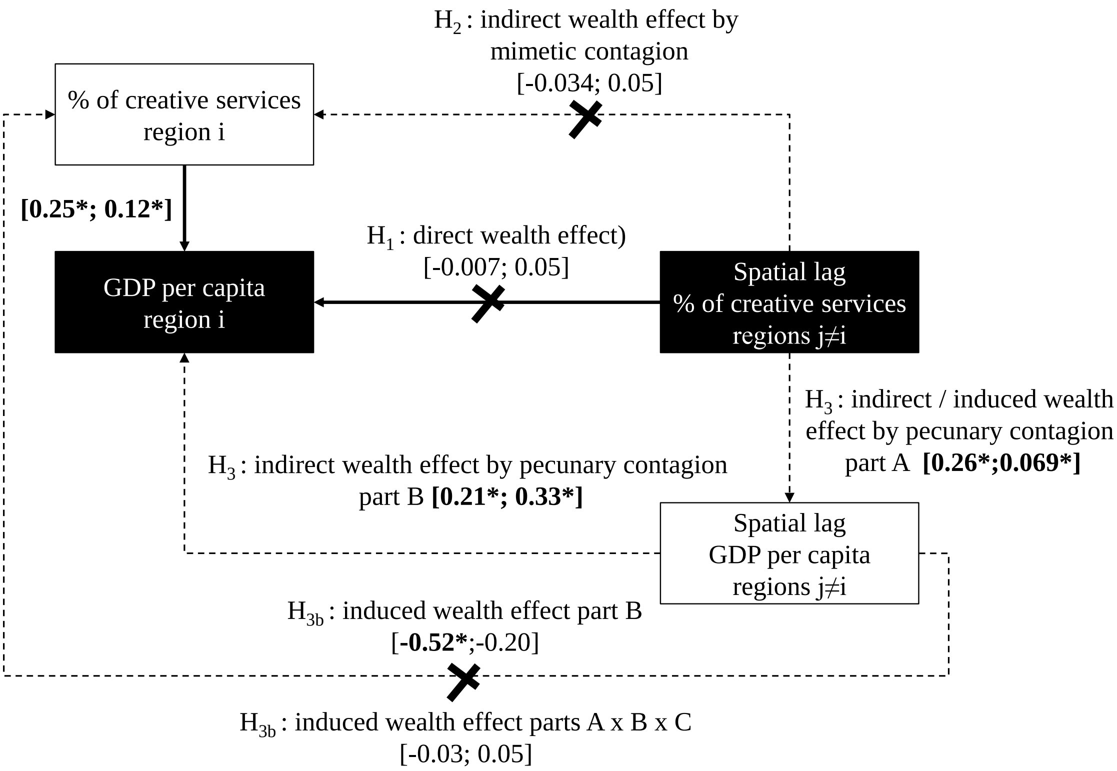
[6] In the model in logarithms there is evidence of an additional spatial error process. As discussed in Fingleton & López-Bazo (2006), this is not due to the dominance of the error model or a true residual spatial error, but to specification issues. By incorporating country dummies as explanatory variables (see for example Maursetintrh & Verspagen 2002 or Fischer et al. 2006), the remaining error disappears, although this introduces collinearity problems.

secondly, a consequence is an increase in demand for CSI in region, where subsequently CSI increasese its share of the total employment. Thirdly, and finally, the higher share of CSI results in an increase of wealth for region *i*. Figure 4 makes clearer the movement through the three phases. It has been previously proved that phases 1 and 3, that is, the effects of CSI on wealth, are significant (See Figure 4, Tables 4 and 6). The results of the second phase are significant for the additive model (-0.52, p=0.00) but not for the endogenous growth model (-0.20, p=0.218). The total effect of the three phases in the additive model is about -0.037 and statistically non-significant (which is consistent with the results of Hypothesis 2). Thus, Hypothesis 3b is not supported[7].

Another fact must be noted: the introduction of capital investment rate and the rate jobs/population results is a significant improvement of the model, but also serves to moderate the absolute and relative impacts of CSI on regional wealth. The effect is still strong in the case of the additive model, where an increase of 1% in the share of CSI increases regional wealth by more than 800 euros on average, with an elasticity above 0.20% (Tables 4 and 5); this can be compared with an increase of about 1,400 euros, with an elasticity of 0.39%, found by De Miguel et al. (2012) and Boix et al. (2012). In the endogenous growth model, the impact of creative industries is moderate, with an increase of 200 euros, and an elasticity of 0.08%.

[7] The negative impact of wealth on the share of creative industries was unexpected. This could be indicating that there is spatial competition between neighbouring regions for attracting creative industries. The total wealth effect of one region on another is positive because the remaining factors have a positive spatial effect (e.g. analytic and synthetic knowledge).

Figure 4. Summary of hypotheses and results in equivalent elasticities. The first value in brackets is produced by the additive model and the second the endogenous model



* Statistically significant at 5%

Table 4. Estimates of the non-spatial models for the GDP per capita.

	Additive model				Endogenous growth model			
Dependent variable: GDP per capita in PPS	(1) OLS Robust(1)		(2) OLS Robust(1)		(3) OLS Robust(1)		(4) OLS Robust(1)	
	Complete		Parsimonious		Complete		Parsimonious	
	Impact	Elasticity	Impact	Elasticity	Impact	Elasticity	Impact	Elasticity
Constant	-23679.25	-	-22806.81	-	-	0.9418	-	2.0243
		(0.000)		(0.000)		(0.265)		(0.000)
% jobs in creative services (symbolic knowledge)	915.11	0.2572	865.67	0.2433	317.69	0.0893	450.03	0.1265
		(0.000)		(0.000)		(0.003)		(0.000)
% jobs in analytic knowledge	-0.9645	-0.00006			-19.39	-0.0074		
		(0.996)				(0.526)		
% jobs in synthetic knowledge	179.00	0.5242	170.06	0.4980	2055.39	0.1391		
		(0.000)		(0.000)		(0.091)		
Firm size	97.77	0.0328	104.46	0.0350	-53.64	-0.0180	-81.96	-0.0275
		(0.031)		(0.002)		(0.158)		(0.000)
Diversity	-33.67	-0.0230			98.41	0.0673		
		(0.647)				(0.220)		
Population density (population/Km2)	2.31	0.0343	2.36	0.0350	6.36	0.0945	6.07	0.0901
		(0.001)		(0.002)		(0.000)		(0.000)
Total employment	-0.0002	-0.0102			-0.0001	-0.0063		
		(0.518)				(0.789)		
Capital investment rate	0.6685	0.3107	0.6750	0.3137	0.6695	0.3112	0.6796	0.3159
		(0.000)		(0.000)		(0.000)		(0.000)
n+g+d	149.06	0.0324			140.16	0.0305		
		(0.779)				(0.215)		
Rate jobs/population	437.09	0.8095	435.70	0.8069	5393.08	1.1464	5510.69	1.1714
		(0.000)		(0.000)		(0.000)		(0.000)
R2		0.8310		0.8305		0.7268		0.7192
R2-adj		0.8239		0.8253		0.7154		0.7134
Akaike		4838.81		4831.58		-69.53		-72.61
BIC		4877.54		4856.23		-30.80		-51.48
Mean VIF		1.72		1.43		1.84		1.33
Normality(2)		No		No		No		No
Homoscedasticity(3)		No		No		Yes		Yes
Endogeneity of creative services		No		No		No		No
LM-error(4)		Yes		Yes		Yes		Yes
Robust LM-error(4)		No		No		Yes		Yes
LM-lag(4)		Yes		Yes		Yes		Yes
Robust LM-lag(4)		Yes		Yes		Yes		Yes
Observations		250		250		250		250

Notes (1) Huber-White robust estimators. (2) Breusch-Pagan test. (3) Shapiro-Wilk and Shapiro-Francia tests. (4) Based on a contiguity matrix, row standardized.

Table 5. Estimates of the spatial models for the GDP per capita. Contiguity matrix, row-standardized

Dependent variable: GDP per capita in PPS	Additive model (1) Cross-regressive OLS Robust[(1)]		(2) Spatial lag IV Robust[(5)]		Endogenous growth model (3) Cross-regressive OLS Robust[(1)]		(4) Spatial lag IV Robust[(5)]	
	Impact	Elasticity	Impact	Elasticity	Impact	Elasticity	Impact	Elasticity
Constant	-33554.98	-	-16574.38	-	-	-1.6770	-	0.4313
		(0.000)		(0.000)		(0.190)		(0.505
% jobs in creative services (symbolic knowledge)	810.40	0.2277	825.95	0.1994	177.96	0.0500	292.85	0.0823
		(0.000)		(0.000)		(0.140)		(0.000
% jobs in synthetic knowledge	93.09	0.2726	91.01	0.3039	7.48	0.0219	-7.42	-0.0217
		(0.044)		(0.034)		(0.821)		(0.753
Firm size	116.71	0.0391	96.91	0.0360	-30.77	-0.0103	-54.70	-0.0184
		(0.001)		(0.002)		(0.171)		(0.041
Population density (population/Km2)	2.47	0.0366	2.36	0.0255	6.41	0.0951	5.81	0.0862
		(0.000)		(0.002)		(0.000)		(0.000
Capital investment rate	0.6220	0.2891	0.5879	0.2931	0.6482	0.3013	0.5621	0.2612
		(0.000)		(0.000)		(0.000)		(0.000
Rate jobs/population	433.26	0.8024	338.92	0.6468	622.08	1.1521	481.24	0.8913
		(0.000)		(0.000)		(0.000)		(0.000
W*(% jobs in creative services)	-27.84	-0.0075			192.00	0.0522		
		(0.836)				(0.143)		
W*(% jobs in analytical knowledge)	708.04	0.0500			566.06	0.0400		
		(0.029)				(0.057)		
W*(% jobs in synthetic knowledge)	224.78	0.6611			179.59	0.5283		
		(0.003)				(0.010)		
Spatial lag (ρ)			0.2168	0.2168			0.3396	0.3396
				(0.003)				0.000
R2		0.8427		0.8514		0.7556		0.8133
R2-adj		0.8368		0.8484		0.7464		0.8087
Akaike		4818.91		4800.01		-99.32		170.74
BIC		4854.12		4828.18		-64.10		-142.57
Mean VIF		1.57				1.93		
Normality[(2)]		No				No		
Homoscedasticity[(3)]		No				No		
Endogeneity of creative services		No				No		
LM-error[(4)]		Yes		No		Yes		Yes
Robust LM-error[(4)]		Yes		No		Yes		Yes
LM-lag[(4)]		Yes				Yes		
Robust LM-lag[(4)]		Yes				Yes		
Observations		250		250		250		250

Notes [(1)] Huber-White robust estimators. [(2)] Breusch-Pagan test. [(3)] Shapiro-Wilk and Shapiro-Francia tests. [(4)] Based on a contiguity matrix, row standardized. [(5)] Instruments: spatial lags of the explanatory variables. Elasticities of the spatial lag model refer to the estimated coefficient, not to the “total effect” describe in LeSage and Pace (2009).

Table 6. Effects of structure, agglomeration and spatial effects (lag) on the percentage of jobs in creative industries in the region. Contiguity matrix row standardized.

Dependent variable: % jobs in creative services	Additive model			Endogenous growth model		
	(1) OLS Robust(1)(6)	(2) OLS Robust(1)(6)	(3) Spatial lag IV Robust(5)(6)	(4) OLS Robust(1)	(5) OLS Robust(1)	(6) Spatial lag IV Robust(5)
	Elasticity	Elasticity	Elasticity	Elasticity	Elasticity	Elasticity
Constant	6.4085	7.2164	0.0000	-11.6411	-5.1485	-4.9814
	(0.016)	(0.273)	(0.0999)	(0.000)	(0.000)	(0.000)
GDP per capita in PPS	0.9002	1.0694	0.8295	0.4059	0.5970	0.4371
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
% jobs in analytic knowledge	0.0112	0.0016	0.0191	-0.0521	-0.0222	-0.0157
	(0.630)	(0.949)	(0.847)	(0.050)	(0.208)	(0.319)
% jobs in synthetic knowledge	-1.2913	-0.8726	-0.8492	0.2464	-0.3341	-0.4391
	(0.000)	(0.008)	(0.000)	(0.381)	(0.039)	(0.000)
Firm size	0.0595	0.0800	0.0580	0.1607	0.1456	0.1392
	(0.036)	(0.032)	(0.045)	(0.000)	(0.000)	(0.000)
Diversity	0.6618	0.7626	0.6684	1.1809	0.9232	0.8580
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Population density (population/Km2)	0.0554	0.0452	0.0623	0.0536	0.0336	0.0433
	(0.000)	(0.007)	(0.000)	(0.029)	(0.074)	(0.025)
Total employment	0.1426	0.1376	0.1479	0.2278	0.2260	0.2329
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Capital investment rate	-0.1308	-0.0866	-0.1190	0.3103	0.1770	0.1939
	(0.017)	(0.257)	(0.027)	(0.000)	(0.000)	(0.000)
n+g+d	0.0388	0.1264	0.2806	0.1068	0.0418	0.0286
	(0.827)	(0.504)	(0.083)	(0.019)	(0.188)	(0.390)
Rate jobs/population	-0.3463	-0.1999	-0.0507	-0.7126	-0.6582	-0.6492
	(0.114)	(0.374)	(0.779)	(0.004)	(0.000)	(0.001)
Spatial lag (γ) of the GDP per capita		-0.5288			-0.2015	
		(0.000)			(0.218)	
Spatial lag of the endogenous variable (ρ)			-0.0343			0.0527
			(0.604)			(0.407)
R2	0.7758	0.7973	0.7707	0.7080	0.7949	0.7992
R2-adj	0.7664	0.7879	0.7611	0.6958	0.7854	0.7902
Akaike	1087.19	1063.63	1094.38	308.76	71.11	65.83
BIC	1125.93	1105.89	1136.64	347.50	113.37	108.09
Mean VIF	1.92	2.08		1.82	2.19	
Normality(2)	No	No		No	No	
Homoscedasticity(3)	No	No		No	No	
LM-error(4)	Yes	Yes	Yes	Yes	Yes	Yes
Robust LM-error(4)	Yes	Yes	Yes	Yes	Yes	Yes
LM-lag(4)	Yes	Yes		Yes	Yes	
Robust LM-lag(4)	Yes	Yes		Yes	Yes	
Observations	250	250	250	250	250	250

Notes (1) Huber-White robust estimators. (2) Breusch-Pagan test. (3) Shapiro-Wilk and Shapiro-Francia tests. (4) Based on a contiguity matrix, row standardized. (5) Instruments: spatial lags of the explanatory variables.(6) Logistic transformation of the dependent variable ln(1/(1-p)) is performed since it is bounded between 0 and 100. Elasticities of the spatial lag model refer to the estimated coefficient, not to the "total effect" describe in LeSage and Pace (2009).

Table 7. Effects of creative industries in neighbouring regions on the wealth of these regions. Contiguity matrix row standardized.

Dependent variable: GDP per capita in PPS	Additive model	Endogenous growth model
	Spatial lag IV Robust[5]	Spatial lag IV Robust[5]
	Elasticity	Elasticity
Constant	0.0000	-0.4040
	(0.999)	(0.518)
% jobs in creative services (symbolic knowledge)	0.2693	0.0693
	(0.000)	(0.001)
% jobs in analytic knowledge	0.0092	-0.0028
	(0.402)	(0.755)
% jobs in synthetic knowledge	0.0687	0.1284
	(0.277)	(0.089)
Firm size	0.0117	-0.0134
	0.366	(0.070)
Diversity	-0.0865	0.0466
	(0.023)	(0.164)
Population density (population/Km2)	-0.0865	0.0462
	(0.452)	(0.000)
Total employment	-0.0038	0.0096
	(0.383)	(0.583)
Capital investment rate	0.1864	0.1717
	(0.000)	(0.000)
n+g+d	-0.2556	0.0080
	(0.000)	(0.646)
Rate jobs/population	0.2738	0.6423
	(0.000)	(0.000)
Spatial lag (ρ2)	0.5351	0.4842
	(0.000)	(0.000)
R2	0.9118	0.9146
R2-adj	0.9091	0.9110
Akaike	4574.68	-449.90
BIC	4613.42	-407.64
Normality[2]	No	No
Homoscedasticity[3]	No	No
LM-error[4]	No	Yes
Robust LM-error[4]	Yes	Yes
Observations	250	250

Notes [1] Huber-White robust estimators. [2] Breusch-Pagan test. [3] Shapiro-Wilk and Shapiro-Francia tests. [4] Based on a contiguity matrix, row standardized. [5] Instruments: spatial lags of the explanatory variables. Elasticities of the spatial lag model refer to the estimated coefficient, not to the "total effect" describe in LeSage and Pace (2009).

6. CONCLUSIONS

Hitherto, the literature on creative industries has implied that the effects of CI on regional performance take place in a static space, within regions (Potts & Cunningham 2008; Sacco & Segre 2006; Rausell et al. 2011; DCMS 2001; Florida et al. 2008; De Miguel et al. 2012), neglecting the effects of inter-regional spillovers. This study challenges our understanding of the creative industries, and confronts the implicit assumption that their impacts on wealth are strictly intra-regional with a more realistic assumption that creative industries also have effects on the wealth of neighbouring regions.

We differentiate three mechanisms (translated into hypotheses) through which spillovers can arise: a *direct wealth effect* (that is, direct spillovers from CSI on the wealth of other regions); a *mimetic contagion* effect (that is, the occurrence of indirect spillovers, where the occurrence of CSI in one region firstly affects the growth of CSI in another region, which in turn affects that latter region's level of wealth); and *pecuniary* and *induced* effects (that is, the occurrence of indirect spillovers where the occurrence of CSI first impacts on the wealth of one region, and then on the wealth of neighbouring regions, either directly or induced through other intermediate variables). Then, we propose two theoretical approaches and make comparisons for a sample of 250 European regions in the year 2008, using exploratory analysis of data and spatial econometric confirmatory models.

Three relevant facts may be highlighted:

Firstly, there is evidence of inter-regional spillovers of CSI on wealth, but only in the form of an indirect *pecuniary contagion*. In a first step, creative industries increase the wealth of a region where they are located, and then in a second step the wealth of that region has a direct positive impact on the wealth of neighbouring regions. The net spillover effect in the additive model is about 208 euros (with an elasticity of 0.058%) and 87 euros (with an elasticity of 0.024%) in the endogenous growth model.

Secondly, the short spatial elasticity of symbolic knowledge means that *direct wealth effects* from CSI onto neighbouring regions are not significant. This is due to the fact that the dominant type of knowledge in creative industries is symbolic, which means that it is highly tacit and contextual and, as a consequence, highly local (Jensen et al. 2007; Asheim & Parrilli 2012). The physical distance between regions limits the range of emission of spillovers at the same time that social and cognitive distance between regions disable mechanisms of absorption. Some local exceptions have been found in the south of England and in the centre of the Netherlands, indicating that these places deserve a more differentiated focus.

Thirdly, the share of CSI in a region does not affect the proportion of creative industries in a neighbouring region (*mimetic contagion*), and therefore does not impact on the wealth of a neighbouring region by this way. Such an effect is more noticeable than in most of the literature on spatial spillovers (Varga 2000; Adams & Jaffe 1996; Anselin et al. 2000; Jaffe et al. 1993; Audrestch & Feldman 1996) based on analytic or synthetic types of knowledge. Indeed, we found evidence of positive and significant direct spillovers across regions of analytic and symbolic knowledge-based activities, which were expected due to their higher spatial elasticity.

The conclusion is that there are indirect pecuniary spillovers from CSI between regions, but, according to our results, these spillovers will be only economically significant when the wealth of neighbouring regions is at a certain high level; otherwise, the indirect effect is small.

In addition, the effects of CSI on wealth moderate when new variables requested by the theoretical model are introduced. The effect reduces from 1,400 euros and an elasticity of 0.40% (De Miguel et al. 2012; Boix et al. 2012) to 825 euros and an elasticity of 0.20% in the additive model, or 290 and an elasticity of 0.08% in the endogenous growth model.

These results have implications for both scholars and policy-makers. Regarding the former, we note three points:

Firstly, regarding creative industries, a perspective of dynamic space must be introduced into theoretical and empirical models and considered in policy-making. This dimension is absent in most leading researches and reports (e.g. DCMS 2001; UNCTAD 2010; Howkins 2007; O'Connor 2007; Flew & Cunningham 2010; Power & Nielsén 2010; De Miguel et al. 2012; Boix et al. 2012). Neglecting the role of inter-regional spillovers has two direct consequences: it produces an incomplete picture of the mechanisms by which creative industries impact on regional wealth growth, which is to say existing theoretical models are biased; and in empirical analysis, the estimates of the effects of creative industries will be biased and inconsistent (see Anselin 1988 and LeSage & Pace 2009).

Secondly, the literature on regional knowledge spillovers must pay particular attention to types of knowledge flows being researched. So far, most articles addressing inter-regional spillovers have made broad spectrum conclusions, without being mindful of the specific type of knowledge under consideration. In the light of our results, it is clear that attention must be paid to distinguishing the analytic, synthetic or symbolic nature of knowledge spillovers.

Thirdly, in general, regional economics must incorporate the novel insights and challenges that the creative industries and the creative economy pose. In order to achieve a more complete body of knowledge it is necessary to interweave conclusions from research on cross-regional spillovers of creative industries with other research on issues such as cross-regional dimensions of the creative class, human capital, and innovation. Such topics have a strong impact on the regional wealth and are highly interrelated.

Our findings also are relevant for policy addressed to CSI, indicating a need to go beyond previous policy recommendations (DCMS 2001; European Commission 2010), with implications, in particular, for competitiveness and cohesion objectives. Firstly, if an objective is to develop the size of CSI in a region, active policies are required because of the absence of external mimetic contagion effects. Secondly, active policy aimed at increasing the level of CSI in a regional economy can have high returns, and most of the benefits take place within the region. Thirdly, "clubs" of neighbouring regions with high levels of GDP per capita will have extra benefits if they coordinate simultaneously the development of their CSI, because internal returns are complemented by an indirect spillover effect. However, such coordination will not offer significant extra returns for clubs of low income regions, where the majority of effort must be focused internal to each region. Maurseth & Verspagen (2002) and (Parent & LeSage 2008, p.254) arrive at a similar conclusion in respect of analytic and synthetic knowledge flows (patent data), finding that "in Europe the largest spillovers are for the most part taking place between a limited set of highly developed regions". This last result is particularly relevant for cohesion policy, since the mechanism described can exacerbate differences between rich and poor regions, and implies that those areas of Europe with lower income levels may need additional help to develop their creative sector at the same rate as richer areas.

The study has several limitations. Firstly, a criticism of the conclusions would be justified if it happens that spillovers are different for each type of creative service.

Secondly, because we have been interested in proximity and neighbourhood spillover mechanisms our focus has been on horizontal mechanisms. However, it is reasonable to consider that CSI may in fact be at an early stage of a diffusion process and, if so, it is possible spillovers could occur vertically, through the urban hierarchy or, perhaps, through global networks of cities. In practice, an investigation of such phenomena would require the introduction of different types of matrices of flows that are able to take them into account.

Future research must focus on these two limitations. It should differentiate within CSI in order to corroborate the existence or absence of exceptions for some CSI or combinations of CSI. Also, it must complete the range of mechanisms and ways of diffusion by considering other types of inter-regional flows, such as, for example, via people travelling on air flights, or thanks to network links between headquarters and subsidiaries of companies, or through internet flows, and it must separate the effects of institutional, cognitive and social proximities.

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REFERENCES

Abreu, M., Groot, H.L.F. De & Florax, R.J.G.M., 2005. Space and growth: a survey of empirical evidence and methods. *Région et Développement*, 21, pp.13–40.

Adams, J.D. & Jaffe, A.B., 1996. Bounding the effects of R & D: an investigation using matched establishment-firm data. *Rand Journal of Economics*, 27(4), pp.700–721.

Aghion, P. & Howitt, P., 1992. A Model of Growth Through Creative Destruction. *Econometrica,*, 60(323-361).

Almeida, P. & Kogut, B., 1997. The Exploration of Technological Diversity and the Geographic Localization of Innovation. *Small*, pp.21–31.

Anselin, L., 1988. *Spatial econometrics: Methods and moments*, Dordrecht: Kluwer.

Anselin, L., Varga, A. & Acs, Z.J., 2000. Geographic and sectoral characteristics of academic knowledge externalities. *Business*, 443, pp.435–443.

Arbia, G., 2006. *Spatial econometrics: statistical foundations and applications to regional convergence*, Berlin: Springer.

Arora, V. & Vamvakidis, A., 2005. Economic Spillovers Exploring the impact trading partners have on each other's growth. *Finance and Development*, 42(3), pp.48–50.

Asheim, B.T. & Parrilli, M.D., 2012. Introduction: Learning and interaction - Drivers for innovation in current competitive markets. In B.T. Asheim & M.D. Parrilli, eds. *Interactive Learning for Innovation: A Key Driver within Clusters and Innovation Systems*. Basingstoke: Palgrave Macmillan, pp. 1–32.

Audrestch, D.B. & Feldman, M.P., 1996. R&D spillovers and the geography of innovation and production. *The Americal Economic Review*, 86(3), pp.630–640.

Audretsch, D.B. & Keilbach, M., 2002. The Role of Labour Mobility and Informal Networks for Knowledge Transfer,. *Knowledge Creation Diffusion Utilization*, (November), pp.5–7.

Autant-bernard, C., 2001. Economics of Innovation and New Technology The Geography Of Knowledge Spillovers And Technological Proximity. *Economics of Innovation and New Technology*, 10(4), pp.237–254.

Basile, R., Capello, R. & Caragliu, A., 2012. Technological interdependence and regional growth in Europe: Proximity and synergy in knowledge spillovers. *Papers in Regional Science*, 91(4), pp.697–722.

Baumol, W.J. & Bowen, W., 1965. On the performing arts: The anathomy of their economic problems. *American Economic Review*, 55((1/2)).

Boix, R., De Miguel, B. & Hervás, J.L., 2012. Creative service business and regional performance: evidence for the European regions. *Service Business*.

Bottazzi, L. & Peri, G., 2000. Innovation and spillovers: Evidence from European regions. *October*.

Caniëls, M.C.J. & Verspagen, Bart, 2001. Barriers to knowledge spillovers and regional convergence in an evolutionary model. *Journal of Evolutionary Economics*, 11(3), pp.307–329.

Capello, R., 2009. Spatial Spillovers and Regional Growth: A Cognitive Approach. *European Planning Studies*, 17(5), pp.639–658.

Ciccone, A. & Hall, R.E., 1996. Productivity and the Density of Economic Activity. *The Americal Economic Review*, 86(1), pp.54–70.

Cooke, Philip & Lazzeretti, L. eds., 2008. *Creative Cities, Cultural Clusters and Local Economic Development*, Cheltenham: Edward Elgar.

DCA, 1994. *Creative Nation: Commonwealth Cultural Policy*, Camberra.

DCMS, 2001. *Creative industries mapping document 2001*, London.

DCMS, 1998. *The Creative Industries Mapping Document*, London.

DeMiguel, B. et al., 2012. The importance of creative industry agglomerations in explaining the wealth of the European regions. *European Planning Studies*, 20(8).

Dolfman, M.L., Holden, R.J. & Fortier Wasser, S., 2007. The economic impact of the creative arts industries: New York and Los Angeles. *Monthly Labor Review*, (October), pp.21–34.

Döring, T. & Schnellenbach, J., 2006. What do we know about geographical knowledge spillovers and regional growth?: A survey of the literature. *Regional Studies*, 40(3), pp.375–395.

European Commission, 2010. *GreenPaper: Unlocking the potential of cultural and creative industries*, Brussels.

Eurostat, 2009. High-technology' and "knowledge based services" aggregations based on NACE Rev. 2.

Fingleton, B. & López-Bazo, E., 2006. Empirical growth models with spatial effects. *Papers in Regional Science*, 85(2), pp.177–198.

Fingleton, B. & López-bazo, E., 2006. Empirical growth models with spatial effects *. *Main*, 85(2).

Fischer, M.M., 2009. A spatial Mankiw-Romer-Weil model : Theory and evidence.

Fischer, M.M., Scherngell, T. & Jansenberger, E., 2006. The Geography of Knowledge Spillovers Between High-Technology Firms in Europe : Evidence from a Spatial Interaction Modeling Perspective. *Geographical Analysis*, 38, pp.288–309.

Flew, T. & Cunningham, S., 2010. Creative Industries after the First Decade of Debate. *The Information Society*, 26(2), pp.113–123.

Florida, R., 2002. *The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life*, Basic Books.

Florida, R., Mellander, C. & Stolarick, K., 2008. Inside the black box of regional development--human capital, the creative class and tolerance. *Journal of Economic Geography*, 8(5), pp.615–649.

Francesco Capone, 2008. Mapping and anlysing creative systems in Italy (1991-2001). In Philip Cooke & L. Lazzeretti, eds. *Creative cities, cultural clusters and local economic development*. Cheltenham: Edward Elgar, pp. 338–364.

Funke, M. & Niebuhr, A., 2005. Regional Geographic Research and Development Spillovers and Economic Growth: Evidence from West Germany. *Regional Studies*, 39(1), pp.143–153.

Garnham, N., 2005. From cultural to creative industries. *International Journal of Cultural Policy*, 11(1), pp.15–29.

Glaeser, E.L. et al., 1992. Growth in Cities. *The Journal of Political Economy*, 100(6), pp.1126–1162.

Greunz, L., 2005. Intra and inter-regional knowledge spillovers: Evidence from European regions. *European Planning Studies*, 13(3), pp.449–473.

Grossman, G. & Helpman, E., 1991. *Innovation and Growth in the Global Economy*, Cambridge MA: Cambridge: MIT Press.

Hägerstrand, T., 1967. *Innovation diffusion as a spatial process*, Chicago: University of Chicago Press.

Hesmondhalgh, D., 2008. Cultural and Creative Industries. In *Online*. Sage Publications Ltd, pp. 1–16.

Howkins, J., 2007. *The Creative Economy: How People Make Money from Ideas*, London: Penguin.

Jaffe, A.B., Trajtenberg, M. & Henderson, R., 1993. Geographic localization of knowlege spillovers as evidenced by patent citations. *The Quarterly Journal of Economics*, 108(3), pp.577–598.

Jensen, M.B. et al., 2007. Forms of knowledge and modes of innovation. *Research Policy*, 36(5), pp.680–693.

Jones, C.I., 2001. *Introduction to economic growth*, W. W. Norton & Company.

Jones, C.I., 1995. R & D-Based Models of Economic Growth. *The Journal of Political Economy*, 103(4), pp.759–784.

Kelejian, H.H. & Prucha, I.R., 2010. Specification and estimation of spatial autoregressive models with autoregressive and heteroskedastic disturbances. *Journal of Econometrics*, 157, pp.53–67.

Lazzeretti, L. ed., 2012. *Creative industries and innovation in Europe: Concepts, Measures and Comparative Case Studies*, Routledge.

Lazzeretti, L., Boix, R. & Capone, F., 2008. Do creative industries cluster? Mapping Creative Local Production Systems in Italy and Spain. *Industry & Innovation*, 15(5), pp.549–567.

Lesage, J.P. & Pace, R.K., 2009. *Introduction to Spatial Econometrics*, Boca Raton: Chapman and Hall/CRC.

Marrocu, E., Paci, R. & Usai, S., 2011. The complementary effects of proximity dimensions on knowledge spillovers. , pp.1–25.

Maurseth, P. & Verspagen, B, 2002. Knowledge spillovers in Europe: A patent citations analysis. *The Scandinavian Journal of Economics*, 104(4), pp.531–545.

Mommaas, H., 2004. Cultural clusters and the post-industrial city: towards the remapping of urban cultural policy. *Urban Studies*, 41(3), pp.507–532.

O'Connor, J., 2007. *The cultural and creative industries : a review of the literature*, London: Arts Council England.

Parent, O. & Lesage, J.P., 2008. Using the variance structure of the conditional autoregressive spatial specification to model knowledge spillovers. *Journal of Applied Econometrics*, 256, pp.235–256.

Parent, O. & LeSage, J.P., 2008. Using the variance structure of the conditional autoregressive spatial specification to model knowledge spillovers. *Journal of Applied Econometrics*, 23, pp.235–256.

Potts, J. & Cunningham, S., 2008. Four models of the creative industries. *International Journal of Cultural Policy*, 14(3), pp.233–247.

Power, D. & Nielsén, T., 2010. *Priority Sector Report : Creative and Cultural Industries*, Stockholm.

Propris, L. De et al., 2009. The geography of creativity. London: NESTA.

Raunig, G., 2007. Creative Industries as Mass Deception. *Transversal*, 01(Creativity Hypes). Available at: http://eipcp.net/transversal/0207/raunig/en.

Rausell, P., Marco, F. & Abeledo, R., 2011. Sector cultural y creativo y riqueza de las regiones: en busca de causalidades. *Ekonomiaz*, 78, pp.67–89.

Romer, P.M., 1990. Endogenous technological change. *The Journal of Political Economy*, 98(5), pp.70–102.

Sacco, P.L. & Segre, G., 2006. Creativity , cultural investment and local development : a new theoretical framework for endogenous growth.

Scitovsky, T., 1954. Two concepts of external economies. *Journal of Polítical Economy*, 62, pp.143–151.

UNCTAD, 2010. *Creative economy. Report 2010*, Geneva - New York.

Varga, A., 2000. Local academic knowledge spillovers and the concentration of economic activity. *Journal of Regional Science*, 40(2), pp.289–309.

Viner, J., 1931. Cost curves and supply curves. *Zeitschrift für nationalökomie*, III, pp.23–46.

Wooldridge, J.M., 2002. *Introductory econometrics: A modern approach*, South-Western College Pub.