

FDI and Growth: Can Different Regional Identities Shape the Returns to Foreign Capital Investments?

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Abstract

This paper analyses the role of different components of territorial capital in magnifying or daunting the impact of foreign investments on growth at regional level. The paper starts from a simple theoretical framework that clarifies how territorial capital can shape the returns to foreign direct investments. The subsequent empirical analysis uses data from the European Value Study to identify three soft components of territorial capital that define the identity of a region and can be relevant in shaping the impact of foreign capital on local growth. Using data from Eurostat and FDIregio database, the paper studies the impact of FDI induced spillovers on regional growth in European regions, controlling for possible endogeneity. Results indicate that technological FDI-induced spillovers are an important source of regional growth, but they take place only if the level of trustworthiness/generalized morality is widespread in the region, supporting the idea that low free-riding attitudes increase the efficiency of transactions and the effectiveness of cooperation between multinational and local systems. The effect of relational capital is more ambiguous. A more disaggregated analysis reveals that some effects may vary depending on the type of economic activity (manufacturing vs service FDI).

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1. Introduction

Recent developments in regional science show that growth determinants cannot be fully identified through deterministic cause-effect relationships, but need to take into account manifold relationships between economic agents, largely dependent on perceptions. The idea is that economic growth mainly depends on the ability of regions to take advantage of potential opportunities to sustain their competitiveness, which in its turn, depends on a complex combination of formal and, mainly, informal factors. These factors have been recently defined in the literature as the soft components of territorial capital (Camagni, 2008).¹ This paper discusses how a very local element such as territorial capital may enhance or hamper regions' ability to take advantage of globalization in the form of Foreign Direct Investment (FDI) inflows.

The traditional approach to discuss the relationship between FDI and regional growth is based, on the one hand, on theoretical arguments concerning the potential sources of FDI-induced knowledge and technological spillovers and, on the other hand, the role these spillovers can play in fostering growth and development at regional level. Many policy makers and academics argue that FDI can have important positive effects on a host location's development efforts, the main reason being that, in addition to the direct capital financing it supplies, FDI is also a valuable source of innovation, technology and know-how. Hence, the impact of FDI on growth is expected to go far beyond its contribution to local production capacity. Indeed, it can promote growth by stimulating productivity gains resulting from spillovers to local firms.

These arguments are very common in the literature based on country level evidence and do not consider that, at sub-national level, the FDI-growth relationship is more complex than it seems at first sight. Since several local factors may undermine or reinforce the FDI-growth relationship. Local externalities, local assets, relational distance, local governance, cultural elements and values are all crucial elements in defining the flexibility and the catching up ability of regions in taking advantage of FDI spillovers and complementarities. Theoretical arguments motivating the potential of territorial capital for higher returns on investments are manifold and can be found in different strands of theoretical literature, such as the limited rationality theory (Malgre, 1961; Simon, 1972), contract theory (Williamson, 2002) and the cognitive approach to district economies (Camagni, 1991; Storper, 1995).

These considerations suggest that FDI alone may not suffice to generate a sustainable pattern of economic growth. There are factors that can magnify or inhibit the impact of FDI on growth, all other growth determinants held constant. In this paper, we argue that the extent to which a region takes advantage of FDI depends on the endowment and composition of its territorial capital in general and, in particular, of its *soft components*. Do different levels of social capital determine different levels of FDI-induced growth? Does the closeness of a region towards external and diverse contributions matter in the FDI-growth relationship? How relational capital influences the impact of FDI on the process of economic growth at local level?

In order to provide an answer to these research questions, we first define the theoretical mechanism through which territorial capital affect the FDI-growth relationship, starting from a simple neoclassical framework. Then we assess the impact of FDI on economic growth, testing and controlling for possible endogeneity. Additionally, we introduce those soft components of the territorial capital that may exert an impact on the transmission of FDI-induced spillovers to the local economy, such as human capital, social and relational capital, as well as the attitude of the region toward external contributions and cultures. Such components of territorial capital may enhance the opportunities of a region to take advantage of knowledge by more advanced organizations or markets. Finally, we consider separately the effect of different types of FDI inflows, decomposed according to macro-sectors of activity. We found that FDI-induced spillovers are affected by territorial capital. In particular, closed social capital hampers FDI induced spillovers, while generalized morality magnifies potential benefits from foreign firms.

¹ Territorial capital is broadly defined as the set of localized assets that constitute the competitive potential of a territory. It includes both hard, such as infrastructures, and soft components, such as social capital. See Camagni (2008) for a thorough discussion on territorial capital and its components.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature and discusses the theoretical foundations of this study. Section 3 describes empirical trends in FDI and growth in Europe and then focuses on detailed description of the measurement of territorial capital endowments' indexes for European regions. Section 4 presents a simple theoretical framework showing how territorial capital can shape the returns to FDI and defines the estimation strategy. Section 5 is devoted to discussion of the results. Major conclusions and a summary of the main findings are discussed in Section 6.

2. Theoretical background and relevant literature

2.1 The FDI and growth nexus

The existing empirical literature on FDI has focused on three different aspects: *i)* why foreign firms invest abroad; *ii)* what drives inward FDI flows; *iii)* what the impacts on host economies are and whether they are positive or negative. Only the third aspect is of interest for the present study.²

Generally speaking, the literature acknowledges that FDI plays a relevant role in economic development processes of host economies through several channels, which go far beyond the increase in the local endowment of financial and physical capital. In the neoclassical growth models *à la* Solow (Solow, 1956) this implies that foreign investments do not only contribute to factor accumulation, complementing local endowments, but they can also contribute to technological growth or the so called "Solow residual". Indeed, the impact of FDI may be more relevant because of the presence of such indirect effects that increase total factor productivity through the transfer of new technologies and improvement in the efficiency of production.

Part of these indirect effects that benefit the host economies – called more properly spillovers – occurs since multinational firms cannot completely internalize the benefits of knowledge and technologies which are at the base of their competitive advantage (Kokko, 1994; Markusen, 1995). The intensity of these spillovers may vary according to their nature intra- or inter-sectoral. Multinational firms try to avoid intra-sectoral spillovers because they may benefit direct competitors, while they may be interested in generating inter-sectoral spillovers since they benefit suppliers and clients (Kugler, 2006). Moreover, indirect effects may arise because of increased competition that forces domestic firms to improve their efficiency of production, resulting in productivity gains for the whole region, as the literature on firm heterogeneity suggests (see, for instance, Barrios et al., 2005). Finally, another important indirect effect arising from the presence of multinational firms is export spillovers, which affects local firms' export decisions (Girma et al., 2004; Kneller and Pisu, 2007).

The transmission of FDI-induced spillovers can take place through imitation processes, labour force training, pro-competitive effects, and input-output linkages (Blomstrom and Kokko, 1998; Lipsey, 2002). Regardless of the channel at work, the impact of FDI on growth is far from being automatic; rather, it depends on the degree of complementarity and substitutability between foreign and domestic capitals (De Mello, 1999), the degree of development of the host economies (Johnson, 2006; Carkovic and Levine, 2005; Blonigen and Wang, 2005), the capacity of the host economy to absorb new technologies and knowledge brought by foreign firms (Borensztein et al., 1998), the degree of openness of the host economies (Balasubramanyam et al., 1996), the degree of embeddedness of foreign firms in the local economies (Markusen and Venables, 1999; Rodriguez-Clare, 1996) as well as the quality of the institutions – both formal and informal – and, generally speaking, the business environment (Olofsdotter, 1998; Blomstrom and Kokko, 2003; Xu, 2000).

Despite the *plethora* of FDI-growth studies, the relationship between FDI and growth is still not clear, since many of these works are based on *aggregate* data on FDI, which do not allow either to distinguish between different types of FDI (vertical vs. horizontal; greenfield vs. other forms of FDI), which is potentially important (Beugelsdijk et al., 2008), or to consider a finer geographical disaggregation (sub-national levels).

² Readers interested to deepen why firms become multinationals and what factors drive their location decisions may refer among many others to Barba Navaretti and Venables (2004), and Iammarino and McCann (2013).

Consequently, it is implicitly assumed that, on the one hand, different types of FDI have the same impact on economic growth rates, and, on the other hand, that the impact of FDI on economic growth is constant across space. Finally, with few exceptions, most studies focus on FDI in manufacturing, thus ignoring a finer disaggregation within the manufacturing sector or FDI in services.³

When the FDI-growth relationship is considered at sub-national level, ambiguities increase even more. Generally speaking, Mullen and Williams (2005) argue that the impact of FDI on growth is not affected by the size of the geographical unit taken into consideration, while Girma and Wakelin (2001) claim for a regional dimension of FDI for several reasons. First of all, the effects of FDI-related spillovers are expected to be localized. Secondly, it is not clear whether laggard regions are able to benefit from the presence of foreign firms: a foreign investment increases local capital accumulation, but the host economy might not possess the capacity to absorb the knowledge and the technology incorporated in such an investment (Findlay, 1978; Blomstrom and Kokko, 1998). Other ambiguities relate to the expected transfer of superior technology from foreign to domestic firms, based on the assumption that foreign firms are by definition technologically superior to domestic firms (Markusen, 1995). But, what happens when foreign firms undertake an investment in a technologically advanced region in order to exploit local knowledge (Dunning, 1999; Cantwell, 1989)?

In conclusion, there remains a clear need to quantify and better qualify the impact of FDI on regional economic performance. This paper addresses these issues in the context of the European Union. In so doing, it will not only augment the existing evidence on the impact of FDI on EU regions' performance, which is quite scarce, but also try to overcome some of the ambiguities that still plague the literature.⁴ More specifically, this study aims at uncovering whether and to what extent the FDI-growth relationship depends on the substantial heterogeneity in regional identities. Such identities encompass both soft and hard resources of local economies, and constitute the building blocks of the so called "territorial capital".

2.2 Regional identities and FDI

"It is now recognized that each area has a specific capital – its 'territorial capital' – that is distinct from that of other areas and is determined by many factors [...]. These factors may include the area's geographical location, size, factor of production endowment, climate, traditions, natural resources, quality of life or the agglomeration economies provided by its cities, but may also include its business incubators and industrial districts or other business networks that reduce transaction costs. Other factors may be "untraded interdependencies" such as understandings, customs and informal rules that enable economic actors to work together under conditions of uncertainty, or the solidarity, mutual assistance and co-opting of ideas that often develop in clusters of small and medium-sized enterprises working in the same sector (social capital). Lastly, according to Marshall, there is an intangible factor, 'something in the air', called the 'environment' and which is the outcome of a combination of institutions, rules, practices, producers, researchers and policy makers, that make certain creativity and innovation possible. This 'territorial capital' generates a higher return for specific kinds of investments than for others, since they are better suited to the area and use its assets and potential more effectively" (OECD, 2001, p.15).

What this paper argues is that the role of territorial capital in releasing untapped economic potential is fundamental because it can empower regions to take advantage of globalization benefits. Being FDI a major expression of globalization trends, we believe that its positive externalities on local economies are likely to depend on how deep they are rooted within the local economic context.

³ Bobonis and Shatz (2007), Alfano (2003) and Girma and Wakelin (2001) represent notable exceptions.

⁴ Studies examining the regional dimension of FDI generally deal with location choice rather than the impact on growth and productivity. Exceptions include Figlio and Blonigen (2000), Leichenko and Ericson (1997), Bode and Nunnekamp (2010), Bode et al. (2009) and Mullen and Williams (2005). All these studies refer to the experience of US States. As far as Europe is concerned, the existing works concentrate on specific countries or groups of them, mainly located in Central and Eastern Europe (Girma and Wakelin, 2007; Driffield, 2006; Nicolini and Resmini, 2011).

As the quotation reported above makes clear, territorial capital entails material and non-material assets. While both these kinds of assets affect foreign firms' location decision, only the intangible components of territorial capital are able to affect foreign firms' territorial embeddedness, i.e. the nature and the extent of the connections between foreign investors and host economies (Henderson et al., 2002). Supplier linkages are the most common indicators of territorial embeddedness. As discussed in the previous section, through linkages with indigenous firms foreign firms may create indirect employment and support the development of a higher quality local supplier base, which in turn will stimulate further investments, both internally and from abroad. These intra-firm relations may benefit both foreign and domestic firms. The former may gain access to often unique local tacit knowledge, thus increasing their own innovative capacity (while the latter may gain access not only to global markets but also to international sources of knowledge and extensive resources of multinational corporations (Lyons, 2000; Zanfei, 2000). This reciprocal learning process is mediated by local institutions, both formal and informal, since they shape the cooperation between heterogeneous agents, and provide collective goods, such as qualified employees, innovative capacity, cooperative labour relationships and reliable infrastructures and subsidies (Mayer et al., 2011). For these reasons, we focus our attention on the intangible elements of territorial capital, which include human capital and different forms of social capital.⁵

Human capital is almost unanimously recognized as a strategic asset for competitiveness, attractiveness and development. Endogenous growth theories consider it as a factor of production distinct from employment since it refers to competencies and knowledge of the labour force rather than to its size (Lucas, 1988; Romer, 1990). Highly qualified labour force, on the one hand, is able to ensure more efficient production processes for any given endowment of physical capital and employment; on the other hand, it helps knowledge and competencies to evolve over time through creativity and entrepreneurship (Camagni, 2008). This implies that a highly qualified local labour force may facilitate the transmission of FDI-induced spillovers since the more competent is the labour force the higher the capacity of the host location to absorb the new technologies and know-how brought into the area by foreign firms. Also, local creativity and entrepreneurship may help foreign firms to further develop their internal capabilities and to assume a wider range of functions and foreign affiliates that continuously upgrade and expand their operations are less in danger to re-locate and more firmly embedded into the local economic system (Malmberg et al., 1996).

As for the other intangible components of territorial capital, we concentrate on three different types of social capital. The first relates to the potential (negative) attitude of local agents towards external and diversified contributions i.e., the *closed social capital*. The importance of informal components of regional openness on regional performance has already been recognized in the literature (Gambardella et al., 2009), but here the focus is especially on such soft components that can act as a catalyst for beneficial effects of foreign investments. Indeed, cultural closeness makes it difficult for multinationals to take roots in the area where they set up production plants, since it may inhibit linkages with local suppliers and the development of co-operative relationships with local agents. In a similar context, FDI-induced spillovers may not arise, thus reducing long-run growth prospects of host locations.

The second informal component of territorial capital that we consider relevant for the growth impact of FDI is what the literature calls *generalized morality* or "trustworthiness" of citizens (Tabellini, 2010). Generalized morality is considered a characteristic of "modern democratic societies, where abstract rules of good conduct apply to many social situations, and not just in a small network of personal friends and relatives" (Tabellini, 2010, p. 260). If the level of generalized morality is high, free-riding attitudes are limited; consequently, the efficiency of transactions and the effectiveness of cooperation between economic agents, both foreign and indigenous, may improve, thus enhancing the transmission of FDI-induced spillovers.

Also, *relational capital* may shape the returns to foreign investments, but its impact is more ambiguous. The literature on territorial capital and innovation defines territories as relational spaces, where functional/hierarchical economic and social interactions take place and are in turn embedded" (Basile et al.,

⁵ See Camagni (2008) for an in-depth analysis of the soft components of territorial capital.

2011, p. 21). In this perspective, collective action and cooperation capabilities foster socio-economic interactions, magnifying the effects of knowledge creation on productivity and growth.⁶ This mechanism is based on the capacity of economic agents to co-operate, which in turn depends on a strong sense of belonging, identity and shared behavioural codes and norms. Therefore, the network effect of relational capital may reinforce mutual understanding and social commitment among local agents, and in so doing increasing the relational distance with external entities, such as multinational firms. Relational capital, thus, may enhance or hinder the impact of foreign multinationals on local economic development, depending on their ability to integrate with local networks. The section that follows discusses in more detail the estimation of the soft components of territorial capital, and describes their potential interplay with the FDI-growth relationship in regions of the EU.

3. Empirical Evidence.

3.1 Some caveats on the measurement of FDI and social capital

Our analysis makes use of two specific types of data, i.e. FDI inflows at regional level and indicators of intangible elements of territorial capital.

Data on FDI inflows at regional level come from FDIRegio database – an original dataset based on the well-known and largely used Bureau Van Dijk's *Amadeus* product – which contains comprehensive information on about 100,000 foreign firms established by both European and non-European multinational firms in the European Union in three different periods of time, i.e. 1997-99, 2001-2003 and 2005-2007 period.⁷ For each company information is available on the ultimate investor (nationality), sector of activity, including both manufacturing and services, and the destination area (country, state/region). This allowed us to count the number of projects in each NUTS-2 region.⁸ Table 1 summarizes some information concerning foreign firms included in the sample.

Given the objective of the paper, it is worth mentioning some of the implications of using number of foreign firms instead of the monetary value of foreign investments. First of all, sequential and cumulated flows of FDI could not be captured. This implies a potential underestimation of real FDI inflows since we implicitly assume that the monetary value of FDI inflows is directly proportional to the number of foreign firms. Results, therefore, should be carefully interpreted, especially if they are weak or not significant since this fact does not necessarily mean that FDI-induced spillovers are not able to enhance growth, but more simply that the present level of FDI does not suffice to positively affect regions' growth rates. Secondly, since the size of foreign firms is unknown, we are forced to assume that a big corporation with thousands of employees has the same weight as a firm with hundreds or fewer employees. Although this assumption might seem quite restrictive and unrealistic, its implications are much less relevant than one might think, at least at first sight. According to the theory, the size of the firms affect how a firm becomes multinational, but not why and, mainly, where. Given the lack of resources and specific expertise, small firms tend to

⁶ The idea that the cognitive elements of territorial capital may act as a catalyst for local development is not new in the regional science literature. Similar considerations are present in the social filter theory (Rodriguez Pose, 1999) – according to which the speed with which local societies adopt innovation strongly depends on social conditions embedded in the local systems – or in the theory of the “milieu innovateur”, an innovation place whose characteristics are able to enhance cooperation among agents while reducing opportunistic behaviour under the threat of social sanctioning (Camagni, 1991 and 2004).

⁷ In so doing we adopted the standard definition of foreign investment, i.e. investment made by a company based in one country, into a company based in another country. Entities making direct investments typically seek control over the company into which the investment is made. It is standard to consider this control ensured when direct investor owns at least 10% of the voting power of the direct investment enterprise (OECD, 2008; UNCTAD, 2013). Moreover, we have considered a three year period instead of annual data in order to minimize fluctuations that usually characterize FDI flows and to avoid single counts in each year.

⁸ Malta and outermost French and Spanish regions have been excluded due to the lack of data. Baltic Republics and Luxembourg have been considered at NUTS1 level. The dataset included therefore 26 EU member states and 254 NUTS-2 regions.

choose less complex forms of internationalization than big corporation (Buckley and Casson, 1976; Kimura, 1989; Caves and Mehra, 1986). However, the potential advantages considered by firms that are willing to become international are the same, regardless of their size. Each firm, in fact, seeks to improve its efficiency and increase profits in the medium-long run by exploiting new markets, factor price differences or resources not available in its own country. This implies that the attractiveness of specific locations vary with the motivations of foreign firms rather than their size. In other words, if we observe a given number of foreign firms in a specific location, there are no reasons to assume that these firms are larger or smaller than those observed in another location.

Table 1. Sectoral distribution of FDI (2005-2007)

	N. of foreign firms
Total	110,573
<i>of which:</i>	
Primary sector	1,168
Manufacturing	20,602
Medium-Low Tech sectors	14,143
Medium-High Tech sectors	6,459
Energy	508
Construction	4,086
Services	84,209
Business services	41,946

Source: FDIRegio

More complex is the issue related to the potential benefits foreign firms are able to ensure to host economies. In that case, it is useful to distinguish between direct and indirect effects. The former concern the contribution to employment and value added of the host location, while the latter regard what are known as spillover effects. Generally speaking, direct effects depend on the size of the foreign firms, as well as on the mode of entry: the contribution to local employment and value added is larger for big companies rather than small ones, as well as for greenfield investments, i.e. a newly established foreign firm, rather than for brownfield investments, that is those carried out through privatization or by the acquisition of an existing indigenous firm. These aggregated effects are difficult to measure since they can be counterbalanced by many other observed and unobserved factors (Lipsey, 2002). Therefore, they are not considered as the largest and most beneficial outcome of multinational enterprises.

As previously discussed, the issue of spillover is correlated to that of knowledge and information flows and technology transfer. Spillover effects arise since the presence of foreign firms stimulates indigenous firms to adopt new technologies and organizational practices in order to remain competitive. Further flows of information, skills and know-how may occur through interactions – both intended and unintended – among foreign firms and local agents. Therefore, spillovers come from the experience and knowledge of foreign firms rather than from their size and tend to affect the behaviour of indigenous firms, with important effects on productivity and regions' production capacity. Thus, our data does not seem less appropriate than other measures of FDI that allow to distinguish the size of potential foreign investments.

As for the territorial capital, its multifaceted nature makes it difficult to find effective and reliable measures of it. These difficulties are further amplified by the presence of immaterial components, such as "qualities of social relationships, e.g., trust, norms of reciprocity, and engagement in social networks (Van Schaik, 2002, p. 8) as well as creativity and entrepreneurship. Therefore, in order to measure soft components of territorial capital, multiple indicators of basic human values and qualities of labour force are needed.

As for the former, we aggregated at regional level individual responses collected in the opinion polls of the European Values Study (EVS) (Van Schaik, 2002, Capello et al., 2011 and Caragliu and Nijkamp, 2012).⁹ In particular, the degree of *cultural closeness* of a region has been evaluated along four dimensions: the concerns with foreigners, the lack of confidence in big companies, the lack of trust in other citizens and the importance of national identity with respect to European identity. Answers to the following questions have been aggregated through a Principal Component Analysis (PCA), where the first principal component has been interpreted as the index of closed social capital:

- “Do you trust other people in your country? [1=trust completely / 5=not trust at all]”
- “How much confidence do you have in major companies? [1=a great deal / 5=none at all]”
- “Are you concerned with immigrants? [1=none at all / 5=very much]”
- “National Identity: A) Some people say: If the European member states were truly to be united, this would mean the end of their national, historical and cultural identities. Their national economic interests would also be sacrificed. B) Others say: Only a truly united Europe can protect its states' national, historical and cultural identities and their national economic interests from the challenges of the superpowers [1=A / 7=B]”

As shown by Table 2, the first component obtained by a PCA explains about 47 percent of total variance of the underlying elements; therefore, it can be considered as a good proxy for closed social capital.

While social capital is embodied in the structure of the relations among people, trust represents its consequence and the strength of those relationships (LeSage and Ha, 2012). Given the objective of the paper, we consider here a broader concept of trust, i.e. what the literature has defined as generalized morality or trustworthiness (Platteau, 2000 and Tabellini, 2010). It characterizes societies where rules of good conduct apply to all social situations, making citizens more reluctant to free-ride on others. The presence of generalized morality has been evaluated by aggregating at regional level answers to the following three questions of the EVS:

“According to you, how many of your compatriots do the following?

- Claiming state benefits to which they are not entitled (1=almost all / 4=almost none)
- Cheating on tax if they have the chance (1=almost all / 4=almost none)
- Paying cash for services to avoid taxes (1=almost all / 4=almost none)”

As before, regional means have been computed and then aggregated in a unique component through a Principal Components Analysis (PCA). The first component explains 47 per cent of total variance and thus represents a good summary indicator of trustworthiness.

Another important informal component of territorial capital able to affect the transmission of FDI-induced spillovers is *relational capital*, i.e. the system of bilateral and multilateral relations built by local economic actors among them. This capital represents the inverse of interpersonal distance between economic actors in the region and it is very important to reduce uncertainty in economic relationships and to facilitate the diffusion of information. We proxied relational capital by computing the shares of population participating in civil society, broadly defined, i.e. clubs and voluntary associations (sport, cultural, communal), religious communities, as well as unpaid voluntary work and social activities with friends and colleagues (Van Schaik, 2002; Capello et al., 2011; Caragliu and Nijkamp, 2012). Then we aggregated these shares regionally and transformed them into a unique index by PCA. The index of relational capital we obtained explains about 49 per cent of the total variance of the underlying factors.

Finally, human capital can be measured in different ways, involving both quantitative and qualitative indicators. Formal education gives insights into the amount of knowledge possessed by individuals, while it is not able to capture specific skills. The latter are better captured by individual's occupation (Bacolod et al., 2009; Florida et al., 2012). Different types of skills generate different impacts not only on territorial

⁹ We used the 1999/2000 release, as the EVS database is updated every 10 years and we wanted to create a predetermined variable for our analysis. Moreover we believe that territorial capital components are stable in the short and medium run.

performance but also on the ability of localities to reap the potential benefits generated by the presence of foreign firms. Cognitive skills are more important in adapting to changes and in the adoption of new technologies than physical skills, while creativity and managerial competencies are fundamental in further improving innovation abilities. Therefore, we build on an indicator of human capital by aggregating measures of cognitive skills (share of scientists and professionals on total local employment), managerial skills (share of corporate and SME managers on total local employment) as well as creativity, proxy by the level of R&D expenditures on regional value added. The component identified by the PCA explains about 67 percent of total variance of the underlying factors.

Table 2. Estimates of Intangible components of territorial capital (Principal component analysis)

Variable	Factor loadings	Variable	Factor loadings
<i>Human Capital</i>		<i>Generalized morality</i>	
R&D expenses (% of GDP)	0.60	claim state benefits	0.44
Share of Scientist and Professionals	0.63	cheat on taxes	0.45
Share of rural population	-0.49	pay cash	0.47
Eigenvalue	1.99	Eigenvalue	2.81
Proportion	0.67	Proportion	0.47
<i>Closed Social capital</i>		<i>Relation capital</i>	
Confidence (companies)	0.41	Voluntary association	0.49
Attitude towards immigrants	0.59	voluntary work	0.61
national identity	-0.42	Social activities	0.62
trust (people)	0.55		
Eigenvalue	1.87	Eigenvalue	0.49
Proportion	0.47	Proportion	1.47

Source: Own estimation

3.2. FDI, growth and territorial capital in EU regions: first evidence

In order to provide a first picture on the potential interplay of foreign firms and territorial capital components, we grouped EU regions according to the presence of FDI and the relative endowment of territorial capital. For sake of clarity and abbreviation, we considered EU regions with a number of foreign firms above or below the EU median and with an endowment of each territorial capital components describe above, above or below the EU median. Then we computed averages growth rates within each group of regions. Results are shown in Table 3.

Several interesting facts emerge from this exercise. First of all, FDI *per se* does not ensure higher growth rates. In fact, regions with a concentration of foreign firms above the EU median do not enjoy, on average, a growth rate higher than that of regions with a concentration of foreign firms below the EU median. This confirms the idea that FDI-induced spillovers may be offset by local factors.

Secondly, the contribution of territorial capital to economic growth is quite ambiguous: Table 3 shows a negative relationship between closed social capital and growth, and a positive relationship between relational capital and regional growth. This implies that regions with levels of relational capital above the EU median and levels of closed social capital below the EU median are able to grow faster than other regions, as suggested by theoretical predictions. As for the other two soft components of territorial capital,

Table 3. FDI, growth and territorial capital: descriptive evidence

	Foregin firms		
	below EU median	above EU medium	Total
Human capital			
<i>below EU median</i>			
Average growth rate	3.74	3.30	3.69
st. dev.	2.29	1.46	2.20
n. of obs.	78	12	90
<i>above EU median</i>			
Average growth rate	3.29	3.30	3.29
st. dev.	1.69	1.92	1.77
n. of obs.	74	43	117
Closed social capital			
<i>below EU median</i>			
Average growth rate	3.63	3.82	3.68
st. dev.	2.47	1.73	2.31
n. of obs.	73	23	96
<i>above EU median</i>			
Average growth rate	3.42	2.92	3.28
st. dev.	1.51	1.81	1.61
n. of obs.	79	32	111
Generalized morality			
<i>below EU median</i>			
Average growth rate	3.81	3.09	3.59
st. dev.	2.41	2.06	2.32
n. of obs.	63	27	90
<i>above EU median</i>			
Average growth rate	3.32	3.50	3.36
st. dev.	1.70	1.56	1.66
n. of obs.	89	28	117
Relation capital			
<i>below EU median</i>			
Average growth rate	3.32	3.97	3.43
st. dev.	2.01	2.24	2.05
n. of obs.	85	18	103
<i>above EU median</i>			
growth rate	3.78	2.97	3.49
st. dev.	2.04	1.50	1.90
n. of obs.	67	37	104
Total			
Average growth rate	3.52	3.30	3.46
st. dev.	2.03	1.82	1.97
n. of obs.	152	55	207

Source: Own elaboration

they do not seem able to foster economic growth, all other things kept constant. These more counterintuitive results may reflect several phenomena. First of all, a region may possess high level of generalized morality but also high level of closed social capital and the negative impact of the latter may be

stronger than the positive one of former. Secondly, severe regulations and an excessive burden of bureaucracy may favour free-riding behaviours, thus preventing generalized morality to exert its beneficial effects on economic growth. Thirdly, growth rates reported in Table 3 are averages across all EU regions; therefore they may hide potential differences across space. For example, the impact of human capital on economic growth is stronger in regions of Central and Eastern Europe than in regions of old EU15 member states, but the former represent only a small fraction of the whole sample and, mainly, of EU regions with an endowment of human capital above the EU median (see Table A2.1 in Appendix 2).

The picture becomes even more ambiguous when the interplay between FDI and soft components of territorial capital are considered simultaneously. As expected, FDI-induced growth effects are stronger with low levels of closed social capital and high levels of generalized morality. These results are consistent with theoretical predictions, according to which high levels of closed social capital make the embeddedness of foreign multinationals into the local economy more difficult, while high generalized morality, by lowering contractual costs, information costs and transaction costs and favouring mutual trust makes it easier.

As for relational capital, the empirical evidence indicates that, on average, it prevents local economies to reap benefits from FDI. This may be due to the fact that network effects, being based on shared norms and behaviour codes, arose only between local agents. Relational capital, therefore, contributes to increase interpersonal distance between indigenous economic agents and foreign firms, making co-operation and the transmission of FDI-induced spillovers difficult.

Also human capital does not seem able to help local economies to maximize the benefits generated by foreign firms. As shown by Table 3, the impact of FDI on growth is the same, regardless of the endowment of human capital. This result may reflect high levels of formal education, but low levels of creativity and entrepreneurship, as well as geographical specificities. As Table A2.1 in Appendix 2 reveals, the interplay between FDI and human capital is very strong in regions of EU12 new member states and rather weak in regions of old EU15 member states.

Overall, these findings confirm the idea that FDI may enhance economic growth and that soft component of territorial capital may act as a filter in the FDI-growth relationship, since they can magnify or hamper FDI-induced spillovers. The next section is devoted to disentangle this puzzle.

4. Empirical strategy

4.1 The model

In order to model the interplay between FDI, growth and territorial capital we start from a simple Cobb-Douglas regional production function, with two standard production inputs, i.e. physical capital (K) and employment (L):

$$Y_{r,t} = AK_{r,t}^{\alpha} L_{r,t}^{\beta} \quad (1)$$

where subscripts indicate regions r and the considered time (t), α and β parameters to be estimated and A represents Total Factor Productivity (TFP), i.e. all those factors different from capital and employment that can affect the level of output. Following previous discussion, we assume that FDI is able to enhance growth through indirect (spillovers) effects rather than directly. This implies that FDI does not enter directly the production function, but only indirectly through its potential effects on Total Factor Productivity, i.e. parameter A :

$$Y_{r,t} = e^a e^{\gamma FDI_{r,t}} K_{r,t}^{\alpha} L_{r,t}^{\beta} \quad (2)$$

or, in log-linear form:

$$y_{r,t} = \alpha k_{r,t} + \beta l_{r,t} + \gamma FDI_{r,t} + a \quad (3)$$

where lower-case letters indicate the log-form of original variables. Note that this form FDI enters as an additive term and not as a multiplicative term. This implies that regional production is not necessarily driven to zero if no FDI takes place.

Equation (3) needs to be modified in order to take into account the potential effects of territorial capital (Capello et al., 2011). The latter may act as a catalyst for FDI spillovers, enhancing or daunting their effects on the general level of TFP. In formal terms, this implies that the coefficient of FDI, γ , depends on territorial capital endowments, tc_r , in the following way:

$$\gamma = \gamma_0 + \gamma_1 tc_r \quad (4)$$

so that the explicit form of equation (3) becomes:

$$y_{r,t} = \alpha k_{r,t} + \beta l_{r,t} + \gamma_0 FDI_{r,t} + \gamma_1 tc_r FDI_{r,t} + a \quad (5)$$

By first differentiating eq. (5), the relationship between FDI and regional growth becomes more explicit:

$$\Delta y_{r,t} = \alpha \Delta k_{r,t} + \beta \Delta l_{r,t} + \gamma_0 \Delta FDI_{r,t} + \gamma_1 tc_r \Delta FDI_{r,t} \quad (6)$$

For technical reasons, we augmented eq. (6) with territorial capital indicators, country dummies (c_i) and sector controllers (ss_j) in order to capture the direct contribution of territorial capital to economic growth, as well as country and sector specific effects that may further affect the relationship between FDI, growth and territorial capital:

$$\Delta y_r = \alpha \Delta k_r + \beta \Delta l_r + \gamma_0 \Delta FDI_r + \gamma_1 tc_r \Delta FDI_r + tc_r + c_i + ss_j \quad (7)$$

Eq. (7) indicates that increases in regional production capacity depend on capital and employment accumulation as well as FDI-induced spillovers, whose final effect may be magnified or reduced by territorial capital, as indicated by the interaction term. Soft components of territorial capital are expected to facilitate foreign firm operations in the host locations, improving the transmission of spillovers to indigenous firms and their capacity to benefit from them.

4.2 Data and methodological issues

The empirical analysis presented in this section is based on different sources of data. Data on production, physical capital and labor accumulation derive from Eurostat regional database. In particular, as a dependent variable we use gross regional value added measured at basic prices, while physical capital stock has been estimated by perpetual inventory method.¹⁰ Growth rates have been computed at nuts2 level and refer to the period from 2005 to 2007.

As a proxy for FDI spillovers we use the number of newly created foreign firms established in each EU27 region during the period 2005-07. Different measures for FDI, from total number of FDI to more disaggregated variables which distinguish between sectors of economic activity (manufacturing vs. services) have been used.

Territorial capital indicators, instead, are dichotomous variables that assume value 1 if the region has an index above the European median value and 0 otherwise. These dummy variables are the four components of the tc_r variable defined in equation (6).

Sectorial controllers are dummy variables taking the value of one if a region is specialized in manufacturing activities and 0 otherwise.¹¹

Eq (7), the baseline specification, has been further augmented by including the initial GDP level in a “convergence-like” framework since persistency of FDI flows over time and their potential contribution to GDP may create endogeneity problems.

Other two possible sources of endogeneity are reverse causality and omitted variables: do foreign investors select more dynamic regions as best destinations of their investments because they anticipate higher

¹⁰ Note that, when using the perpetual inventory method, the sum of depreciation rate of capital and growth rate of capital investment is constant over time.

¹¹ In order to understand whether an EU region is specialized in manufacturing activities, we applied the traditional formula for location quotients, using the EU as a benchmark and employment as unit of measure.

future profits, or do regional growth rates depend directly on the contribution of foreign investors? The literature that studied this relationship at country level does not provide a definitive answer.¹² This source of endogeneity, however, could be absent or negligible in a regional perspective, given that foreign investors locating in any of the European regions are more likely to be interested in the whole EU market rather than in the local one, which is surely too small for their profit objectives (Mariotti and Piscitello, 1995). However, there might be some of region or foreign firm unobservable time constant characteristics, usually captured by the error term, may also bias the estimators due to a correlation with FDI and thus with one of the interacted terms ($(tc_r \Delta FDI_r)$). To solve the problem of FDI variable and the interacted terms potential endogeneity, an appropriate measure for FDI which is not related to economic growth is needed. We proposed the following sets of potential instruments:

- A time lagged FDI variable, i.e. the number of foreign firms established in each EU regions during the 1997-1999 period, i.e. eight year before the considered period.
- Two spatially lagged FDI variables, i.e. the distance-weighted sum of FDI inflows – during the 2005-2007 period – in those regions that share a border with neighboring regions of the region of interest. We excluded immediate neighbors and considered only second and third-order contiguous regions.

While using FDI lagged over time as instrument is quite standard, being FDI flows persistent over time, spatial lagged instruments deserve further explanations. Foreign firms in one location may be correlated with foreign firms in other locations since multinational firms tend to delocalize different production stages in different locations in order to exploit input price differences and take advantage of specific location advantages in each stage of the production chain. Moreover, given the size of the EU market, multinational firms may find profitable to set up multiple production plants in Europe in order to minimize transportation costs. Also, FDI-induced spillovers tend to be localized; this implies that regions' growth rate may be affected by foreign firms located within each region or, at last, in immediate neighboring regions, which however have not been considered in the spatially lagged instruments. As explained later on in this paper, these variables proved to be good instruments.

Apart from this endogeneity-related aspect, another important concern is the possible heteroskedasticity and spatial autocorrelation that regional data often display. We will address this issue by controlling for the specific structure of the variance and covariance matrix of the error terms. Therefore, statistics presented later on are robust to heteroskedasticity, while no evidence of residual spatial autocorrelation arose from spatial diagnostics (see Table A2.2 in Appendix 2).

5. Results

Table 4 shows the estimated results of the general model, i.e. eq. (3), with and without the FDI variable. Results confirm that, aside from the effect of accumulation of input factors, spillovers from foreign firms play an important role in European regions. Eq. (3) has been augmented to include also the level of GDP at the beginning of the period. This term has been introduced in order to control for possible endogeneity derived from the persistence characterizing the FDI variable. Indeed, if FDI flows are driven by agglomeration economies and, at the same time, they contribute to the GDP of the region in every period, it is possible that this self-reinforcing process cause endogeneity. Note also that the coefficient of GDP variable is negative but not significant, confirming a pattern of convergence at regional level in Europe, that has been widely discussed both at the academic and at the institutional level. Both region's specialization and urbanization economies are able to affect regional growth rates, though in different direction. Regions specialized grow faster than non-specialized regions, while growth rates in rural regions are smaller than those reported by more urbanized regions.

¹² The existence of a reciprocal relationship between FDI and growth is confirmed by Choe (2003) and Chowdhury and Mavrotas (2006), while Feridun and Sissoko (2006) find that, according to Singapore's experience, it is growth to determine FDI. An opposite result has been found by Zhang (2001) and partially by Chowdhury and Mavrotas (2006).

Table 4. Estimation results: general model

	b/t	Eq. (3) b/t
l_empl3	9.835***	9.262***
	4.18	4.09
l_gfcapf3	0.915**	0.857**
	2.23	2.17
LiGDP3	-0.066	-0.299
	-0.24	-1.02
specS_3	0.263*	0.263*
	1.72	1.76
specM_3	0.240*	0.267*
	1.67	1.86
area	0	0
	-0.24	-0.33
capital3	0.197	0.268
	1.15	1.59
rurality_index	-0.026*	-0.027*
	-1.66	-1.72
tot_FDI_t3		0.088***
		3.31
_cons	3.292	5.649*
	1.23	1.97
country dummy	yes	yes
N	209	209
r2	0.64	0.65

***, **, * indicate significance at one, five and 10 percent level, respectively.

As argued in the previous section, an additional source of endogeneity could originate from possible reverse causality or to omitted variable bias. For this reason, eq. 4 has been estimated using an instrumental variable approach. In so doing, we use the *ivreg2* STATA routine and partial out country fixed effects and regional specialization variables.¹³

Summary results for the first stage regressions are reported in the Appendix. The diagnostic confirms that the instruments respect the exogeneity and relevance assumptions. Moreover note that the endogeneity test implemented by *ivreg2* does not reject the null hypothesis of regressors' exogeneity, indicating that the FDI variable could be treated as exogenous. This confirms the idea that foreign investors locating in European regions are not interested in the local market directly because it is too small for their industrial objectives. Given that instrumental variable estimation at worst implies a loss of efficiency in estimates with respect to OLS, but it guarantees the consistency of results, all subsequent models have been estimated using instrumental variables, notwithstanding the result of the endogeneity test.

At this point it is interesting to inspect more in detail which types of FDI are more relevant for local economic development. To this aim, we separate FDI inflows on the basis of economic activity:

¹³ The Frisch-Waugh-Lovell theorem (Frisch and Waugh, 1933, Lovell, 1963) demonstrate that regressing Y a set of exogenous regressors X1 and on other regressors X2 is equivalent to projecting Y and X2 on the orthogonal complement of the space spanned by the columns of X1 and then regressing such projections of Y on those of X2.

manufacturing (medium-high and high-tech vs. medium-low and low-tech manufacturing sectors) versus services (business services). Results are presented in table 4, which confirms that all foreign firms offer a positive contribution to local growth, regardless of their sectors of activity.

Table 4. Estimation results: different types of foreign firms

	(1) b/t	(2) b/t	(3) b/t	(4) b/t
tot_FDI_t3	0.118*** 2.73			
l_empl3	9.065*** 4.39	9.447*** 4.32	9.253*** 4.22	9.067*** 4.35
l_gfcapf3	0.837** 2.3	0.890** 2.37	0.909** 2.42	0.835** 2.3
LiGDP3	-0.379 -1.27	-0.329 -1.1	-0.393 -1.25	-0.389 -1.4
area	0 -0.39	0 -0.56	0 -0.61	0 -0.35
capital3	0.293* 1.82	0.255 1.6	0.265* 1.65	0.318** 1.97
rurality_index	-0.027* -1.87	-0.024* -1.69	-0.023* -1.7	-0.028* -1.92
HMTfdi		2.755** 2		
MLTfdi			3.015*** 2.76	
BSfdi				0.223*** 2.7
N	209	209	209	209
r2	0.185	0.171	0.165	0.181

***, **, * indicate significance at one, five and 10 percent level, respectively.

The next and final step concerns the analysis of possible interplay between FDI and soft components of territorial capital. Results are presented in Table 5. Two interesting features emerge. First of all, soft components of territorial capital do not seem *per se* able to improve growth rates, since the estimated coefficients of the corresponding variables are never significant. Despite that, it is worth noting that, as expected, the estimated coefficient of human capital is always positive, while that of closed social capital is always negative. Relation capital is negative in case of high-tech foreign firms and positive for both low-tech and business service foreign firms. This indicates that high-tech foreign firms have more difficulties in entering local networks than low-tech foreign firms or business service foreign providers. Quite surprisingly, the estimated coefficient of general morality is always negative, though not significant. Secondly, when territorial capital components are considered, the FDI variable is no longer significant. This indicates that local and global drivers of growth are not complement. Rather, some components of territorial capital can completely offset positive effects on growth generated by FDI. These results are likely to depend on high level of closed social capital and relational capital, which make cooperation between local agents and foreign firms very difficult. Finally, it is worth noting that only generalized morality is able to magnify FDI-induced spillovers, as indicated by the coefficient of the interacted term, which is positive and significant at the conventional levels in every specification. This implies that a widespread sense of

generalized trust and low free-riding attitudes increase efficiency of transaction and effectiveness of cooperation between multinational and the regional economic system. As for the other soft components of territorial capital, this interaction effect is totally absent.

Table 5. FDI and territorial capital

	MHT FDI b/t	MLT FDI b/t	BS FDI b/t
I_empl3	9.471***	8.428***	9.146***
	4.57	3.79	4.77
I_gfcapf3	0.713**	0.771**	0.751**
	2.13	2.14	2.21
LiGDP3	-0.206	-0.228	-0.29
	-0.64	-0.64	-0.84
SCr	-0.009	0.013	-0.015
	-0.09	0.14	-0.16
SCC	-0.196	-0.098	-0.16
	-1.4	-0.7	-1.06
SCgm	-0.026	-0.103	-0.014
	-0.32	-1.04	-0.19
HC	0.107	0.094	0.082
	0.59	0.53	0.59
area	0	0	0
	-0.2	-0.19	-0.32
capital3	0.255	0.241	0.284*
	1.57	1.52	1.81
rurality_index	-0.019	-0.019	-0.02
	-1.38	-1.38	-1.63
FDI	-7.628	-5.935	-4.923
	-0.71	-0.75	-1
SCr_fdi	0.084	-0.945	-0.298
	0.04	-0.49	-1.18
SCC_fdi	0.967	-2.3	-0.439
	0.26	-0.61	-0.4
SCgm_fdi	4.734**	7.039**	1.440**
	2.12	2.53	2.13
HC_fdi	4.5	4.191	4.344
	0.46	0.64	1.01
N	209	209	209
r2	0.193	0.165	0.221

***, **, * indicate significance at one, five and 10 percent level, respectively.

4. Conclusions

The aim of this paper is to evaluate the growth effect of FDI at the regional level, introducing the idea that development patterns can be very heterogeneous depending on the variety of European regional identities.

The latter are measured along several dimensions, identifying four soft components of territorial capital: relational capital, generalized morality or trustworthiness of citizens, cultural closeness of a region and human capital endowment. Generally speaking, results confirm that FDI can enhance economic growth at the regional level, but they also suggest that this relationship is far from being a deterministic cause-effect link. Indeed, the impact of FDI is constrained by regions' socio-economic characteristics, and mainly by their territorial capital. In particular our findings show that local returns of FDI are boosted by high level of trustworthiness, while other types of territorial capital have negative effects on FDI-growth relationship, offsetting the potential beneficial effects of foreign firms.

Needless to say, these results are preliminary and need to be confirmed by further explorations. The latter concern both methodological and measurement aspects, such as the definition of alternative measures for territorial capital, as well as the introduction of time patterns into the analysis. Without these insights it is quite difficult to draw lessons and recommendations for policy makers. Given the present results, in order to reap positive FDI-induced spillovers, it is necessary to make soft components of territorial capital more open to external social and cultural contributions.

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Appendix 1 : Representativeness of the sample

FDIregio database has been built up starting from Amadeus, an electronic product by Bureau Van Dijk consisting of company accounts reported to national statistical offices by about 11 million public and private companies in 41 European countries. For each company Amadeus provides the year of incorporation, the ownership structure by nationality, the address, as well as the sector of activity. Firms newly created during the 2005-07 period whose percentage of assets owned by non-residents was at least 10% have been considered as foreign. Then they were aggregated in each European NUTS2 region by sector and by origin within or outside Europe. The overall sample includes 264 NUTS2 regions and 25 NACE1 manufacturing and service sectors. A limitation of these data for studying the geographical patterns of foreign firms is that they include firm level information. This can potentially bias the location of FDI in favour of regions and/or countries where headquarters tend to locate. In order to have an idea of the magnitude of such a bias, we compared FDIregio dataset first with the well-known fDiMarkets – a database compiled by Financial Times Business tracking crossborder greenfield investment projects – and, then, with official (UNCTAD) inward FDI flows across EU country. The Pearson correlation coefficient between FDIregio data on the total number of newly created foreign firms in European NUTS2 regions and fDiMarkets data on greenfield investment projects is 0.81, significant at 0.01 level, while that between the distribution of FDI inflows and the number of foreign firms at country level is a bit higher, 0.88, always significant at 0.01 percent.¹⁴ Thus, by considering number of foreign firms instead of values of FDI we do not introduce any significant distortion in the patterns of FDI.

Appendix 2: Further Statistics

Table A2.1 FDI, growth and human capital: geographical distribution

	EU15			EU12		
	FDI below EU median	FDI above EU median	Total FDI	FDI below EU median	FDI above EU median	Total FDI
<i>HC below EU median</i>						
growth rate	2.85	3.05	2.87	5.53	4.55	5.46
st. dev.	1.14	1.47	1.19	2.93	0.19	2.83
n. of obs.	52	10	62	26	2	28
<i>HC above EU median</i>						
growth rate	3.06	2.86	2.99	5.45	6.6	5.93
st. dev.	1.17	1.36	1.24	3.67	2.45	3.14
n. of obs.	67	38	105	7	5	12
<i>Total Human capital</i>						
growth rate	2.97	2.9	2.95	5.52	6.01	5.6
st. dev.	1.16	1.37	1.22	3.04	2.24	2.89
n. of obs.	119	48	167	33	7	40

Source: Own calculation

¹⁴ The comparison does not include Romania. Pearson coefficients drop respectively to 0.62 and 0.65, though still significant at 0.01 level, if we include Romanian data. This is likely due to a different classification of firms' balance sheets in this country. This problem with Romanian data is confirmed by the comparison with official UNCTAD. Because of this reason we exclude Romania from our analysis.

Table A2.2 Spatial diagnostics

	statistics	p-value
<i>Spatial error:</i>		
Lagrange multiplier	0.175	0.675
Robust Lagrange multiplier	3.696	0.055
<i>Spatial lag:</i>		
Lagrange multiplier	0.367	0.544
Robust Lagrange multiplier	3.888	0.049

Table A2.3 First stage

Appendix 3. Perpetual Inventory Method

The perpetual inventory method defines the mechanism of capital formation as the following formula:

$$K_t = (1 - \delta_K)K_{t-1} \left(\frac{P_t}{P_{t-1}} \right) + I_t$$

Where P is the industry-level capital goods deflator, K represent capital stock and I investment, while δ_K is the depreciation rate of capital.

Assuming δ_K is constant over time, and that capital investments I grow at a constant rate g so that

$$I_t = (1 + g)I_{t-1}$$

it is possible to derive recursively a direct relation between capital stock and investment in the following way¹⁵:

$$K_t = I_t \sum_{i=0}^{+\infty} \left(\frac{P_t}{P_{t-1}} \right)^i \left(\frac{1 - \delta_K}{1 + g} \right)$$

So the physical capital stock ratio can be defined as

$$\frac{K_t}{K_{t-1}} = \frac{I_t \sum_{i=0}^{+\infty} \left(\frac{P_t}{P_{t-1}} \right)^i \left(\frac{1 - \delta_K}{1 + g} \right)}{I_{t-1} \sum_{i=0}^{+\infty} \left(\frac{P_{t-1}}{P_{t-2}} \right)^i \left(\frac{1 - \delta_K}{1 + g} \right)}$$

or

$$\frac{K_t}{K_{t-1}} = \frac{I_t}{I_{t-1}}$$

Thus, the physical capital stock ratio can be approximated by the ratio of capital investment if I assume sufficiently constant depreciation rate and growth rate of investments and stable inflation rate.

¹⁵ Assuming that inflation is stable, i.e. the ratio of the price level over two periods is constant over time. In the context of the EU in the years we consider (2005-2007) this assumption holds.